Public Health Assessment for

KERR–MCGEE CHEMICAL CORPORATION
(a/k/a Tronox, Inc.)
COLUMBUS, LOWNDES COUNTY, MISSISSIPPI
EPA FACILITY ID: MSD990866329
JUNE 12, 2014

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. The revised document was released for a 90-day public comment period. Subsequent to the public comment period, ATSDR will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

PUBLIC HEALTH ASSESSMENT

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(a/k/a Tronox, Inc.)
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EPA FACILITY ID: MSD990866329

Prepared by:

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SUMMARY

Introduction

The Agency for Toxic Substances and Disease Registry's (ATSDR) top priority is to ensure that the people in the community surrounding the Kerr-McGee Chemical Corporation (Kerr-McGee) in Columbus, Lowndes County, Mississippi, have the best information possible to safeguard their health.

While operational from 1928 to 2003, the Kerr-McGee company manufactured pressure-treated wood products. The production processed at the site utilized creosote and creosote coal tar solutions to produce pressure-treated wood products. The facility also used pentachlorophenol for wood-treating from the 1950s until the mid-1970s.

This public health assessment (PHA) will describe ATSDR's public health activities at the Kerr-McGee site and will provide the Agency's opinion about the public health significance of exposure to chemicals at the site. ATSDR prepared this PHA in response to a petition received by citizens of Columbus, Mississippi. The petitioners were concerned about potential health effects from exposures to hazardous substances associated with the Kerr-McGee facility. The Kerr-McGee Chemical Corporation was added to EPA's National Priority List (NPL) in September 2011.

ATSDR staff evaluated available environmental data about hazardous substances in soil, sediment, and surface water on or near the Kerr-McGee facility to determine whether exposures are occurring and whether health effects could result from those exposures. The PHA lists actions, as needed, to be taken to protect the public's health.

The public comment version of this PHA was released in September 2008. ATSDR received numerous comments from the public and other third parties. Comments received during the public comment period are addressed in Appendix E in this document.

Conclusions

After evaluating the available data, ATSDR reached seven major conclusions in this public health assessment.

Conclusion 1

ATSDR concludes that contact with dioxin in surface soil in some residential yards could harm people's health if exposed for many years. This is a current public health hazard.

Basis for Conclusion Surface soil samples collected from residential yards in 2010 and 2011 revealed the presence of 2,3,7,8-TCDD (dioxins) at levels that might cause children to experience non-cancer health effects if exposure occurs for many years.

The above conclusion was based on limited residential yard sampling. EPA plans to conduct additional sampling in residential yards to determine the full nature and extent of contamination in yards. The results of the new sampling data will assist with evaluating exposures and determining potential harmful effects. ATSDR will update our conclusion after reviewing the additional residential yard sampling results.

Next Steps ATSDR recommends that proper measures be taken to reduce dioxin exposures to soil in residential yards or public places where the levels represent a hazard.

Conclusion 2 ATSDR concludes that frequent contact with contaminated sediment in neighborhood ditches could harm people's health. This was a past public health hazard; current public health implications could not be determined because of the lack of data.

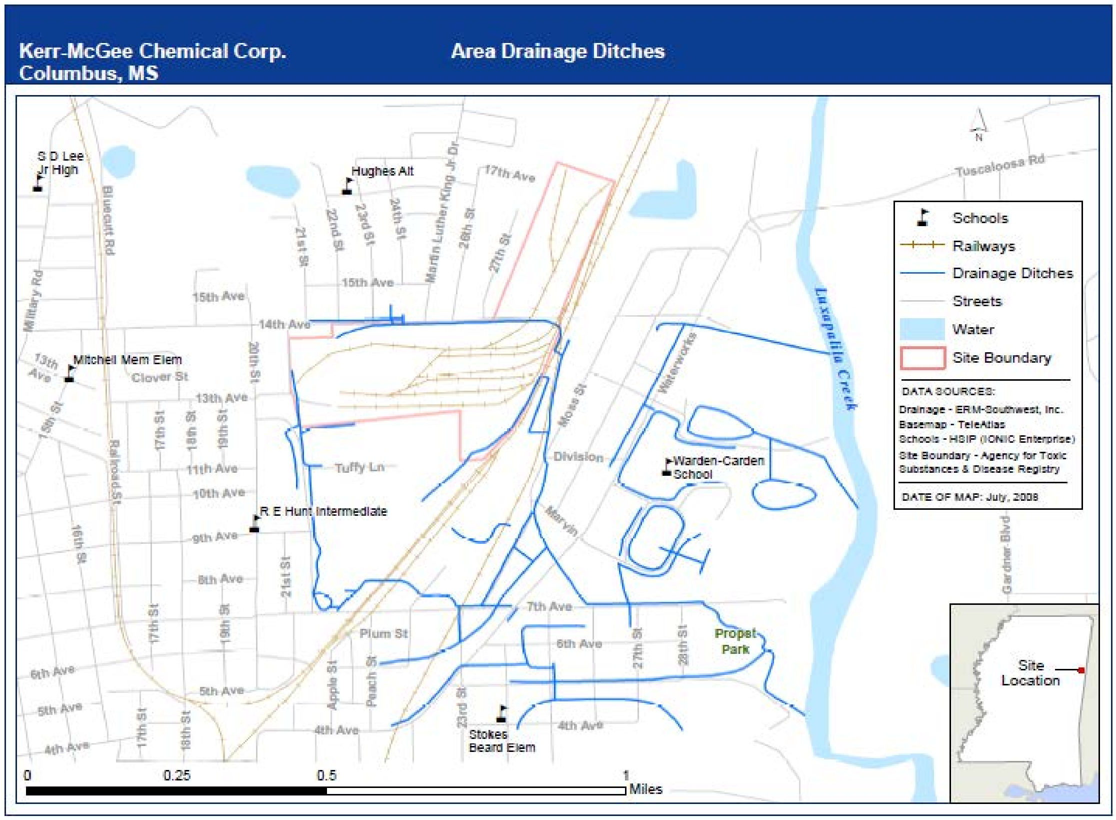
Basis for Conclusion Sediment samples collected from the ditches near the Kerr-McGee facility from 1996 to 2002 revealed the presence of PAHs at levels high enough to cause a moderate increased risk of cancer (skin and stomach cancers). This conclusion is based on residual contamination levels after the removal activities in 2004 – 2009, but before the erosion and flood events of 2010. The erosion and flooding might have caused the contamination in the ditches to migrate to other locations, or it might have moved new contamination into the ditches.

Note: EPA conducted limited additional sediment sampling in April 2010. The 2010 sampling data did not reveal PAH levels high enough to harm people's health. However, the April 2010 sampling data are limited and may not represent contaminant levels throughout the larger drainage ditch system.

Next Steps ATSDR recommends that proper measures be taken to reduce or eliminate human exposures to contaminants in sediments near the facility and in the nearby community. Remove/contain on-site sources that contribute to off-site migration of contaminants, and off-site soils/creosote-contaminated materials that people might contact as a result of erosion, digging, or other excavation activities.

Conclusion 3	ATSDR concludes that there is not enough information to determine current contaminant levels in the drainage ditches in the community.
Basis for Conclusion	The conclusion regarding the health hazards from exposure to sediment in ditches is based on sampling conducted between 1999 to 2002. Sampling conducted in April 2010 did not reveal concentrations of contaminants at levels high enough to harm people's health. However, the data were limited in nature and scope. For example, ATSDR did not have dioxin sampling results for the sampling event. Flooding and erosion may cause contaminants to migrate to and within the ditches. Lack of data from throughout the drainage ditches does not allow full characterization of exposures. Therefore, current conditions could not be accurately assessed.
Next Steps	ATSDR recommends additional sampling to determine the nature and extent of contamination to the community drainage ditches. Take proper measures to prevent access to impacted drainage ditches.
Conclusion 4	ATSDR concludes that past contact with sediments in the 14th Avenue drainage ditch will not harm people's health. This conclusion does not apply to other ditches throughout the community. However, ATSDR believes it prudent to take measures to reduce contamination in the 14th Avenue Ditch to limit migration of contaminants to the larger drainage ditch system.
Basis for Conclusion	In July and September 2012, EPA collected sediment samples as part of an interim remedial investigation (RI) at the 14th Avenue Ditch Area. The levels of contaminants in the ditch were too low to harm people's health. The 14th Avenue Ditch Area is an approximately 1,830-foot long stormwater ditch adjacent to the Kerr-McGee facility along the northern border. The 14th Avenue Ditch Area is part of an improvement project for the area. The City has proposed to relocate the existing stormwater ditch between 14th Avenue and the Kerr-McGee facility so that 14th Avenue can be widened and a new ditch with a concrete culvert can be installed. These actions will reduce drainage flow in the ditch and limit contaminant migration to the greater off-site ditch system.

The 14th Avenue Ditch Area is only part of a larger drainage system in the community (See figure below). As mentioned above, additional sampling is needed to evaluate current conditions and to determine the nature and extent of contamination throughout the greater drainage ditch system.



Conclusion 5 ATSDR concludes that occasional trespassing on the Kerr-McGee property (on-site) is not expected to harm people's health.

Basis for Conclusion The typical trespasser is assumed to begin trespassing on the facility property as an adolescence and to continue into adulthood. The trespasser scenario assumes that the trespassing events occur at a frequency of 2 times per week for a total of 30 years. A trespasser's exposure to PAHs, dioxin and PCP in on-site soil is not expected to cause harmful cancer or non-cancer health effects.

However, additional disturbance of on-site soils is likely to occur in the future. ATSDR recommends that people not trespass on the facility property and that efforts be maintained to prevent trespassing on the facility property.

Next Steps ATSDR recommends that proper measures be taken to ensure that people are not exposed to on-site contamination, including but not limited to, maintaining the existing perimeter fencing.

Conclusion 6 ATSDR concludes that students who played on the athletic field at Hunt Intermediate School are unlikely to experience harmful health effects.

Basis for Conclusion The levels of dioxin and PAHs detected in the soil of the athletic field were too low to cause harmful health effects in students.

Cleanup activities have already been completed at the Hunt Intermediate School athletic field. The soil excavation activities at the athletic field should reduce exposures to students.

Conclusion 7 ATSDR concludes that frequent exposure to the creosote waste pile on the property of the Maranatha Faith Center could have harmed people's health. This was a past public health hazard.

Basis for Conclusion A person exposed to the creosote waste pile for 13 years (the amount of time the pile was uncovered and unsecured) might experience dermatological effects and a moderately increased excess cancer risk.

In February 2011, EPA excavated and disposed of approximately 30 tons of contaminated soil from the church property. After the waste material was removed, the contaminant levels were lower. The lower contaminant levels no longer pose a public health hazard.

More Information You can call ATSDR at 1-800-CDC-INFO for more information on the Kerr-McGee Chemical Superfund Site in Columbus, Mississippi.

PURPOSE AND HEALTH ISSUES

The purpose of this document is to describe ATSDR's public health assessment activities at the Kerr-McGee Chemical Corporation Superfund Site (aka Tronox, Inc.) and to provide the Agency's opinion about the public health significance of exposure to chemicals at the site. A public health assessment (PHA) is a document prepared after an evaluation of pertinent environmental data, community concerns, and when appropriate, health outcome data, to determine whether people have been, are being, or will be exposed to hazardous substances, and if so, whether those exposures are harmful. If the exposure is harmful, ATSDR will recommend actions to prevent or reduce those exposures.

ATSDR prepared this PHA in response to a petition received from citizens of Columbus, Mississippi. The petitioners were concerned about potential health effects from exposures to hazardous substances associated with the Kerr-McGee Chemical Corporation. This health assessment evaluates available environmental data about hazardous substances in soil, sediment, and surface water on or near the Kerr-McGee facility to determine whether exposures occurred and whether health effects are expected to result from these exposures.

The public comment version of this PHA was released in September 2008. ATSDR received numerous comments from the public and other third parties. Comments received during the public comment period are addressed in Appendix E in this document.

The public comment PHA was prepared using data available at the time. At that time, a full evaluation of the nature and extent of off-site contamination had not been completed. One of the recommendations in the public comment PHA was for additional characterization of off-site areas to further define the nature and extent of contamination near the site. EPA conducted additional off-site surface sampling in 2010, 2011 and 2012 in residential and other public areas. The new sampling data are evaluated in this document.

In 2010, the Environmental Protection Agency (EPA) announced that it was proposing the Kerr-McGee Chemical site to the National Priorities List (NPL) list of hazardous waste sites. In September 2011, EPA added the Kerr-McGee Chemical site to the NPL.

BACKGROUND

Site Description and Operational History

The Kerr-McGee Chemical Corporation, Forest Products Division (herein referred to as Kerr-McGee), now known as Tronox Inc., owns a wood-preserving facility at 2300 North 14th Avenue in Columbus, Lowndes County, Mississippi. Kerr-McGee purchased the facility from Moss American Corporation in 1964. The site occupies approximately 90 acres. The facility was operational from approximately 1928 to 2003 [1]. It is now closed.

While operational, Kerr-McGee manufactured pressure-treated railroad products such as wooden crossties, switch ties, and timbers. The production processes at the site utilized creosote and creosote coal tar solutions to produce pressure-treated wood products. The facility also used pentachlorophenol (PCP) for wood-treating from the 1950s until the mid-1970s [2]. As part of facility operations, the facility generated hazardous waste regulated under the Resource Conservation and Recovery Act (RCRA). Past operational practices at the facility caused hazardous materials to be released to the environment. These historical releases have impacted local groundwater and off-site soils and sediments [1].

Demographics and Land Use

Figure 1 displays the site map with basic demographic information about the community near the Kerr-McGee facility. According to data from the 2010 U.S. Census, approximately 7,527 people live within one mile of the Kerr-McGee site. Within the one mile radius, approximately 732 persons are children aged 6 or younger. Approximately 1,038 persons are aged 65 or older. Approximately 1,567 are women between the ages of 15 to 44.

A mix of residential, commercial and industrial properties surrounds the facility. Six public school sites are located within approximately one mile of the facility (See Figure 2). The nearest school is Hunt Intermediate School. Hunt Intermediate is located southwest of the site. The school has approximately 863 students in grades 5 through 6 [3]. The other schools located within approximately one mile of the site are Stokes Beard Elementary School, S.D. Lee Jr. High School, Hughes Alternative School, Mitchell Elementary, and Warden-Carden School. Approximately 16 daycare facilities are located within one mile of the site [4].

Natural Resources

<u>Groundwater</u>

Underlying the Kerr-McGee facility are three aquifers [6]. The geology underneath the site consists of quaternary age alluvial deposits consisting of interbedded clays, silts, sands, and gravels that are generally coarser with depth. The thickness of the alluvium averages about 25 feet in the area of the Kerr-McGee facility. Groundwater flow in the alluvium was determined to be in a south-easterly direction [6]. Underlying the alluvium is the Eutaw Formation, which is composed of two members. The uppermost member is the Tombigbee Sand; the lower is referred to as the “typical” Eutaw [7,8]. The Tombigbee is a fine, medium-grained, glauconitic, calcareous, fossiliferrous massive sand. The lower “typical” Eutaw is less glauconitic sand with a slightly coarser texture, with associated clay layers [7,8]. The Eutaw is a regional source of both industrial and domestic water supplies. At the site, groundwater flow in the Eutaw formation is in the east-southeasterly direction [6]. In the area of the Kerr-McGee facility, the Eutaw consists of finer grained material that is less permeable [7]. Beneath the Eutaw is the McShan aquifer [6].

The Eutaw and McShan formations are sometimes considered one formation, the Eutaw-McShan aquifer, because they are hydraulically interconnected [8]. Of the major aquifers in Mississippi, the Eutaw-McShan ranks lowest in the capacity to transmit and yield water. Values for hydraulic conductivity (the rate of flow through a 1-foot-square section of the aquifer under unit hydraulic gradient) average the lowest of all major aquifers in Mississippi. Transmissivity, related to hydraulic conductivity and aquifer thickness, is low because sand beds are rare and the screened zone in large wells commonly includes multiple layers of clay [8]. The hydraulic characteristics of the aquifer, according to 41 aquifer tests, showed transmissivity values ranging from 200 to 4,900 $(ft^3/d)/ft$ [8]. The aquifer tests showed a median value for hydraulic conductivity of 13.4 $(ft^3/d)/ft^2$[8].

Luxapalila Creek

The Kerr-McGee facility is located in the drainage basin of the Luxapalila Creek. The Luxapalila Creek is the largest perennial drainage in the vicinity of the facility. It is located approximately 0.5 miles east of the site, and 1.3 miles southeast of the site as water would flow down the ditch. Luxapalila Creek is classified as a public water supply upstream of the facility. The downstream portion of the creek, to the confluence with the Tombigbee waterway system, is classified for fish and wildlife [9]. The classification of fish and wildlife denotes secondary usage for recreation such as swimming and wading [10]. The creek waters are intended for fishing and propagation of fish and for public water supply. During the public meeting with ATSDR, residents stated that they catch fish from the Luxapalila Creek. Interested anglers may be attracted to this area because the state fly-fishing record for a spotted bass was set on this creek in 2004 [11].

Site Visit

Staff from ATSDR visited the Kerr-McGee site on several occasions. The initial scoping visit was conducted on October 28, 2002, after receiving the initial petition in July 2002. The purpose of the scoping visit was to observe activities at the site and to note the location of potential human receptors. ATSDR made additional visits to the site in April 2003, June 2006, November 2006, and June 2007. The purpose of these visits was to meet with key officials and community members who have knowledge of the site, to gather community health concerns, and to conduct public health education activities in the community. Public meetings were also held in April 2003, June 2006, and June 2007. Additional site visits were made in 2009, 2010 and 2011 to follow-up on ongoing activities at the site.

During the site visit in November 2006, the site team met with local community members and walked the fence line and ditches adjacent to the site. The ditches along 14th Avenue, 7th Avenue, and Moss Street and the ditches behind the residential area near Waterworks Street were also observed. These drainage ditches contained approximately 2-3 feet of standing water at the time of our visit. No children were seen playing in the ditches in the community. The team followed the drainage ditch along 7th Avenue to the city park, Propst Park. The city was installing new drainage systems near the park. According to local residents, city employees encountered creosote contamination during excavation activities and had to temporarily halt their activities. At the time of our visit, the drainage ditch appeared freshly dug and contained approximately 2-3 feet of standing water. No workers were observed at the excavation site.

Staff made the following observations about site conditions during the site visits:

- The facility was not open for business
- The areas surrounding the site are a mix of residential, commercial, and industrial properties

- The nearest school to the site is Hunt Intermediate School, which is approximately 200 feet southwest of the site
- The closest residential property is approximately 100 feet from the site boundary
- The unlined, open drainage ditches run throughout the neighborhood and sometimes abut residential properties.

To date, ATSDR has:

- participated in community meetings, public availability sessions, and health education workshops;
- met with concerned citizens, community liaisons, and public officials to discuss the site;
- evaluated environmental data and community concerns;
- conducted two exposure investigations (EIs) that sampled residential tap water and fish from Luxapalila Creek; and
- communicationed with involved stakeholders to keep informed of activities at the site, including facility operations, clean-up (removal) efforts, and activities that may result in potential impacts to human receptors.

Figure 1. Demographic Profile of 1 mile and 3 mile radius of the Kerr-McGee Site

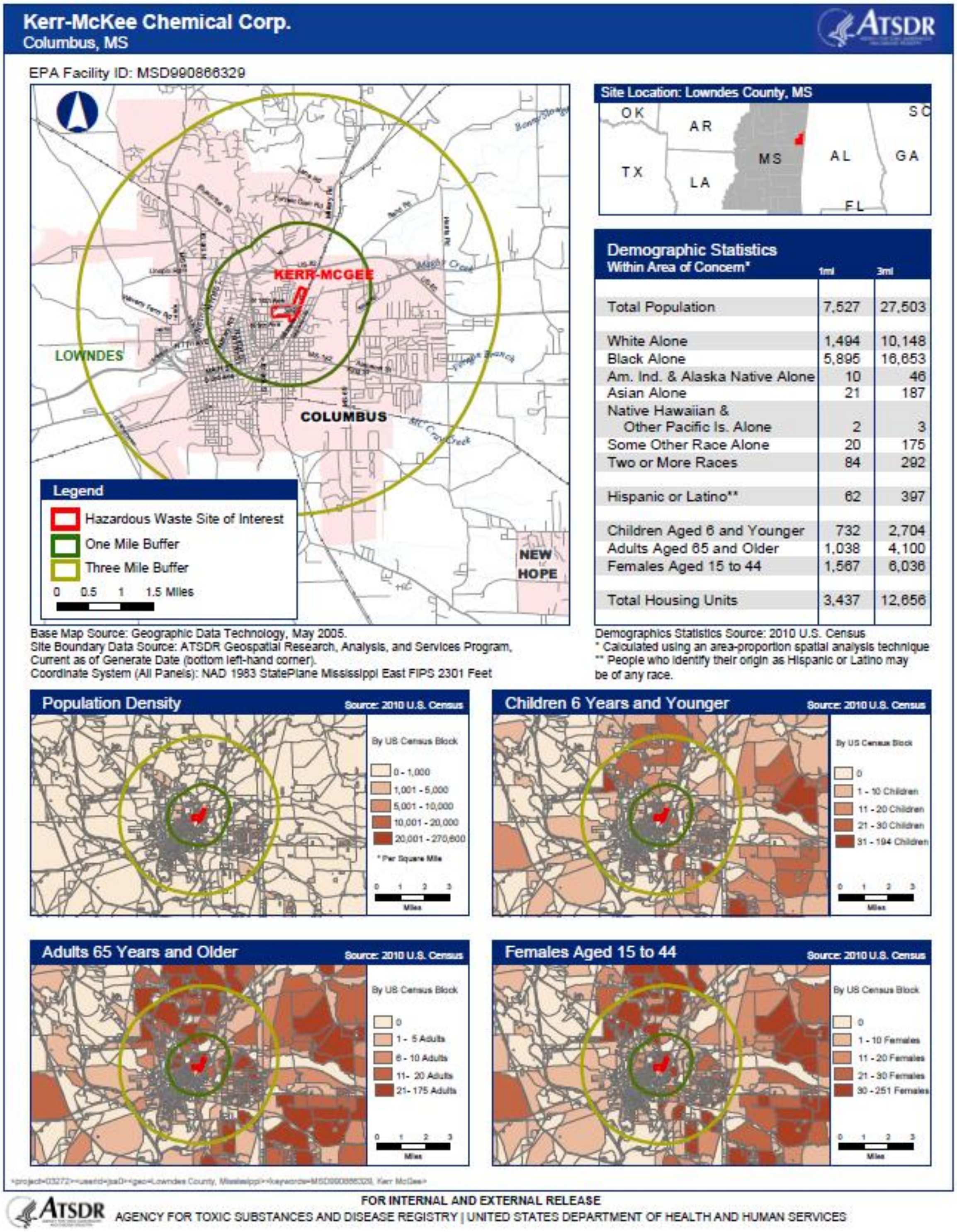
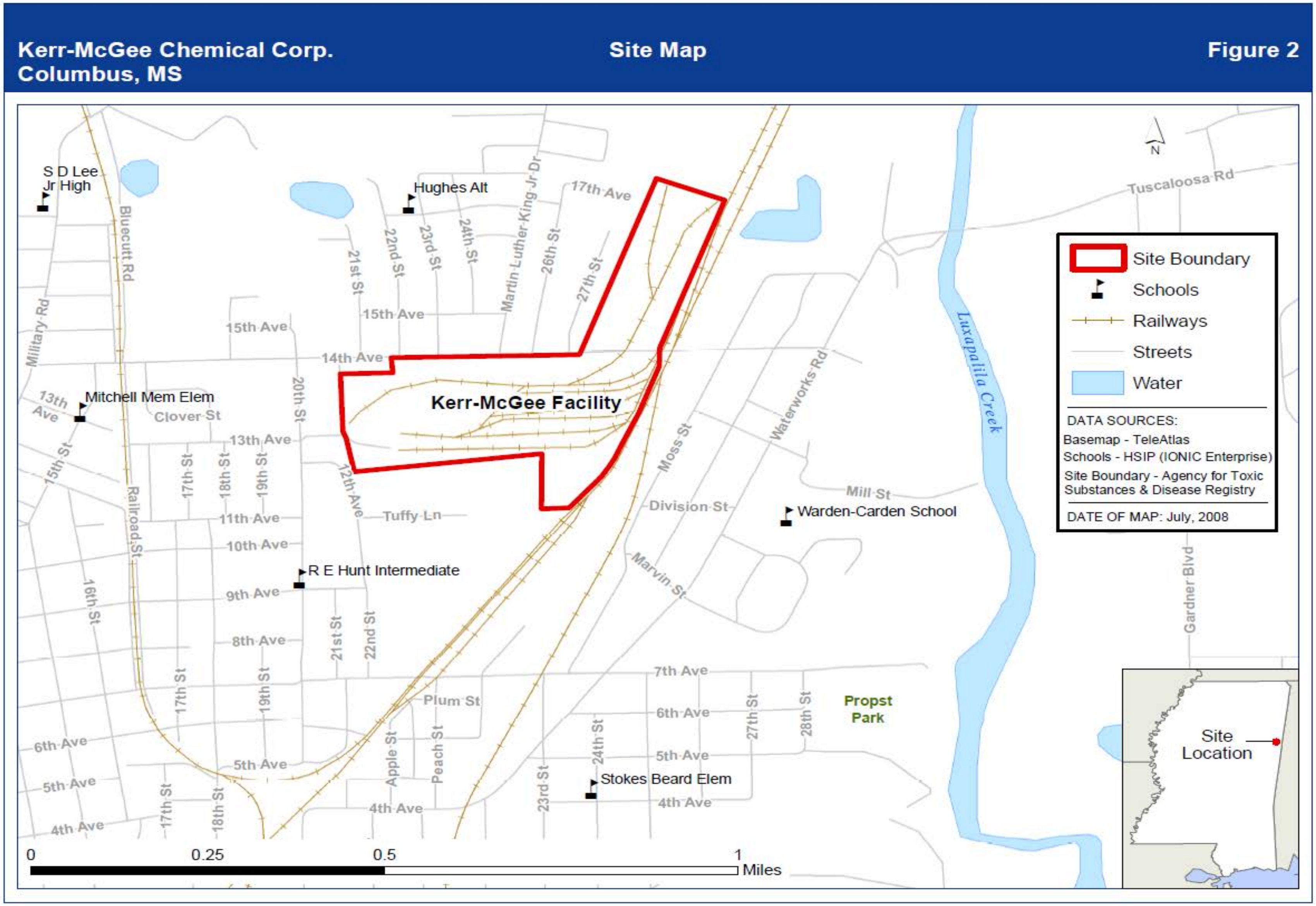


Figure 2. Site Map Showing Site Boundary and Schools Near the Kerr-McGee Facility



ENVIRONMENTAL CONTAMINATION

An integral part of the evaluation of a site is the identification of relevant, site-specific environmental data. The conclusions and recommendations in this document are based on sampling results obtained from parties that conducted investigations at the site. In the following sections, the results of the environmental sampling conducted at the Kerr-McGee site are discussed for each environmental medium of concern.

Identifying Which Chemicals to Evaluate

The reports and documents made available to ATSDR contain a list of contaminants found in environmental media. In the included tables, concentrations of chemicals in each medium are compared to appropriate comparison values to determine which chemicals should be selected for further evaluation. Contaminant levels that do not exceed a comparison value are dropped from further analysis because these concentrations are too low to cause adverse health effects. A contaminant level found to exceed a comparison value does not mean it is a health concern; rather, it means that a more detailed analysis is necessary for that chemical.

Comparison values (CV) are used only to screen for chemicals that require further evaluation. Levels of contamination greater than these values do not necessarily mean that adverse health effects will occur. The amount of the chemical, the duration of exposure, the route of exposure, and the health status of exposed individuals are also important factors in determining the potential for adverse health effects.

Those chemicals selected for further evaluation are designated as contaminants of potential concern. (See Appendix B for a more detailed discussion of ATSDR's evaluation process).

Analytical results indicate that *polycyclic aromatic hydrocarbons (PAHs), dioxins, and pentachlorophenol (PCP) are the chemicals of potential concern at the site*. Concentrations of these chemicals exceed comparison values most often. The discussions which follow focus on these chemicals.

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete combustion of organic substances such as coal, oil and gas, garbage, tobacco or charbroiled meat. PAHs may occur naturally or unintentionally through manufacturing processes. "Dioxin" is the generic name for a group of chemicals including both polychlorinated dibenzodioxins and polychlorinated dibenzofurans. Each unique individual compound in this group is called a congener. 2,3,7,8- TCDD is the most studied and believed to be the most toxic. Dioxins are not intentionally produced and have no known use. They are found in very small amounts almost everywhere in the environment. Pentachlorophenol (PCP) was widely used as a pesticide and wood preservative. It is no longer available to the general public. Pentachlorophenol is a manufactured chemical that does not occur naturally. It is used industrially as a wood preservative for utility poles, railroad ties, and wharf pilings.

Environmental Sampling

The nature and extent of contamination (environmental characterization) at the Kerr-McGee facility has been documented through previous investigations conducted by Kerr-McGee Chemical Corporation, the Mississippi Department of Environmental Quality (MSDEQ), EPA and by Lundy & Davis LLC, representing a plaintiff in a lawsuit. Although evaluated in the public comment release version of this document, the environmental data from Lundy & Davis LLC, will not be used in this document to determine health risks related to the Kerr-McGee facility. The Lundy & Davis, LLC, data are discussed as a separate evaluation in Appendix E. ATSDR took this measure because the Lundy & Davis, LLC, data had no or limited quality assurance/quality control information and, therefore, could not be used to draw public health conclusions.

Groundwater sampling was a part of the sampling protocol. However, groundwater results are not discussed in this document because residents in the area are connected to the municipal water supply. Groundwater could become an issue in the future if the site is redeveloped for other uses.

Sampling Data (Pre-Remediation) – 1996 to 2002

From June 1996 to February 2002, the Kerr-McGee Corp. conducted multiple phases of a RCRA field investigation (RFI) at the site. As part of its RCRA permitting process, Kerr-McGee was required to investigate and delineate impacted media associated with solid waste management units (SWMUs) at the Columbus, Mississippi facility [7]. The investigation occurred in three phases, which are summarized below. The MSDEQ also conducted limited sampling during the same timeframe.

RFI Phase I

The Phase I RFI, completed in November 1996, included on- and off-site ditch sediment sampling, groundwater sampling, and on-site surface soil sampling. (As previously mentioned, the groundwater results will not be discussed or evaluated in this document.)

Sediment samples were collected at each of the 5 discharge points (outfalls) at the facility boundary that collect surface-water run-off. Two sediment samples were collected from each outfall area: one sample was collected within the property at the beginning of the ditch (designated as sample “A”) and the other was collected at the point at which the ditch left the property (designated as sample “B”).

The analytical results for the sediment samples indicate the presence of creosote constituents, mostly PAHs, in each of the 10 ditch samples. PAH concentrations are expressed as BaP Equivalents[1]. Table 1 shows the resulting BaP equivalent exposure doses (sometimes referred to

[1] In order to calculate the carcinogenic potential of the PAHs, each carcinogenic PAH is assigned a toxic equivalence factor (TEF), which is an estimate based on its relative potency to benzo(a)pyrene. The concentration of each PAH is multiplied by its TEF, and the sum of the products is described as the benzo(a)pyrene equivalent (BaP equivalent).

as cPAHs). Benza(a)pyrene equivalent levels up to 188 ppm were found. Pentachlorophenol up to 20 ppm was also detected in sediment samples. See Table 1 below.

Table 1. Pentachlorophenol (PCP) and Benzo(a)pyrene Equivalents (BaP equivalent) in Ditch Sediment Kerr-McGee Data (1996-1999) Phase I Results – Areas Surrounding the Kerr-McGee Facility PRE-REMOVAL CONCENTRATIONS

Sample ID	PCP (ppm)	BaP equivalent Total (ppm)	Depth (inches)
001-A	1.2	**27**	Unspecified
001-B	0.6	**1.3**	Unspecified
002-A	0.3	**7.3**	Unspecified
002-B	**6.8**	**51.6**	0-6
003-A	1.4	**16.4**	0-6
003-B	**20**	**188**	0-6
004-A	1.3	**54**	0-6
004-B	ND	**165**	0-6
005-A	ND	**5.7**	0-6
005-B	ND	**11.5**	0-6

Bolded = concentration exceeds applicable comparison value (CV) of 1.8 ppm for Pentachlorophenol (PCP) and 0.1 ppm for Benzo(a)pyrene (BaP equivalent)

RFI Phase II

The Phase II RFI, performed in March 1998, included additional soil and groundwater investigations at the site. In July 1999, the Mississippi Department of Environmental Quality (MDEQ) conducted an investigation of the off-site drainage ditches downgradient of the facility in response to a request by the Maranatha Faith Center [7]. The samples (identified as MFC1 through MFC10) were split between MDEQ and Kerr-McGee.

Analytical results for sediment from the drainage ditches indicated the presence of PAHs (up to 50.2 ppm). Pentachlorophenol (PCP) was detected at concentrations up to 11 ppm in sediment samples. See Table 2 below.

The following TEFs were used in the calculation of the BaP equivalent:

benzo(a)anthracene	0.1
chrysene	0.001
benzo(b)fluoranthene	0.1
benzo(k)fluoranthene	0.01
benzo(a)pyrene	1.0
indeno(1,2,3-cd)pyrene	0.1
dibenz(a,h)anthracene	1.0

Van den Berg et al., The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds, Toxicol Sci 2006;93(2): 222-241.

Table 2. Pentachlorophenol (PCP) and Benzo(a)pyrene Equivalents (BaP equivalent) in Sediment
Kerr-McGee Data (1996-1999) Phase II Results – Areas Surrounding the Kerr-McGee Facility
PRE-REMOVAL CONCENTRATIONS

Sample ID	PCP (ppm)	BaP Equivalent Total (ppm)	Depth (inches)
(MDEQ) MFC1	ND	**22.4**	0-12
(KM) MFC1	ND	**50.2**	0-12
(MDEQ) MFC3	ND	**0.4**	0-12
(KM) MFC3	**7.2**	**3.4**	0-12
(MDEQ) MFC4	ND	**1.0**	0-12
(KM) MFC4	0.3	**7.1**	0-12
(MDEQ) MFC5	ND	N/A	0-12
(KM) MFC5	0.023	**1.5**	0-12
(MDEQ) MFC6	ND	**24.6**	0-12
(KM) MFC 6	1.1	**31.7**	0-12
(MDEQ) MFC7	ND	**10.2**	0-12
(KM) MFC7	0.92	**10.4**	0-12
(MDEQ) MFC9	ND	**0.3**	0-12
(KM) MFC9	0.092	**3.7**	0-12
(MDEQ) MFC 10	ND	**21**	0-12
(KM) MFC10	**11**	**18.7**	0-12

N/A = not applicable; sample not taken
ND = chemical not detected; contaminant level below analytical testing laboratory's reporting limits
Bolded = concentration exceeds applicable comparison value (CV) of 1.8 ppm for Pentachlorophenol (PCP) and 0.1 ppm for Benzo(a)pyrene (BaP equivalent)
Split samples designated "(MDEQ)" = MS Dept. of Env. Quality and "(KM)" = Kerr-McGee

Supplemental RFI Phase II

Kerr-McGee conducted a Supplemental Phase II investigation in February 2001 and February 2002 to further characterize sediment and surface water in off-site drainage ditches near the site.

During the February 2001 Supplemental Phase II investigation, Kerr-McGee collected 5 surface water samples from off-site ditches. The analytical results for the surface water samples are in Table 3.

Table 3. Chemicals Detected in Surface Water from Off-Site Ditches

Chemical	Frequency Detected	Maximum Result (ppm)	Comparison Value (CV) (ppm)	Type of CV
Indeno(1,2,3-c,d)Pyrene	1/5	**6**J	0.000029	RBC
bis(2-chloroisopropyl) ether	5/5	**7**J	0.4	iEMEG

Bolded text indicates that the maximum concentration exceeds the comparison value (CV) for that chemical.
RBC = EPA Risk Based Concentration
iEMEG = ATSDR intermediate Environmental Media Evaluation Guide

The results indicate the presence of bis(2-ethylhexyl)phthalate in all 5 samples and indeno(1,2,3-cd)pyrene in one sample. Since bis(2-ethylhexyl)phthalate was also reported in rinsate blanks, it is reasonable to conclude that it is a laboratory contaminant[2], and will not be evaluated for potential toxicity. Indeno(1,2,3-c,d)pyrene was detected in one surface water sample at a maximum result of 6 mg/L, which exceeds the comparison value of 0.000092 mg/L for the chemical. However, the water solubility of indeno(1,2,3-c,d)pyrene is only 0.062 mg/L [43]. Because of its low water solubility, the higher level of indeno(1,2,3-c,d)pyrene is probably the result of suspended sediments in the water sample that are not dissolved.

Off-site sediment samples were collected at different depth intervals (0-6 and 6-12 inch depth intervals) at locations where there was an increase in sediment deposition [7]. Buried sediments (greater than one foot) were not evaluated because most people are not likely to come into contact with these deeper sediments. The analytical results for the sediment samples are in Table 4 (identified as SB-01A through SB-06B). Results indicate the presence of PAHs (up to 20 ppm) at each depth interval. Pentachlorophenol (PCP) was detected (up to 15 ppm) in 5 out of 12 sediment samples.

During the February 2002 Supplemental Phase II investigation, Kerr-McGee collected 8 additional off-site sediment samples (identified as SB-07A through SB-10B in Table 4) from 4 locations historically identified as containing elevated contaminant levels. Analytical results indicate the presence of PAHs (up to 51.3 ppm) in these sediment samples. PCP was detected (up to 6.0 ppm) in 4 sediment samples.

[2] Laboratory contamination is defined as the inadvertent addition of target analytes to samples during the sample collection, transportation or analysis process.

Table 4. Pentachlorophenol (PCP) and Benzo(a)pyrene Equivalents (BaP equivalent) in Off-site Sediment Kerr-McGee Data (2001-2002) Supplemental Phase II Results – Areas Surrounding the Kerr-McGee Facility PRE-REMOVAL CONCENTRATIONS

Sample ID	PCP (ppm)	BaP equivalent Total (ppm)	Depth (inches)
SB-01A	0.27	**0.7**	0-6
SB-01B	ND	**20**	6-12
SB-02A	**15**	**18.7**	0-6
SB-02B	**15**	**13.5**	6-12
SB-03A	ND	**2.8**	0-6
SB-03B	0.2	**3.9**	6-12
SB-04A	ND	**2.2**	0-6
SB-04B	ND	**4.7**	6-12
SB-05A	ND	**0.6**	0-6
SB-05B	N/A	N/A	6-12
SB-06A	0.1	**2.7**	0-6
SB-06B	ND	ND	6-12
SB-07A	**2.4**	**15.7**	0-6
SB-07B	0.5	**3.9**	6-12
SB-08A	ND	**9.4**	0-6
SB-08B	ND	**3.0**	6-12
SB-09A	ND	**0.2**	0-6
SB-09B	ND	**0.2**	6-12
SB-10A	1.8	**16.8**	0-6
SB-10B	**6.0**	**51.3**	6-12

N/A = not applicable; sample not taken
ND = not detected; contaminant level below analytical testing laboratory's reporting limits
Bolded = concentration exceeds applicable comparison value of 1.8 ppm for Pentachlorophenol (PCP) and 0.1 ppm for Benzo(a)pyrene (BaP equivalent)

Residual Contamination (Post-Remediation)

In September 2004, Kerr-McGee removed contaminated sediment from four areas in drainage ditches bordering the facility. Between September 2006 and November 2007, Kerr-McGee excavated and removed sediments in and near Propst Park. This section summarizes the removal activities and evaluates sediment contamination that remained after (residual contamination) these removal events.

Note: EPA collected limited additional sediment sampling from the drainage ditches in 2010. Those sample results are discussed separately.

Kerr-McGee performed the interim remedial measures in 2004 to address areas of impacted sediments in drainage ditches bordering the Kerr-McGee property [1]. Impacted sediments were defined by EPA as those with concentrations of carcinogenic PAHs in excess of one in 10,000 (10^{-4}) target risk based on the land-use designation (i.e., residential or industrial) for the area proximal to the ditch [1].

As part of the remedial action, Kerr-McGee excavated 4 areas of impacted sediment in drainage ditches bordering the property. Excavation area 1 was located in the northwestern part of the Kerr-McGee property. Excavation area 2 was located outside the Kerr-McGee property, south of 14th Avenue and west of the railroad. Excavation area 3 was located south of 14th Avenue and east of the railroad line. Excavation area 4 was located between the two railroad lines, cutting west onto the facility property. Confirmatory samples from the excavation areas confirmed that residual contamination did not exceed established risk levels [1].

Major work activities completed as part of the remedial measure included:

- Excavation of approximately 1,800 linear feet of impacted sediments from perimeter drainage ditches
- Confirmation soil sampling
- Transportation and off-site disposal of excavated sediments
- Dust control and ambient air monitoring during remedial activities
- Stormwater management
- Site restoration (backfilling and grading) [1]

Visibly contaminated sediments were discovered during earth moving activities near and within Propst Park. The contaminated sediments were excavated from the drainage ditches near and within Propst Park. No pre-removal or post-removal sample results were available to ATSDR from the Propst Park area. Therefore, ATSDR cannot determine if people, other than workers, were exposed to contamination from this area and to what levels they might have been exposed.

To evaluate post-removal contamination levels, ATSDR excluded ditch sediments that were cleaned up as part of the removal action. What is left is called the residual contamination. The residual contamination forms the basis for evaluating current exposures at the site. However, it is worth noting that the residual contamination might not represent current contaminant levels if conditions at the site have changed significantly because of flooding and/or erosion events, like the documented flooding and erosion in 2010.

PAH concentrations up to 50.2 ppm are part of the residual sediment contamination at the site. The average residual concentration is 9 ppm for PAHs. PCP concentrations up to 15 ppm are part of the residual sediment contamination at the site. The average residual PCP concentration is 2 ppm. Table 5 below shows residual sediment contamination levels.

Table 5. Pentachlorophenol (PCP) and Benzo(a)pyrene Equivalents (BaP equivalent) in Sediment Areas Surrounding the Kerr-McGee Facility
POST-REMOVAL CONCENTRATIONS (Residual)

Sample ID	PCP (ppm)	BaP equivalent Total (ppm)	Depth (inches)
001-A	1.2	**27**	Unspecified
001-B	0.6	**1.3**	Unspecified
002-A	0.3	**7.3**	Unspecified
003-A	1.4	**16.4**	0-6
(MDEQ) MFC1	ND	**22.4**	0-12
(KM) MFC1	ND	**50.2**	0-12
(MDEQ) MFC3	ND	**0.4**	0-12
(KM) MFC3	**7.2**	**3.4**	0-12
(MDEQ) MFC4	ND	**1.0**	0-12
(KM) MFC4	0.3	**7.1**	0-12
(MDEQ) MFC5	ND	N/A	0-12
(KM) MFC5	0.023	**1.5**	0-12
SB-01A	0.27	**0.7**	0-6
SB-02A	**15**	**18.7**	0-6
SB-03A	ND	**2.8**	0-6
SB-04A	ND	**2.2**	0-6
SB-05A	ND	**0.6**	0-6
SB-06A	0.1	**2.7**	0-6
SB-08A	ND	**9.4**	0-6

N/A = not applicable; sample not taken
ND = not detected; contaminant level below analytical testing laboratory's reporting limits
Bolded = concentration exceeds applicable comparison value (CV) of 1.8 ppm for Pentachlorophenol (PCP) and 0.1 ppm for Benzo(a)pyrene (BaP equivalent)

Environmental Data Collected Since Release of the Public Comment version of this PHA

In the public comment version of this document, ATSDR recommended more off-site sampling to further define the nature and extent of contamination. We recommended focusing on residential yards and other areas where vulnerable populations might come into contact with contamination. We also recommended testing for site-related contaminants of particular concern, such as dioxin-like compounds and carcinogenic PAHs.

In April 2010, October 2010 and February 2011, EPA conducted soil sampling in nearby residential yards and other properties [65] and sediment sampling in on- and off-site ditches [75]. The purpose of the sampling was to determine if soil and sediment in the surrounding neighborhood was impacted by former operations at the Kerr-McGee facility. The sampling events and results are discussed below.

Also, in July and September 2012, EPA conducted an interim remedial investigation (RI) of the 14th Avenue Ditch adjacent to the Kerr McGee facility. During the RI, EPA collected soil, sediment, surface water and groundwater samples in and near the 14th Avenue Ditch. The purpose of the sampling was to determine the nature and extent of contamination in the 14th Avenue Ditch Area to assist with an improvement effort to relocate the existing stormwater ditch. The soil, sediment and surface water sampling results are discussed below. The groundwater sampling results are not discussed because there are no known current exposures to groundwater occurring near the site.

Residential Soil and On- and Off-Site Ditch Sediment Sampling - 2010

In April 2010, EPA collected soil and sediment samples from a Hunt Intermediate School, a church property, residential properties and from on- and off-site drainage ditches [75]. A total of 24 locations were sampled - fourteen 5-point composite soil samples (plus one duplicate) and 10 ditch sediment samples. Soil and sediment samples were analyzed for semivolatile organic compounds (SVOCs) and dioxin. The sampling results are in Table 6 below. The sampling locations and results are shown in Figures 3 and 4 below.

Table 6. Benzo(a)pyrene Equivalents (BaP equivalent) and Dioxin in Soil and Sediment
RESIDENTIAL SOIL AND ON- AND OFF-SITE DITCH SEDIMENT (April 2010)

Sample ID	BaP equivalent Total (ppm)	Dioxin (ppt)
Surface Soil		
TN01S (Hunt Intermediate)	**0.19**	**90**
TN02S (Church)	0.06	**43**
TN04S	0.02	11
TN05S	0.00009	7
TN06S	0.02	9.2
TN07S	ND	8.9
TN08S	NA	4.6
TN09S	**0.42**	**760**
TN09SD (duplicate)	**0.61**	**820**
TN10S	0.002	54
TN11S	0.04	**260**
TN12S	0.008	48
TN13S	0.02	37
TN14S	ND	4.9
TN25S	NA	2.3
Sediment		
TN15S	**0.32**	NA
TN16S	**3.1**	NA
TN17S	**1.6**	NA
TN18S	**0.39**	NA
TN19S	**0.18**	NA
TN20S	ND	NA
TN21S	ND	NA
TN22S	ND	NA
TN23S	ND	NA
TN24S	**5.2**	NA

N/A = not available
ND = not detected; contaminant level below analytical testing laboratory's reporting limits.
Bolded = concentration exceeds applicable comparison value (CV) of 0.1 ppm for Benzo(a)pyrene (BaP equivalent) and 35 ppt for dioxin.

The April 2010 surface soil results indicate the presence of PAH concentrations, expressed as BaP equivalent concentrations, ranging from non-detect to 0.61 ppm. Three of the 14 surface soil samples exceed the comparison value of 0.1 ppm for PAHs. Dioxins[3] were detected in surface soil at concentrations ranging from 4.9 to 820 ppt. ATSDR's current comparison value for dioxin is 35 parts per trillion (ppt), or 0.000035 ppm. According to the April 2010 results, 5 of the 14 soil samples exceed ATSDR's comparison value of 35 ppt for dioxin.

Note: A residential yard on Moss Street had the highest concentration of dioxin, 760 ppt and 820 ppt (duplicate), and PAHs, 0.42 and 0.61 ppm (duplicate), in surface soil. EPA performed a removal action at this residence and excavated contaminated soil to reduce the levels of dioxin and PAHs in this yard.

The sediment sampling results from April 2010 indicate the presence of PAHs ranging from non-detect to 5.2 ppm. Six of the 10 sediment samples exceed the comparison value of 0.1 ppm for PAHs. The results for the dioxin concentrations in sediment were not reported. EPA did note that 7 samples exceeded EPA's provision regional screening level (RAL) of 72 ppt for dioxin in residential soil and none of the samples exceeded EPA's Office of Solid Waste and Emergency Response's (OWSER) residential removal action level (RAL) of 1,000 ppt[4] [75]. ATSDR's current comparison value for dioxin in soil is 35 ppt.

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[3] Dioxins are evaluated by comparing to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), the most toxic dioxin, using the toxicity equivalence factor (TEF) approach. Toxicity equivalency factors (TEFs) were developed to relate the toxicity of dioxin congeners to that of TCDD. This comparison is based on the assumption that dioxin congeners act through the same mechanism of action as TCDD. The TEF for TCDD is defined as "1", whereas TEF values for all other congeners are between 0 and 1. A TEF value of 1 means the congener is as toxic as TCDD. Congeners with TEF value less than 1 means that it has less toxicity than that of TCDD. The concentration of each dioxin is multiplied by its TEF to obtain the toxicity equivalent (TEQ). For example, if the detected 1,2,3,4,6,7,8,9-octachlorinated-dibenzo-p-dioxin (OCDD) concentration is 500 parts per trillion (ppt), and the TEF of OCDD is 0.0001 (meaning it is 10,000 times less toxic than TCDD), then the TEQ of OCDD is 0.05 ppt (500 x 0.0001). All the TEQs are added together to obtain the TCDD TEQ, which is an estimate of the toxicity of all congeners present.

[4] EPA's screening criteria for dioxin at that time was based on a Regional Screening Level (RSL) of 72 ppt and a Removal Action Level (RAL) of 1,000 ppt. In May 2012, EPA updated the RSL for dioxin to 51 ppt for residential soil.

Figure 3. Soil and Sediment Sampling Locations, PAH Concentrations (BaP equivalents, ppm), Kerr-McGee Chemical Facility, April 2010 Data

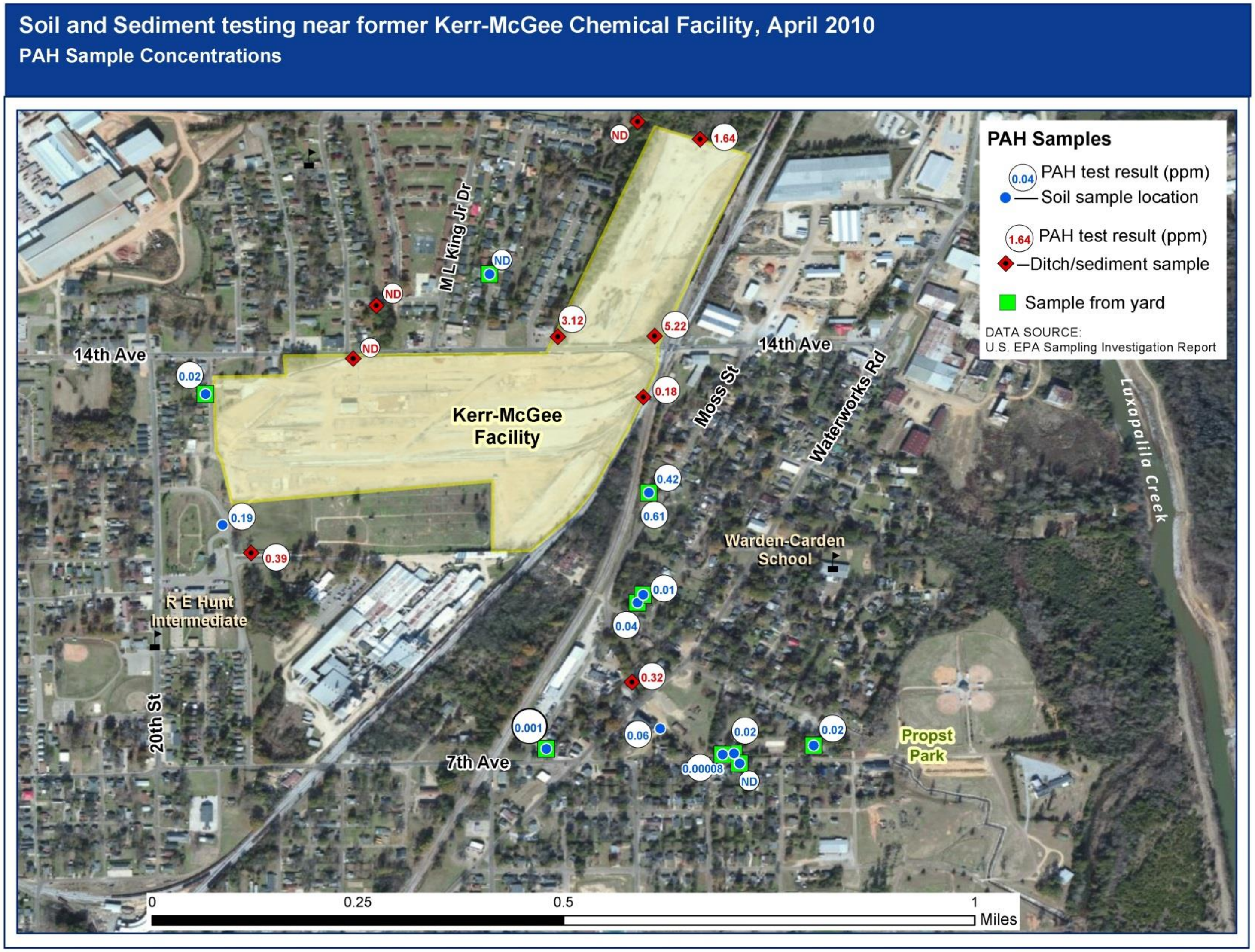
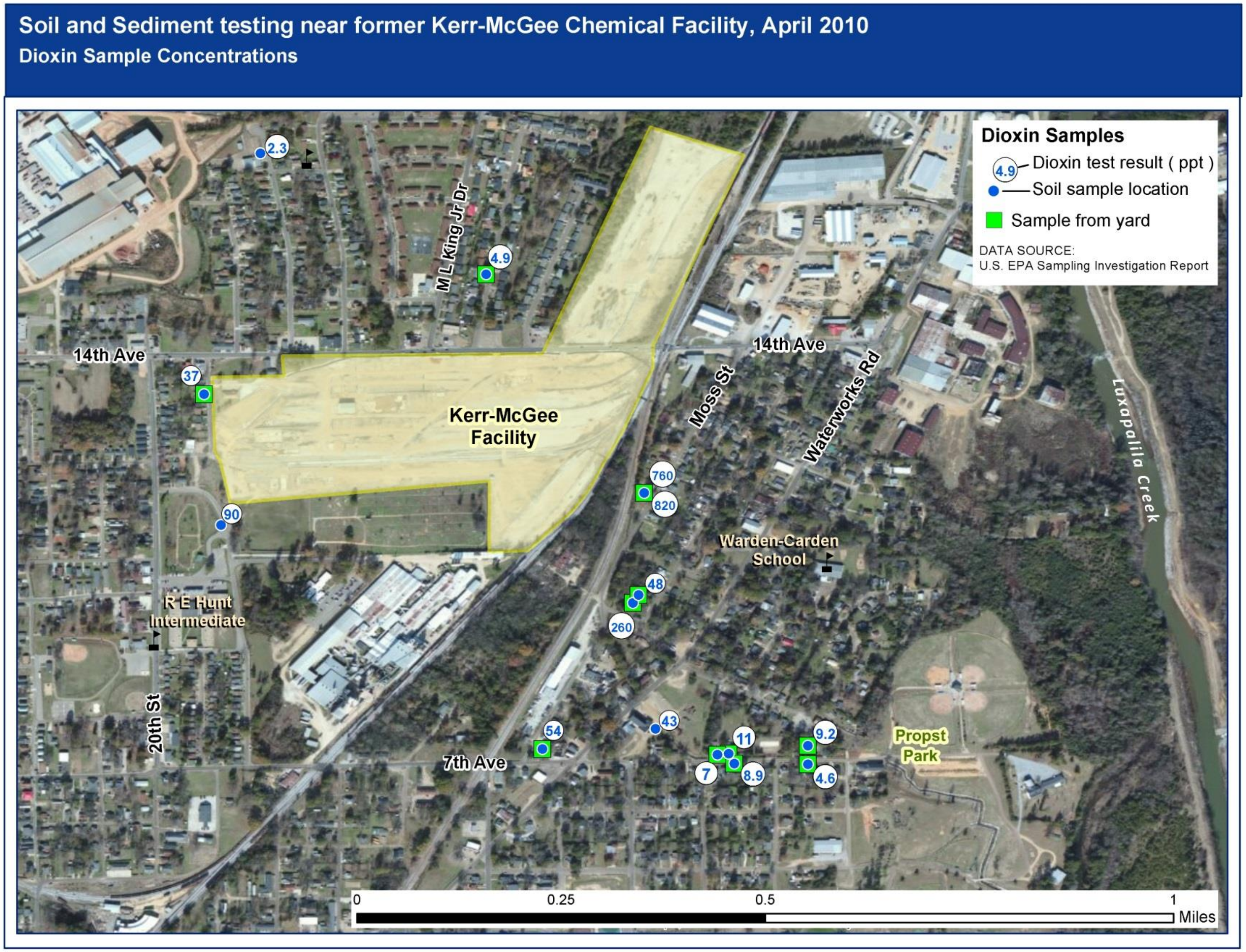


Figure 4. Soil and Sediment Sampling Locations, Dioxin concentrations (ppt), Kerr-McGee Chemical Facility, April 2010 Data



Off-Site Residential and Community Soil Sampling – 2010 and 2011

In October 2010, EPA collected a total of 49 soil samples from 39 residential and community properties adjacent to the former Kerr-McGee facility. The samples were tested for dioxin and semi-volatile compounds (SVOCs). However, most of the data for 2,3,7,8-tetrachlorodibenzo-p-dioxin were reported as non-detected and rejected due to laboratory quality control problems. Due to the rejected data, EPA resampled all locations for dioxin in 2011 [65].

In February 2011, EPA collected a total of 61 soil samples from 45 residential and community properties adjacent to the former Kerr-McGee facility. The samples were tested for dioxins and SVOCs. The areas where dioxin soil samples were rejected in October 2010 were resampled, plus twelve additional samples from other areas, including a creosote waste pile [65].

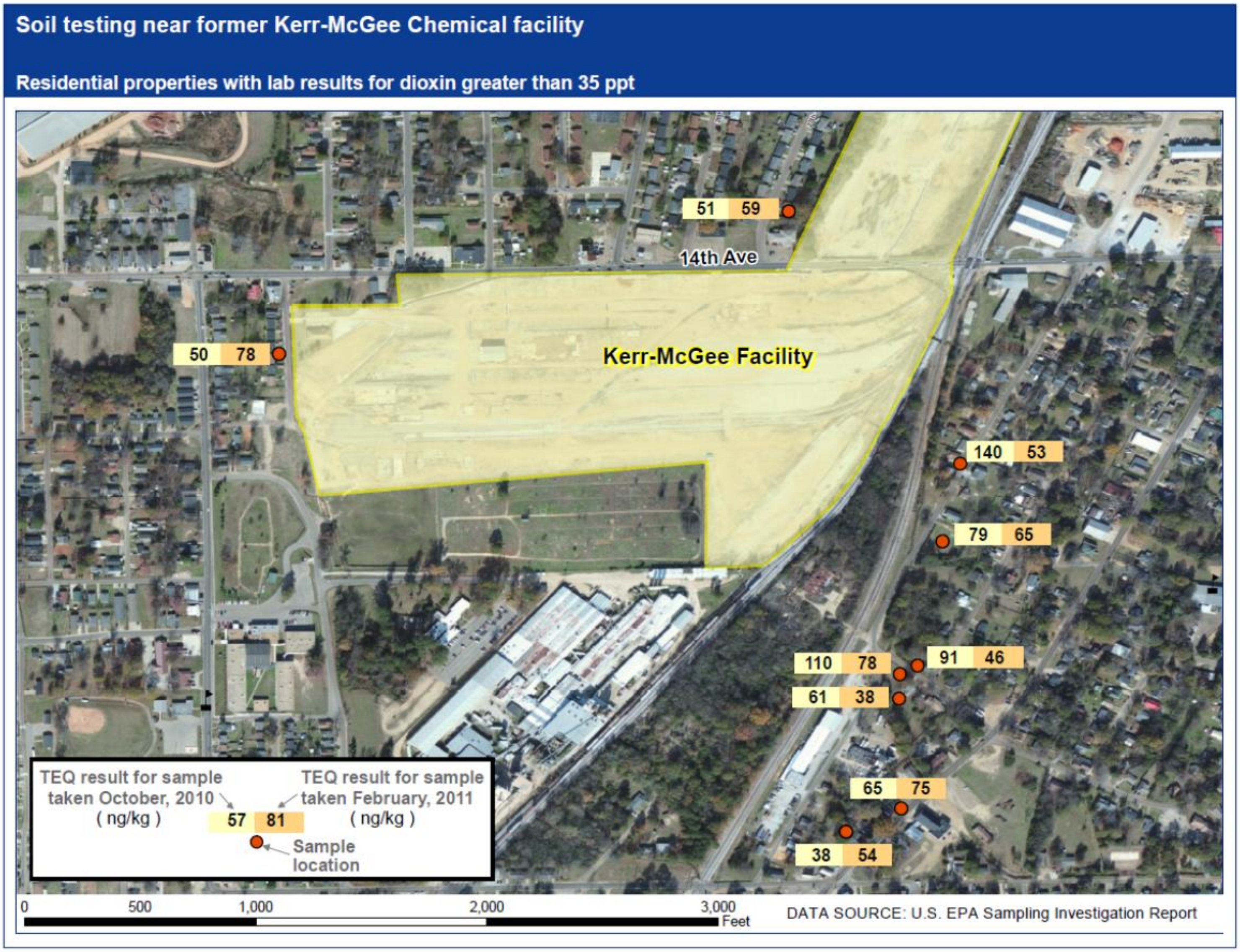
Surface soils samples were collected from a depth of 0-3 inches. Subsurface soil samples were collected from 3 residential properties at a depth of 12-15 inches. Generally, samples consisted of 5 aliquots; however, the number and location of soil aliquots were adjusted to avoid collecting samples from areas that could be potentially impacted by residential activities [65]. Sample locations for Hunt Intermediate School were selected by dividing the field into 5 grids (100 ft x 100 ft); the original 3 sample locations from October 2010 were also resampled.

EPA also collected two samples from a soil pile containing creosote waste material. The waste material was located on property owned by the Maranatha Faith Center. The cutting and removing of a large culvert on the property had generated the waste pile. The waste pile consisted of a mix of soil and creosote material. The waste pile was unsecured and open to contact by people coming onto the property. EPA completed an emergency action which removed and secured the waste pile. A sample was collected before and after removal of the waste pile [65].

ATSDR reviewed both the October 2010 and February 2011 data when conducting our evaluation. As human exposure is usually limited to the uppermost few inches of soil, only surface soil samples (0-3 inches) are evaluated in this document. The sampling results for dioxin concentrations in surface soil from October 2010[5] ranged from 3 to 140 ppt. ATSDR's current comparison value for dioxin is 35 parts per trillion (ppt), or 0.000035 ppm. According to the October 2010 results, nine samples exceeded ATSDR's comparison value of 35 ppt for dioxin (See Figure 5).

[5] EPA compared the two rounds of dioxin data (October 2010 and February 2011) and noted that the 2010 sample data are generally consistent with, yet slightly higher than, the 2011 dioxin data. EPA recommends that the 2010 data be maintained but given careful consideration when used in the decision-making process. After careful consideration, ATSDR determined that the October 2010 data are sufficient for purposes of this public health assessment process.

Figure 5. Residential properties with dioxin concentrations greater than ATSDR's comparison value of 35 ppt

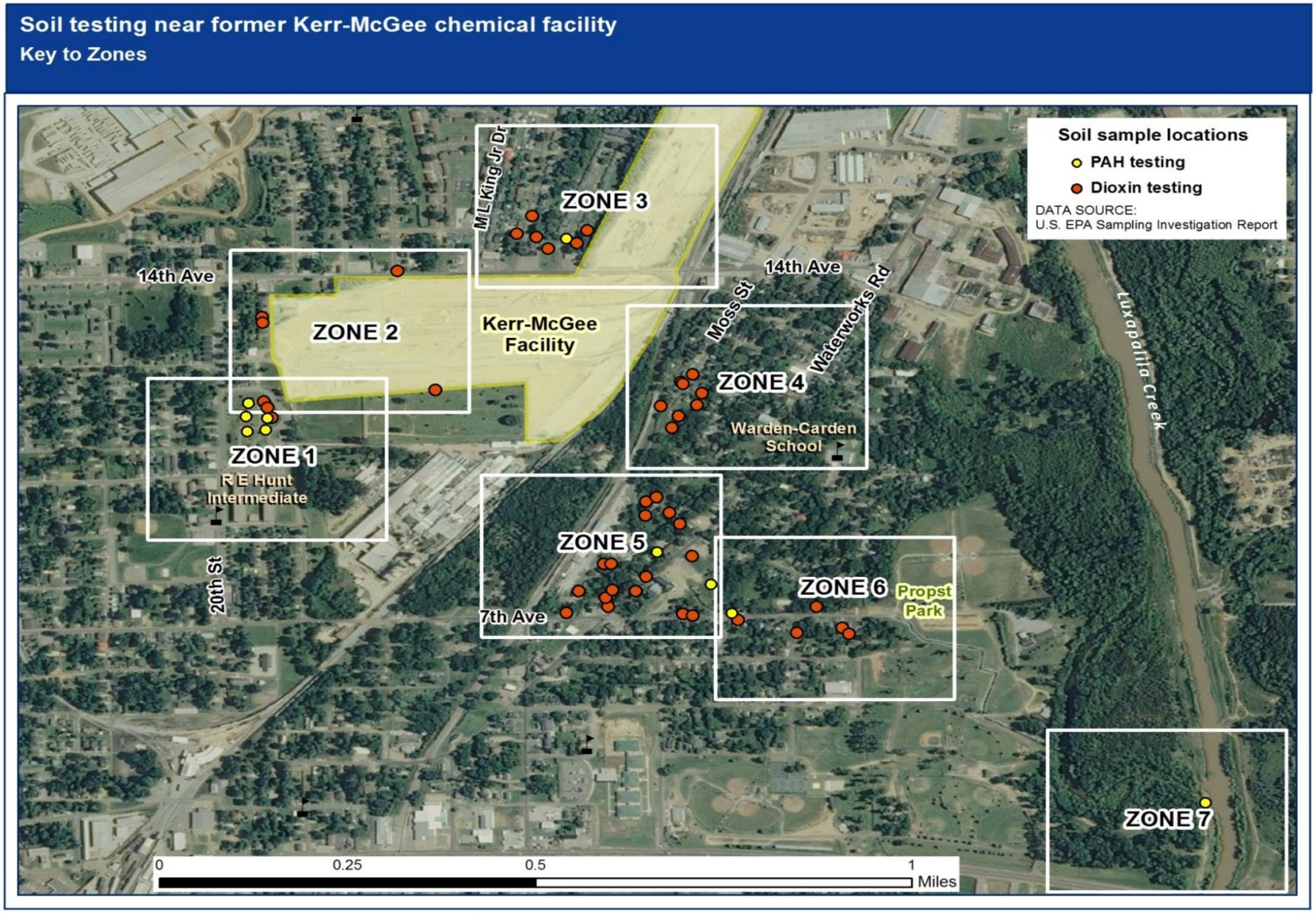


The sampling results for dioxin concentrations in surface soil from February 2011 ranged from 2 to 81 ppt. Nine samples exceed ATSDR's current residential screening level of 35 ppt for dioxin (See Figure 5). A dioxin concentration of 850 ppt was reported for the sample collected from the waste pile location. The dioxin concentration after the waste material was removed was reported as 2 ppt.

The February 2011 sampling results for PAH concentrations, expressed as BaP equivalent concentrations, ranged from 0.02 to 0.49 ppm. The highest PAH concentration was taken from the field at the Hunt Intermediate School. None of the residential samples exceeded the comparison value for PAHs.

The October 2010 and February 2011 sampling events covered a large area near the Kerr-McGee facility. ATSDR divided the sampling area into 7 different zones to better illustrate the location of the samples and to determine if certain areas are more contaminated than others. The sampling zones are shown in Figure 6. Each equal-sized zone represents an area approximately 2000 ft x 1200 ft.

Figure 6. The sampling area was divided into 7 equal-sized zones.
The zones were selected so that the samples closest together are in the same zone.



The sampling results for dioxin and PAHs from the October 2010 and February 2011 sampling events are shown in the Table 6 below. Only surface soil samples (0-3 inches) are reported. For ease of description, the sampling area and results are divided into 7 zones (See Figure 5). The table includes a general description of the streets/area in each zone.

Table 7. Summary of Dioxin and Benzo(a)pyrene Equivalents (BaP equivalent) Concentrations In Off-Site Surface Soil (2010 and 2011) Areas Surrounding the Kerr-McGee Facility Zones 1 through 7

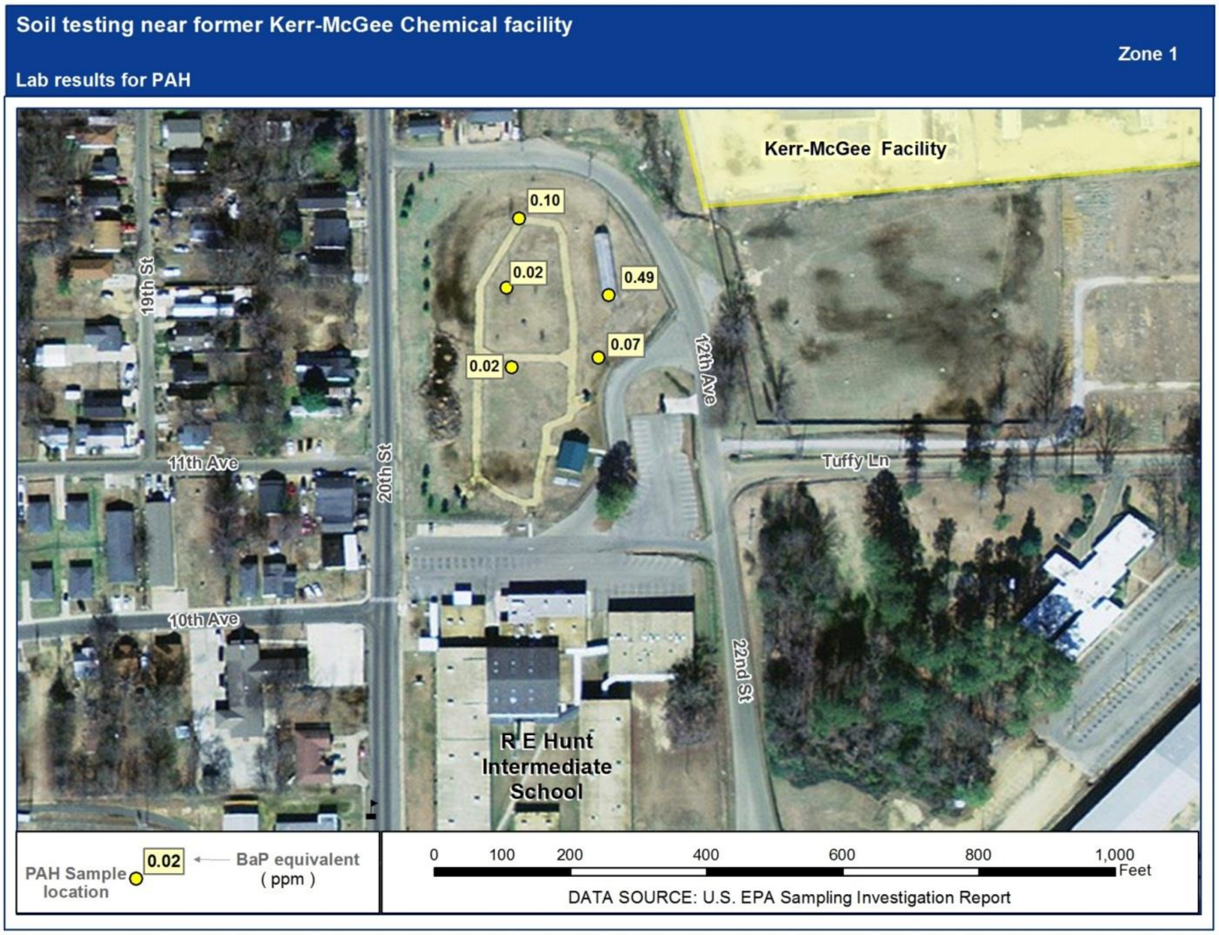
Zone		Dioxin Results (ppt)	Number of Samples Exceed CV (35 ppt)	BaP Equivalent Results (ppm)	Number of Samples Exceed CV (0.1 ppm)	General Zone Description
Zone 1	Min	22	4/8	0.02	1/5	R.E. Hunt Intermediate School athletic field
	Max	**88**		**0.49**		
	Avg*	**49**		**0.14**		
Zone 2	Min	18	4/8	----	N/A	21rd St and 14th St; 23st St. west of the facility; south facility boundary
	Max	**110**		----		
	Avg*	**52**		----		
Zone 3	Min	4	2/14	0.05	0/1	26th to 27th St and 14th Ave northwest of the facility boundary
	Max	**59**		0.05		
	Avg*	17		0.05		
Zone 4	Min	5	4/16	----	N/A	Moss St, Shady St area; southeast of the facility boundary
	Max	**140**		----		
	Avg*	30		----		
Zone 5	Min	3	10/36	0.06	0/2	Moss St, 7th Ave; area south of the facility boundary; includes creosote waste pile
	Max	**110**		0.08		
	Avg*	32		0.07		
Zone 6	Min	3	0/10	0.10	0/1	26th to 28th St., 7th Ave., area southeast of the facility
	Max	20		0.10		
	Avg*	9		0.10		
Zone 7	Min	----	N/A	0.02	0/1	Propst Park; area near the Luxapalila Creek
	Max	----		0.02		
	Avg*	----		0.02		

* Dioxin averages were calculated by adding the October 2010 and February 2011 results for the same location and dividing by the number of samples.
Bolded text = above the screening/comparison value (CV) of 35 ppt for dioxin or 0.1 ppm for PAHs.
N/A = not applicable; no sample was taken in the designated zone.

Zone 1 is the field at the R.E. Hunt Middle School. Dioxins up to 88 ppt and PAHs up to 0.49 ppm were detected in the soil at the school field. The average concentration for dioxins in Zone 1 is 49 ppt; the average concentration for PAHs is 0.14 ppm. ATSDR's current comparison value for dioxin is 35 ppt; the comparison value for PAHs is 0.1 ppm. Both the maximum and average concentrations for dioxins and PAHs exceed their respective comparison values in Zone 1. (See Figures 7 and 8)

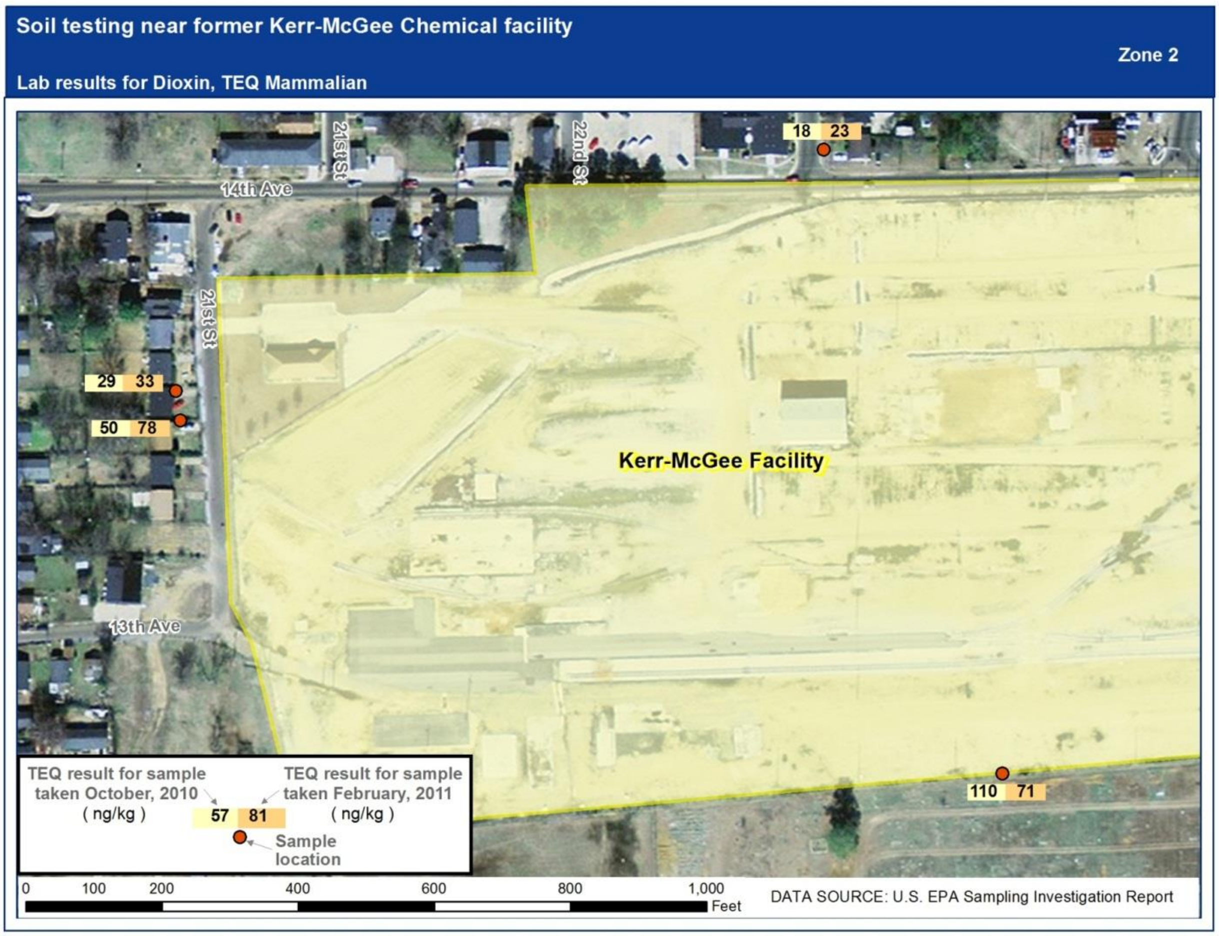
Figure 7. Dioxin Results for Zone 1.

Figure 8. PAH results for Zone 1



Zone 2 is described generally as the residential area along 21st Street, 23rd Street, and a semi-industrial area along the southern facility boundary. No PAH samples were included in Zone 2, a result of the layout of the designated zones by ATSDR. Eight dioxin samples were collected from 4 locations in Zone 2. Dioxin concentrations up to 110 ppt, with an average concentration of 52 ppt, were detected. The maximum and average concentrations of dioxin ATSDR's comparison value of 35 ppt for dioxin. (See Figure 9)

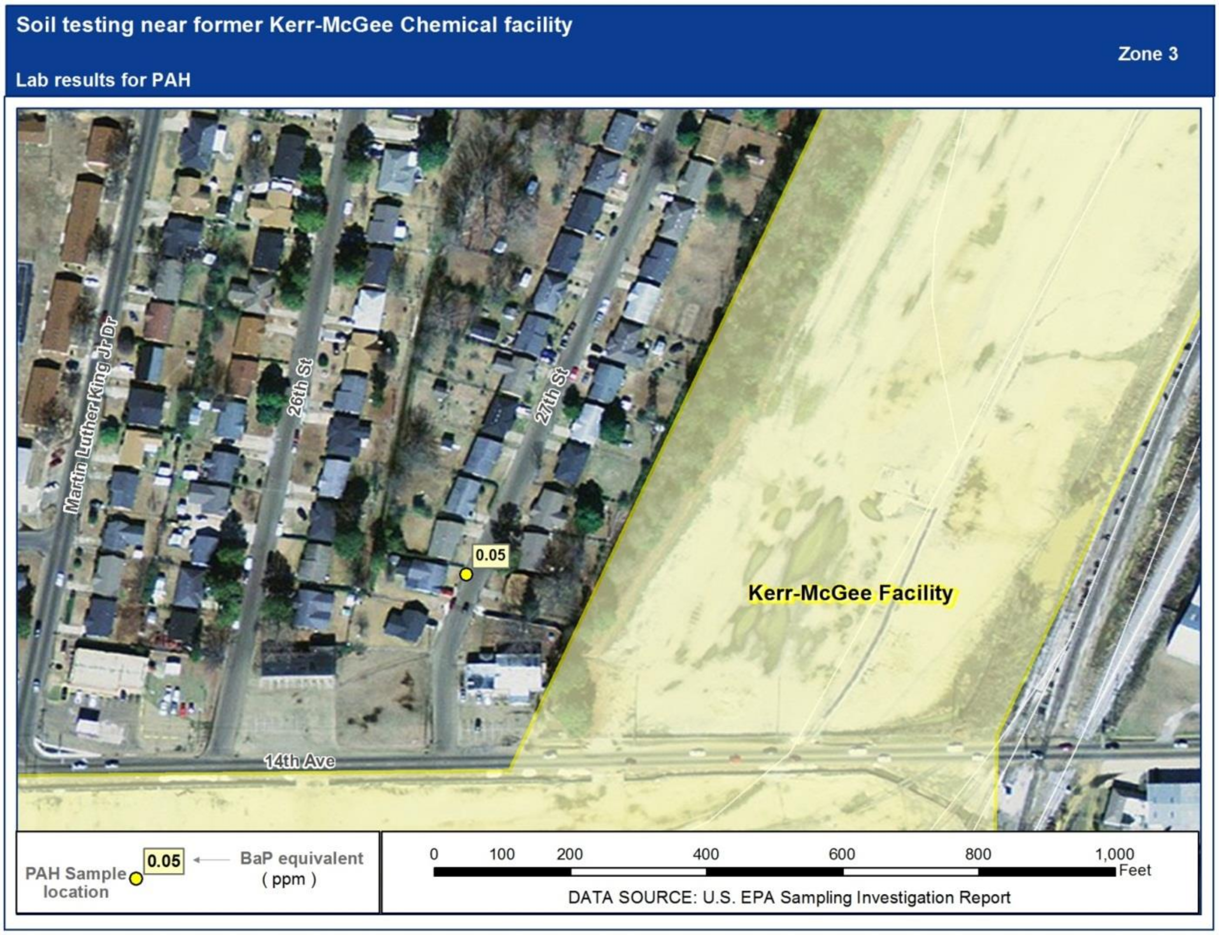
Figure 9. Dioxin Results for Zone 2



Zone 3 is the residential area between 26th, 27th Streets and 14th Avenue. Six locations were sampled to yield a total of 14 dioxin sample results. One location was sampled for PAHs and yielded one PAH sample result. The maximum concentration of dioxins is 59 ppt and the average is 17 ppt. The PAH concentration in the one sample is 0.05 ppm. The maximum concentration of dioxin exceeds ATSDR's comparison value of 35 ppt, but the average concentration does not. The PAH concentration does not exceed the comparison value of 0.1 ppm for PAHs. (See Figures 10 and 11)

Figure 10. Dioxin Results for Zone 3

Figure 11. PAH results for Zone 3



Zone 4 is described generally as the residential area near Moss Street and Shady Street. Eight locations were sampled to yield a total of 16 sample results. No PAH samples were collected from Zone 2. Dioxin was detected up to 140 ppt with an average concentration of 30 ppt. The maximum concentration of dioxin in Zone 4 exceeds ATSDR's comparison value of 35 ppt for dioxin, but the average dioxin concentration does not. (See Figure 12)

Figure 12. Dioxin Results for Zone 4

Zone 5 is the area between Moss Street and 7th Avenue. Seventeen locations were sampled to yield a total of 36 sample results for dioxin. Two locations were sampled for PAHs (one location was the creosote waste pile and is discussed separately). The maximum dioxin concentration in Zone 5 is 110 ppt with an average concentration of 32 ppt. The maximum PAH concentration is 0.08 ppm, with an average concentration of 0.07 ppm. The maximum concentration of dioxin in Zone 5 exceeds ATSDR's comparison value of 35 ppt for dioxin, but the average dioxin concentration does not. Neither the maximum or average concentration of PAHs exceeds the comparison value of 0.1 ppm for PAHs. (See Figures 13 and 14)

Note: The creosote waste pile pre-removal sampling results were not used to determine maximum or average contaminant concentrations for Zone 5. The creosote waste pile is evaluated separately.

The creosote waste pile, located at a church on Waterworks Road, is included in Zone 5. Samples for PAHs and dioxins were collected from the waste pile prior to and after the material was removed. PAHs up to 88 ppm were detected in the waste pile prior to removal. The PAH concentration after removal was 0.08 ppm. Dioxin was detected at 850 ppt prior to removal and 1.8 ppt after removal.

Figure 13. Dioxin Results in Zone 5

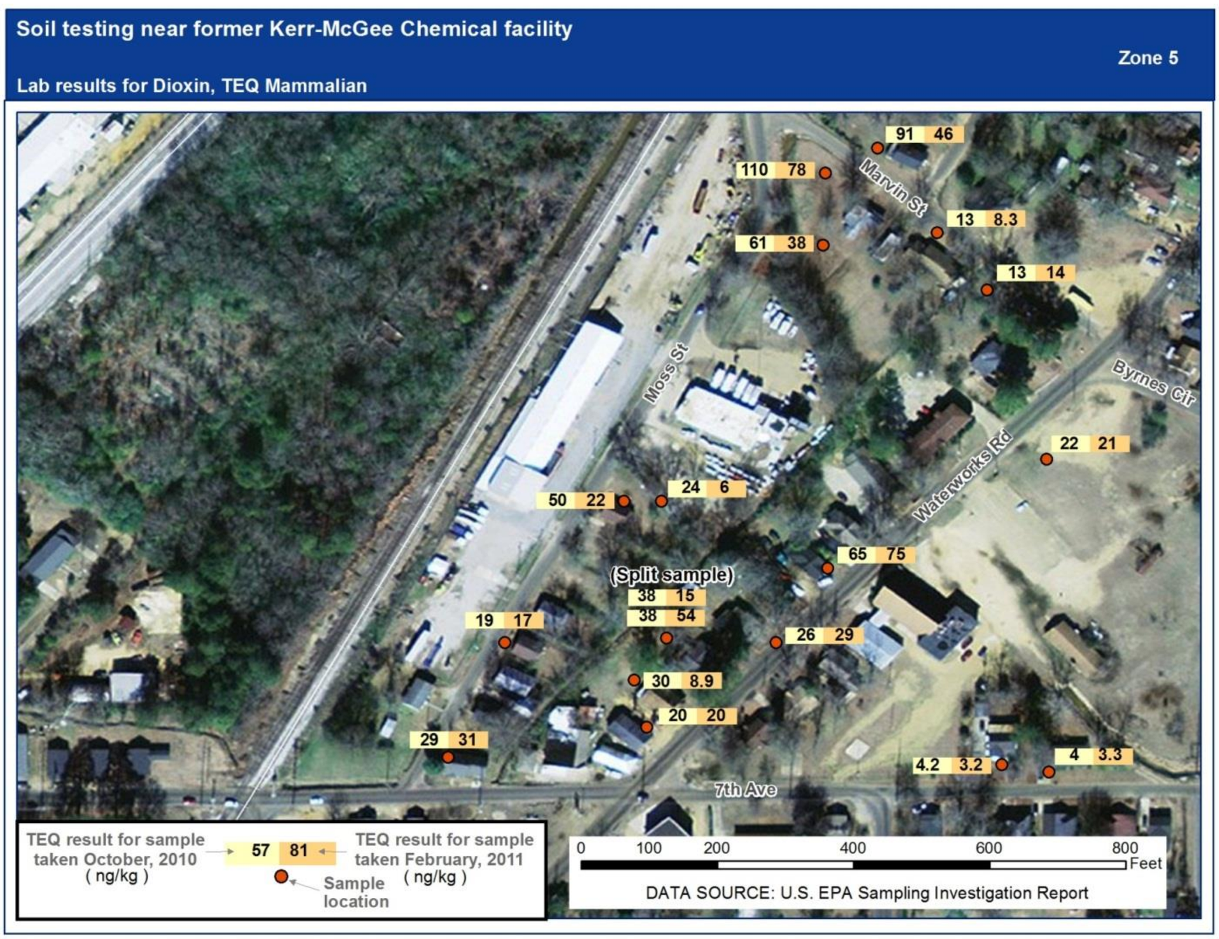
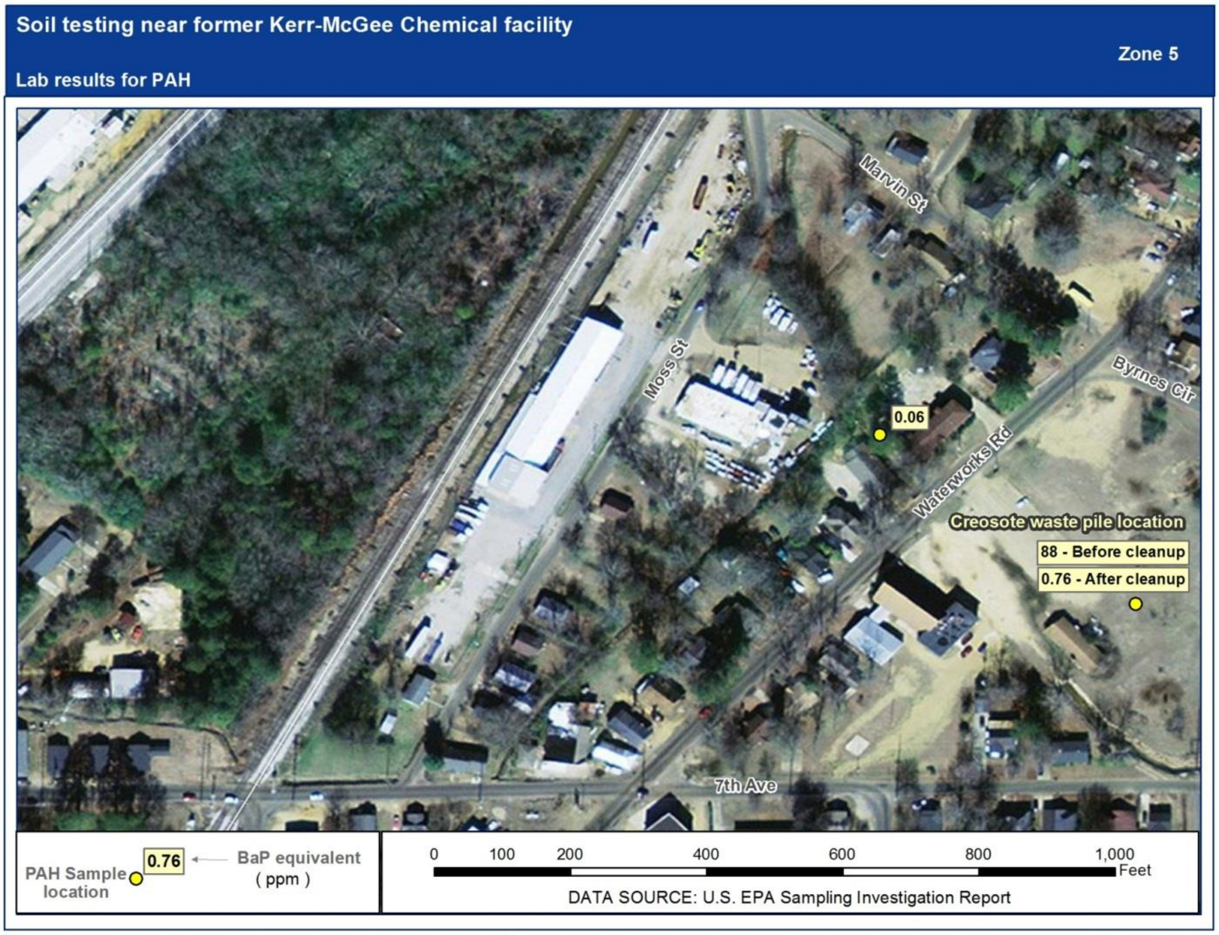


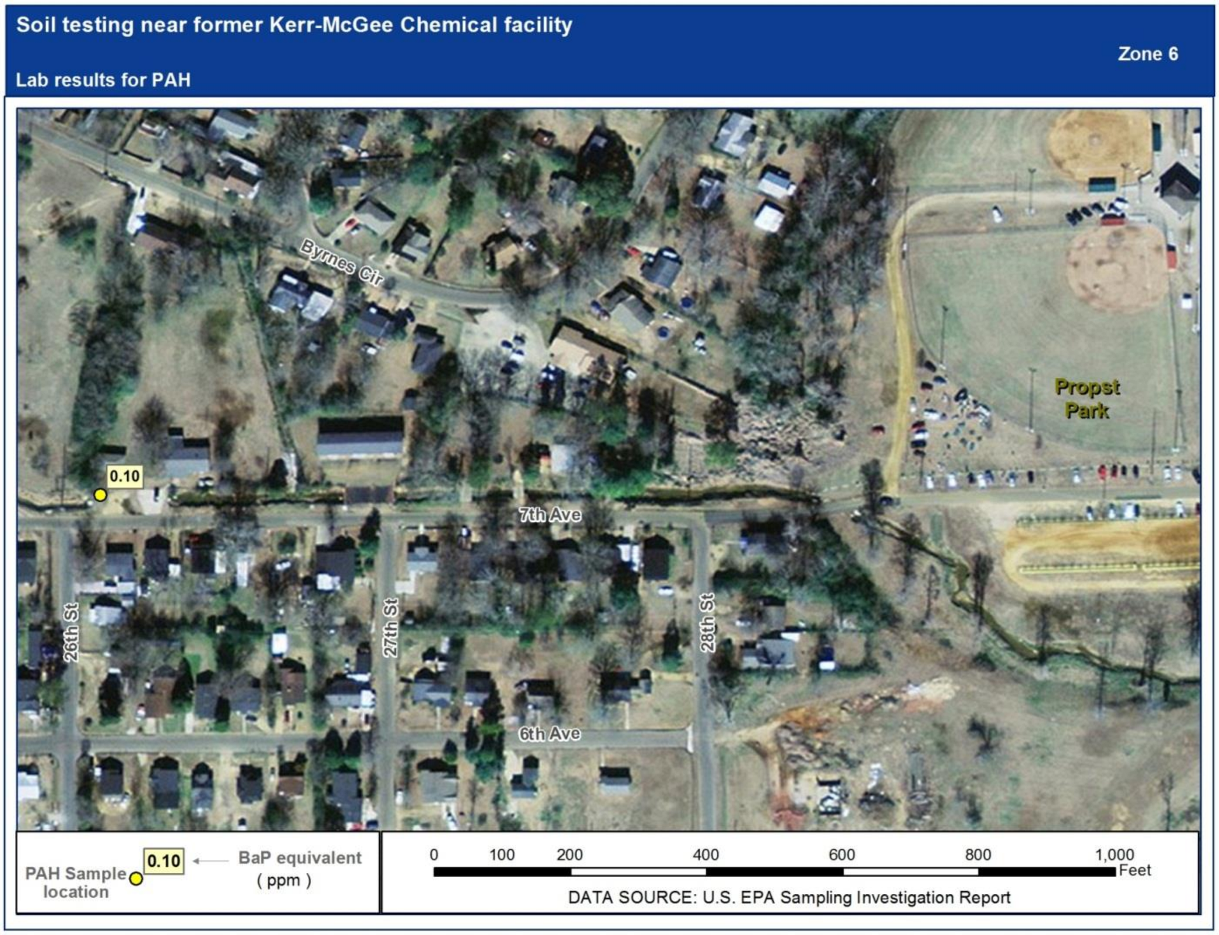
Figure 14. PAH Results in Zone 5



Zone 6 is the area between 26th and 28th Streets and 7th Avenue. Five locations were sampled to yield 8 sample results for dioxin. One location was sampled for PAHs and yielded one PAH sample result. The maximum dioxin concentration was 20 ppt and the average was 9 ppt, both of which are below ATSDR's comparison value of 35 ppt for dioxin. The PAH concentration was 0.1 ppm, which is equal to the comparison value of 0.1 ppm for PAHs. (See Figures 15 and 16)

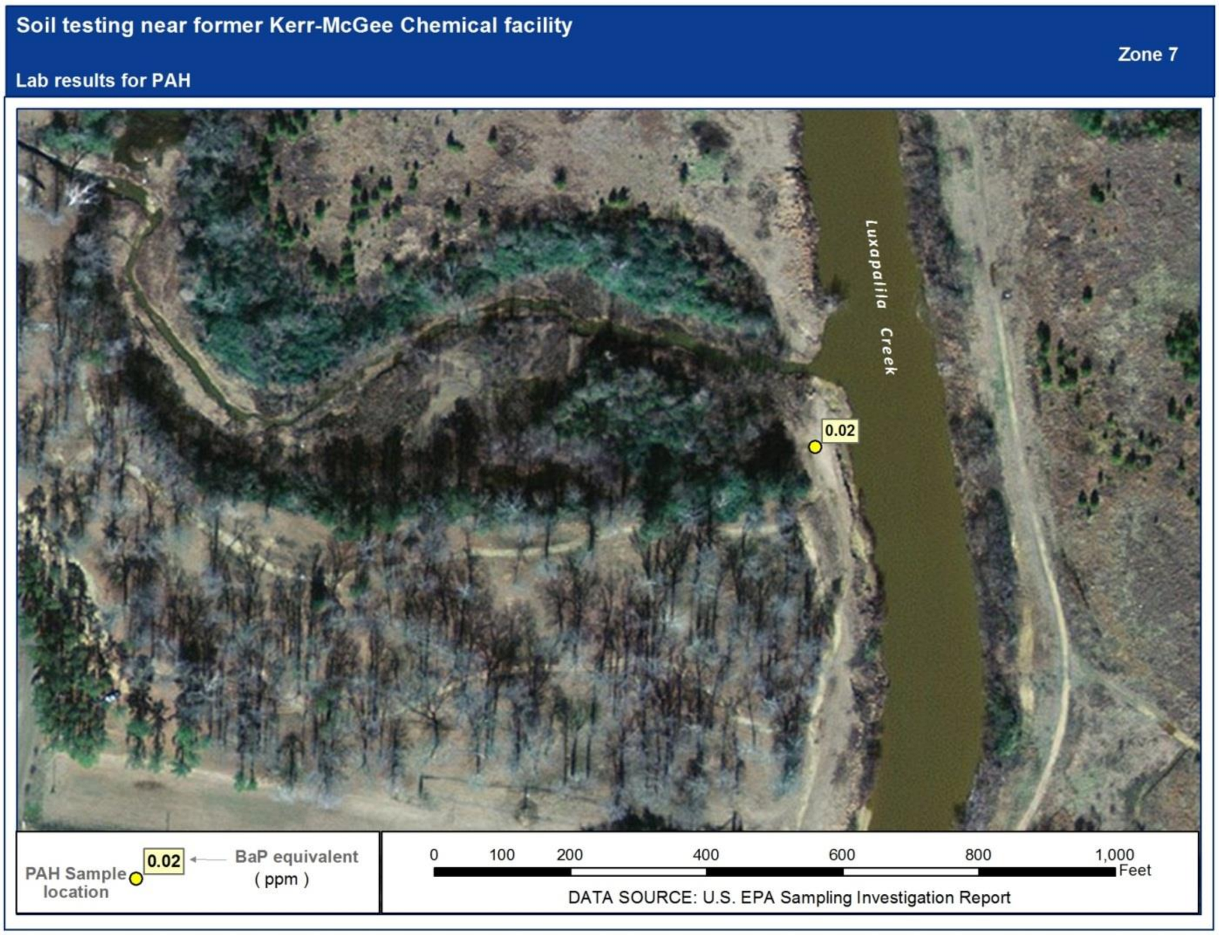
Figure 15. Dioxin results for Zone 6

Figure 16. PAH results for Zone 6



Zone 7 encompasses Propst Park in an area near Luxapalila Creek. One sample for PAHs was taken at one location adjacent to the creek and southeast of the facility. The PAHs concentration in the one sample was 0.02, which does not exceed the comparison value of 0.1 ppm for PAHs. (See Figure 17)

Figure 17. PAH results for Zone 7



In July and September 2012, EPA conducted an interim remedial investigation (RI) of the 14th Avenue Ditch Area. The 14th Avenue Ditch Area is an approximately 1,830-foot long stormwater ditch adjacent to the Kerr-McGee facility along the northern border. One of the goals of the interim RI was to delineate the nature and extent of environmental contamination in the 14th Avenue Ditch so that the City of Columbus can complete an improvement project in the area [70]. The city has proposed to relocate the existing stormwater ditch between 14th Avenue and the facility so that 14th Avenue can be widened and a new ditch with a concrete culvert can be installed [70].

EPA collected soil, sediment, surface water and groundwater samples from on-site and off-site locations near the 14th Avenue ditch [70]. The sampling events and results for surface soil, sediment and surface water are discussed below. See Figure 16 for the sampling locations.

<u>14th Avenue Ditch Area Interim Remedial Investigation Sampling - 2012</u>

On-Site Surface Soil

On-site surface soil samples were collected from 8 locations along the northern portion of the site, adjacent to the 14th Avenue ditch. These samples are considered on-site because they were taken from the northern edge of the facility property (See Figure 18). Nine grab samples, including a duplicate, were collected from 0 to 6 inches bgs [70].

Analytical results indicate the presence of PCP, PAHs, arsenic and dioxin at levels that exceed their applicable screening or comparison value. PCP was detected at concentrations ranging from 1.6 to 91.8 ppm. PAHs, reported here as BaP equivalents, were detected at concentrations ranging from 0.5 to 126 ppm. A dioxin concentration of 138 ppt was detected in the one sample analyzed for dioxin. Arsenic was detected at concentrations ranging from 2.0 to 20.8 ppm. See Table 8 below.

Table 8. Pentachlorophenol (PCP), Benzo(a)pyrene Equivalents (BaP equivalents), Dioxin And Arsenic Concentrations in On-site Surface Soil, 2012 On the Kerr-McGee Facility Property

Sample ID (see Figure 16 for location)	PCP (ppm)	BaP equivalent Total (ppm)	Dioxin (ppt)	Arsenic (ppm)
14AD-KM01-SS-A	**2.8**	**15.3**	---	**7.9**
14AD-KM02-SS-A	1.8	**0.5**	---	**2.0**
14AD-KM03-SS-A	**4.3**	**15.3**	---	**4.3**
14AD-KM04-SS-A	**6.9**	**5.3**	**138**	**14.9**
14AD-KM05-SS-A	1.6	**4.0**	---	**3.4**
14AD-KM06-SS-A	**3.3**	**10.3**	---	**3.2**
14AD-KM07-SS-A	**8.7**	**1.4**	---	**2.8**
14AD-KM08-SS-A	**91.8**	**126**	---	**13.4**
14AD-KM08-SS-A-DUP	**8.6**	**48**	---	**20.8**

--- = not analyzed
ND = chemical not detected or contaminant level below analytical testing laboratory's reporting limits
Bolded = concentration exceeds applicable comparison value (CV) of 1.8 ppm for Pentachlorophenol (PCP) , 0.1 ppm for Benzo(a)pyrene (BaP equivalent), 35 ppt for Dioxin or 0.47 ppm for arsenic

Off-Site Surface Soil

Surface soils samples were collected from 6 residential and commercial properties along the northern side of 14th Avenue. Seven grab surface soil samples, including a duplicate, were collected from 0 to 6 inches below ground surface. Off-site soil sampling locations were chosen based on risk assessment requirements for the ditch improvement project [70].

Analytical results indicate the presence of PAHs and arsenic at levels that exceed their applicable comparison value. PAHs, reported as BaP equivalents, were detected at concentrations ranging from 0.25 to 0.26 ppm. Dioxin was detected at 5.4 ppt in the one sample tested for dioxins. Although the dioxin concentration is below ATSDR's comparison value of 35 ppt for dioxin, the results are reported here because dioxin is identified as a contaminant of concern at the site. Arsenic was detected at concentrations ranging from 0.8 to 2.7 ppm. See Table 9 below.

Table 9. Benzo(a)pyrene Equivalents (BaP equivalent), Dioxin and Arsenic Concentrations in Off-site Surface Soil, 2012 Near the Kerr-McGee Facility Property

Sample ID (see Figure 16 for location)	BaP equivalent Total (ppm)	Dioxin (ppt)	Arsenic (ppm)
14AD-RP01-SS-A	**0.26**	---	**1.6**
14AD-RP02-SS-A	**0.25**	---	**1.2**
14AD-RP03-SS-A	**0.27**	---	**2.7**
14AD-RP03-SS-A-DUP	**0.26**	---	**1.8**
14AD-RP04-SS-A	**0.26**	5.4	**1.5**
14AD-RP05-SS-A	**0.26**	---	**1.8**
14AD-RP06-SS-A	ND	---	**0.8**

--- = not analyzed
ND = chemical not detected; contaminant level below analytical testing laboratory's reporting limits
Bolded = concentration exceeds applicable comparison value (CV) of 0.1 ppm for Benzo(a)pyrene (BaP equivalent), 35 ppt for Dioxin and 0.47 ppm for arsenic

Off-site Sediment, 14th Avenue Ditch

Twenty grab samples, including a duplicate, were collected from areas in the bed of the 14th Avenue ditch. The sediment samples were collected at approximately 100-foot horizontal intervals along the entire length of the 14th Avenue ditch, from North 23rd Street to approximately 100 feet before the railroad spurs adjacent to the eastern property boundary of the Site [70]. Only surface sediment samples (0 to 3 inches) are reported in this document.

Analytical results indicate the presence of PAHs, dioxin and arsenic at levels above their applicable comparison values. PAHs were detected at concentrations ranging from 0.1 to 4.3 ppm. The two samples (one sample plus a duplicate) tested for dioxin contained dioxin concentrations of 243 and 279 ppt. Arsenic concentrations ranged from 0.9 to 13.5 ppm. See Table 10 below.

Table 10. Benzo(a)pyrene Equivalents (BaP equivalent), Dioxin And Arsenic Concentrations in <u>Off-Site Sediment</u>, 2012 14th Avenue Ditch Area

Sample ID (see map for location)	BaP equivalent Total (ppm)	Dioxin (ppt)	Arsenic (ppm)
14AD-FA00-SD-A	**0.81**	---	**3.9**
14AD-FA01-SD-A	**3.3**	279	**2.8**
14AD-FA01-SD-A-DUP	**4.3**	243	**2.1**
14AD-FA02-SD-A	**0.32**	---	**1.7**
14AD-FA03-SD-A	**0.28**	---	**0.9**
14AD-FA04-SD-A	**0.47**	---	**1.8**
14AD-FA05-SD-A	**0.13**	---	**3.9**
14AD-FA06-SD-A	**0.57**	---	**1.3**
14AD-FA07-SD-A	**0.79**	---	**2.2**
14AD-FA08-SD-A	**3.1**	---	**1.5**
14AD-FA09-SD-A	**1.6**	---	**1.5**
14AD-FA10-SD-A	**1.6**	---	**3.1**
14AD-FA11-SD-A	**0.92**	---	**1.8**
14AD-FA12-SD-A	**1.8**	---	**3.0**
14AD-FA13-SD-A	**2.1**	---	**5.0**
14AD-FA14-SD-A	**0.6**	---	**1.1**
14AD-FA15-SD-A	**0.4**	---	**2.1**
14AD-FA16-SD-A	0.1	---	**13.5**
14AD-FA17-SD-A	**0.72**	---	**2.9**
14AD-FA18-SD-A	**1.7**	---	**4.0**

--- = not analyzed
ND = chemical not detected; contaminant level below analytical testing laboratory's reporting limits
Bolded = concentration exceeds applicable comparison value (CV) of 1.8 ppm for Pentachlorophenol (PCP) , 0.1 ppm for Benzo(a)pyrene (BaP equivalent), 35 ppt for Dioxin or 0.47 ppm for arsenic

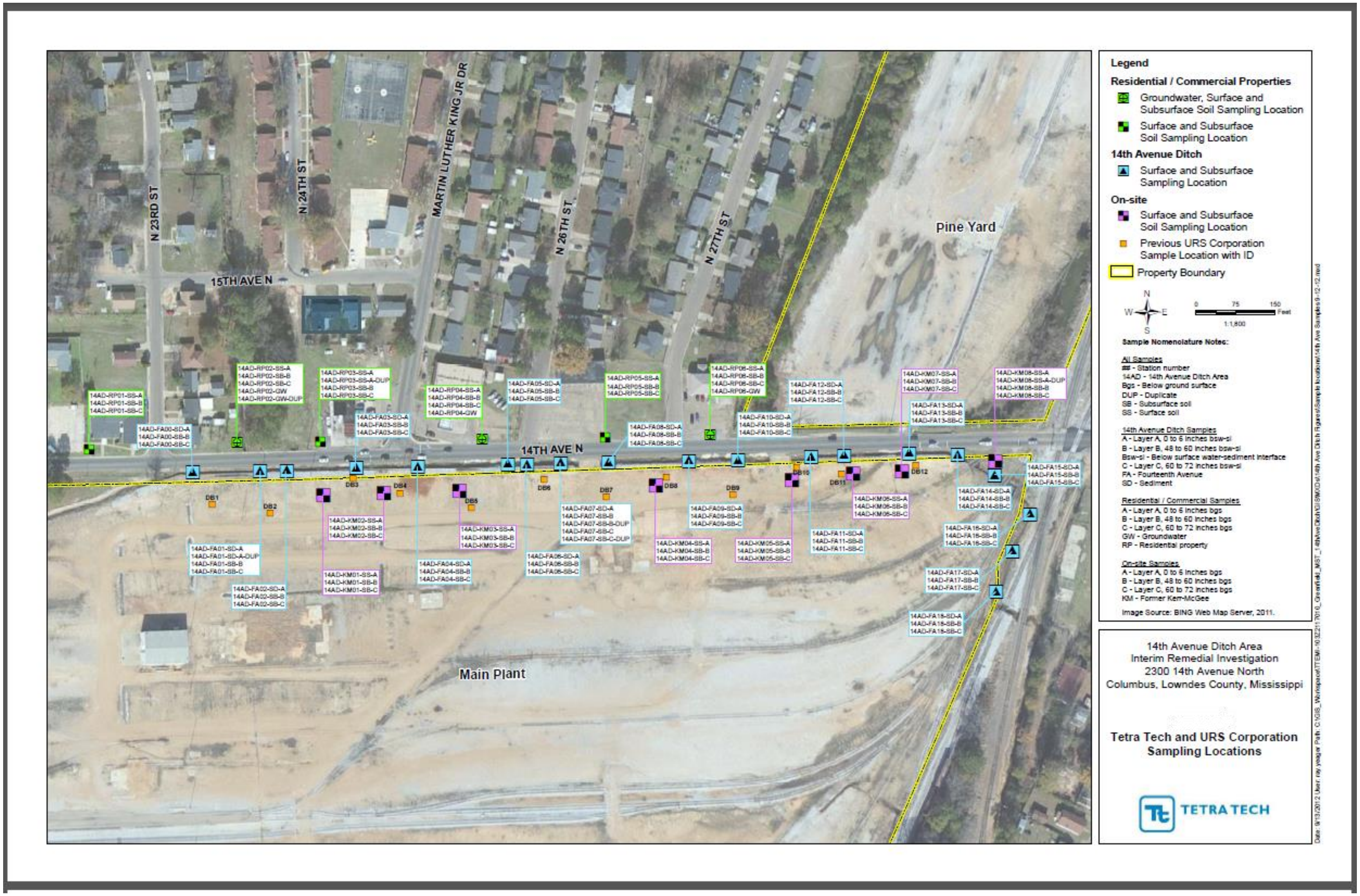
Off-site Surface Water

In September 2012, four surface water samples, including a duplicate, were collected from the 14th Avenue Ditch. One sample was collected from a ditch north of 14th Avenue and was designated as the background surface water sample for the location.

Analytical results indicate the presence of an SVOC and a metal compound above their respective comparison values. 1,4-Dioxane was detected at 1.22 ppb in one site-related sample and at 0.74 ppb in the sample designated as the background surface water sample. Both of these concentrations exceed the comparison value of 0.35 ppb for 1,4-dioxane in drinking water. Manganese was detected at 315 ppb in one site-related sample and 887 ppb in the sample designated as the background surface water sample. These concentrations exceed the comparison value of 300 ppb for manganese in drinking water.

The results for surface water do not reveal levels of contaminants that are of public health concern. We conservatively compared the surface water concentrations to drinking water standards, which are meant to be protective for people who might use the water as a drinking source. Since it is unlikely that people are drinking large amounts of water from the ditches, the exposures would be too low to cause a health concern.

Figure 18. 14th Avenue Ditch Showing Sampling Locations (Figure by TetraTech, Final Interim Investigation Report, 2013)



PATHWAYS ANALYSIS

ATSDR's public health assessment analyses are based on exposure to, or contact with, an environmental contaminant. Contaminants released into the environment have the potential to cause harmful health effects. However, 1) *not every release results in an exposure and* 2) *not every exposure results in harmful health effects.*

People can only be exposed to a contaminant if they breathe it in (inhale), swallow it (ingest), or come into skin contact (dermal) with the substance. If no one is exposed to a contaminant, then no health effects can occur. Additionally, harmful health effects will not occur with every exposure. The type and severity of health effects a person may experience depend on a number of variables, including 1) the exposure concentration (how much chemical), 2) the exposure frequency (how often), 3) the exposure duration (how long), and 4) the route or pathway of exposure. Once exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status of the exposed individual influence how the individual absorbs, distributes, metabolizes, and excretes the contaminant. Together, these factors and characteristics determine which health effects, if any, may occur.

Exposure Pathways Defined

An exposure pathway is the process by which an individual is exposed to contaminants that originate from some source of contamination. The route of a contaminant's movement through the environment is the pathway. ATSDR identifies and evaluates exposure pathways by considering how people might come into contact with a contaminant. ATSDR identifies exposure pathways by the following 5 elements:

1. a source of contamination
2. transport through the environmental medium
3. a point of exposure
4. a route of human exposure
5. a receptor population

> A *source* of contamination is the place where the contamination was released. The *environmental medium* is the groundwater, soil, sediment, surface water, air, or biota that may serve to transport contaminants from the source to possible points of human contact. The *point of exposure* is the place where people come into contact with the contaminated media. The *route* is the means by which contaminants enter the human body. The *receptor population* is the population that is exposed or potentially exposed to contaminants through identified exposure routes.

ATSDR categorizes an exposure pathway as completed or potential, or eliminates the pathway from further evaluation.

- *Completed exposure pathways* exist for a past, current, or future exposure if contaminant sources can be linked to a receptor population. All five elements of the exposure pathway must be present. In other words, people have or are likely to come in contact with site-related contamination at a particular exposure point via an identified exposure route. For an exposure to occur, a completed pathway must exist. Completed pathways require further evaluation to determine if exposures are likely to result in adverse health effects (See Table 11).

- *Potential exposure pathways* indicate that exposure to a contaminant could have occurred in the past, could be occurring currently, or could occur in the future. A pathway is potential if one or more of the five elements is missing but available information indicates possible human exposure. A potential exposure pathway cannot be ruled out, even though not all of the five elements are identifiable (See Table 12).

- An exposure pathway can be *eliminated* if at least one of the five elements is missing. Eliminated exposure pathways can also be ruled out if the site characteristics make past, current, or future human exposures extremely unlikely.

Table 11. Completed Exposure Pathways* for the Kerr-McGee Chemical Site

Exposure Pathway	Exposure Pathway Elements					Time Frame	Comments
	Sources of Contamination	Fate and Transport	Point of Exposure	Potentially Exposed Population	Route of Exposure		
Completed Exposure Pathways							
On-site Surface Soils	Past releases from wood treating operations at the Kerr-McGee facility	Uncontrolled releases onto the ground on the facility property	Contaminated soils on the facility property	Former facility employees, remedial workers, other on-site personnel; trespasser	Dermal Ingestion Inhalation	Past Current Future	Prior to remediation, contaminants were detected in soils on the facility property. Therefore, contact with contaminated on-site soil was a past completed exposure pathway. Residual contamination may still exist in some on-site areas. Currently, the site is closed and fenced, which limits public access except for the occasional trespasser. If the site is re-developed in the future, people may be exposed to residual on-site contamination, if any.
Off-site Surface Soil	Past releases from wood treating operations at the Kerr-McGee facility	Windblown particles, surface water runoff, transport & deposition of sediment during floods	Nearby residential yards, schools, playgrounds, etc.	Residents, children, gardeners, or anyone playing or working in the contaminated soils	Dermal Ingestion Inhalation	Past Present Future	Surface soil samples were collected from residential and public properties near the facility. Soil cleanup activities at Hunt Intermediate School, a residential home and a church have reduced exposures to off-site contaminated soils. However, this pathway cannot be eliminated until on-site wastes are prevented from migrating off-site and the drainage ditches are no longer a pathway for spreading contamination during flood events.

Exposure Pathway	Exposure Pathway Elements					Time Frame	Comments
	Sources of Contamination	Fate and Transport	Point of Exposure	Potentially Exposed Population	Route of Exposure		
Sediment	Past releases from wood treating operations at the Kerr-McGee facility	Contaminants carried in surface water runoff to nearby ditches, creeks, residential yards	Nearby drainage ditches or creek/streams that receive runoff from the site; drainage outfalls	Children playing or recreating in or near contaminated ditches or creeks; adults who contact contaminated sediments while engaging in outdoor activities	Dermal Ingestion	Past Present Future	Sediment in off-site drainage ditches/discharge outfalls has been contaminated by runoff from the site. In 2010, significant erosion and flooding occurred. Erosion and/or flooding may have transported on-site contaminants to off-site locations. The extent of contamination related to the breach must be evaluated and on-site wastes must be prevented from migrating off-site. This exposure pathway is a past, present and future exposure pathway.

**Note: Ambient air is a past completed exposure pathway that is addressed by ATSDR in a separate document.*

Completed Exposure Pathways

On-Site Surface Soil

A completed exposure pathway for on-site soil existed in the past. As part of their previous investigations, Kerr-McGee determined that creosote constituents, including PAHs and PCP, were present in on-site surface soils. The levels exceeded applicable comparison values.

Accidentally eating, breathing in, or touching the soil are considered primary routes of exposure, particularly for facility workers and other on-site personnel. When the facility was operating, employees who worked there might have inhaled contaminants in the air, absorbed the contaminants through their skin, or accidentally ingested the contaminants via hand-to-mouth activities. These exposures could have occurred while workers were performing their work-related duties.

According to personal accounts from people who previously worked at the facility and their families, facility workers often came in contact with the various chemicals used in the wood-treating operations. They report that workers brought their dirty work clothes homes to be washed, thereby potentially exposing their families.

The Kerr-McGee facility was closed at the end of 2003. There are currently no company employees, so any exposures to employees have stopped. ATSDR recommends that workers performing remedial activities at the site wear proper protective equipment.

The facility property is protected by a fence, which should limit and/or reduce the amount of trespassing on the site. However, the occasional trespasser might bypass the current access control features and get onto the facility grounds.

Kerr-McGee has performed source removal of impacted on-site soils in selected areas, including the former drip pad area, tank farm area and black tie storage area [7]. Kerr-McGee excavated and removed impacted soil and back filled the areas with clean soil. In addition, Kerr-McGee constructed a concrete secondary containment around the tank farm and constructed a drip pad in 1988. The removal of these source areas reduces the potential for on-site exposures and continuing contaminant releases to soil and the subsequent overland transport (e.g., via surface water runoff or wind dispersion) of these contaminants to off-site locations.

Remediation efforts have removed some of the on-site soil contamination; however, some on-site contamination remains. The fate of the property has not yet been determined. Future exposures to the on-site soil could occur to workers and others if the property is re-developed for other industrial, commercial, or residential uses. Future exposures could also occur to trespassers if access is not monitored or the fence is not maintained. Therefore, this pathway should be re-evaluated as additional information becomes available about the re-development of the property.

Off-Site Surface Soil

ATSDR identified a completed past, and potential current and future, exposure pathway as exposure to surface soil in nearby off-site areas such as residential yards, playgrounds and gardens. These exposures occur primarily as accidental ingestion of soil and dermal contact with contaminated soil by children and adults. Some dust particles may also be breathed in, although this is not considered a primary route of exposure.

Residents have expressed concerns about periodic flooding occurring in the neighborhoods surrounding the site. Flooding from the nearby ditches could cause the contaminated sediments/soils to be deposited onto yards and other nearby properties. Contaminated windblown particles could also migrate off-site and settle onto properties.

Residents also expressed concern about ponds that they believe received contaminated runoff from the facility. Residents said the ponds were filled in and homes were built on top of them. Some community members said that they smell creosote odors when they dig in their gardens.

To investigate this concern, ATSDR reviewed aerial photographs of the site from 1952, 1974, 1980, 1985 and 1992. From the historical photographs, we do note the construction of residential houses north of the site between 1952 and 1974. There also appears to be some ponds that had been located in this area prior to the construction of the houses. Yet this information alone is not enough for us to determine whether these ponds received runoff from the former facility and are now a source of contamination on residential properties. Therefore, residents who discover contamination or are concerned that there is contamination on their property should contact their local officials or EPA.

Exposure to surface soil has occurred in the past, and could occur in the present and future if there are on-site sources that contribute to off-site migration of contaminants. As stated above, flooding and erosion occurred in 2010 on and near the facility property. The drainage ditches and nearby yards could have received and may continue to receive contaminated effluent from the site. On-site containment systems must be maintained to prevent the migration of contaminants to off-site locations.

Off-site Sediments

A completed past, current and future exposure pathway is exposure to contaminated ditch sediments. In previous investigations, Kerr-McGee collected sediment samples from nearby off-site ditches (including residential and industrial/commercial locations) and from discharge points at the facility boundary (stormwater at the facility flows into an on-site ditch system and is directed to designated outfall locations). The facility had a National Pollution Discharge Elimination System (NPDES) permit to regulate pollutant discharges from the facility into surface waters. Stormwater runoff from the facility was handled by a series of unlined ditches which flow into five permitted NPDES outfalls [7]. Sampling results indicated the presence of PAHs and PCP above applicable comparison values in both surface and subsurface sediments. Although the data are not used to draw health conclusions, Lundy & Davis sampled sediment from several off-site locations, including Sanderson Ditch, ditches along 7th Avenue, Moss Street, and 14th Avenue, and a ditch near an impoundment area. These sampling results also indicate the presence of contaminants in sediment at levels above applicable comparison values.

During the public meetings and availability sessions held by ATSDR, residents reported having played in the ditches in the community during their childhood. They expressed concern that the ditches closest to the site are dirty and malodorous and that their children were sick after playing in them. They said water from the ditches occasionally overflows into their yards and they are concerned about contamination being deposited into their yards.

Contact with contaminated sediment could create exposure through dermal (skin) contact and through incidental ingestion. The primary exposed populations are children who live near the site and play in the ditches. Other exposures could occur if residents come into contact with contaminated sediments in their yards. Photos 1 and 2 in Appendix A show the proximity of drainage ditches to community properties.

In September 2004, Kerr-McGee removed approximately 1,800 linear feet of contaminated sediment from four areas within the drainage ditches bordering the facility. In 2006 and 2007, Kerr-McGee excavated affected soil from the storm drainage ditch near and within Propst Park. Removal of these sediments reduced exposures to contaminants in these areas of the ditches, and decreased source areas that contribute to transport of site-related contaminants to other areas of the ditches.

In early 2010, on-site containment failed. Erosion and flood occurred and may have allowed on-site contaminants to migrate off-site (See Photo 3). The migration of contaminants during these events may have re-distributed contamination to areas previously remediated and may have contaminated previously unimpacted areas. The extent of re-distribution or introduction of contamination to off-site locations is not known and should be investigated.

Possible current and future exposures to contaminated sediments can occur at this site if 1) people come into contact with contaminated sediments in un-remediated areas of the ditch drainage system, 2) people come into contact with contaminated sediments that have migrated to previously unimpacted areas, 3) people come into contact with subsurface (buried) contamination while digging in or excavating contaminated areas, or 4) on-site containment systems fail and allow off-site migration of contaminants from the Kerr-McGee property.

Table 12. Potential Exposure Pathways for the Kerr-McGee Chemical Site

Exposure Pathway	Exposure Pathway Elements					Time Frame	Comments
	Sources of Contamination	Fate and Transport	Point of Exposure	Exposed Population	Route of Exposure		
Potential Exposure Pathways							
Residential Dust (Indoors)							
Dust in Residential Homes	Past releases from wood treating operations at the Kerr-McGee facility	Soil adhering to shoes worn into the home: windblown particles adhering to dust	Residential Home	Occupants of homes with contaminated dust	Inhalation Ingestion	Past Present Future	Contaminants were detected in residential dust samples (attics). However, the presence of contaminants in dust could be from a variety of sources; their presence alone in an environmental sample does not indicate a site-specific completed exposure pathway.
Surface Water							
Surface water	Past releases from wood treating operations at the Kerr-McGee facility	Surface water runoff	Nearby ditches or creek/streams that receive runoff from the site; drainage outfalls	Children playing in or crossing contaminated ditches or creeks; adults who contact contaminated surface water	Dermal Ingestion	Past Present Future	Surface water sampling detected the presence of only two contaminants. The contaminant levels were too low to present a health hazard. Until on-site contamination is removed, this exposure pathway cannot be eliminated because conditions at the site could result in on-going surface water contamination. (e.g., erosion, containment breaches, etc.).
Tap Water							

Exposure Pathway	Exposure Pathway Elements					Time Frame	Comments
	Sources of Contamination	**Fate and Transport**	**Point of Exposure**	**Exposed Population**	**Route of Exposure**		
Public Water Supply	Past releases from wood treating operations at the Kerr-McGee facility	Infiltration of contaminants to municipal wells; infiltration of contaminants in ground through broken water pipes	Residential faucet/tap	Residents in the area who receive public drinking water; residents with broken below-ground pipes	Dermal Ingestion Inhalation	Future	*No elevated levels of chemicals in tested tap water. Future pathway may exist if the groundwater contaminant plume migrates and impacts municipal supply wells.*
Groundwater/Private wells							
Water from private well	Past releases from wood treating operations at the Kerr-McGee facility	Transport of groundwater contamination to private wells	Residential or industrial wells	Residents who use wells for potable purposes	Dermal Ingestion Inhalation	Future	*No one currently using private wells for potable purposes. Future development may require re-evaluation.*
Food Chain							
Fish	Past releases from wood treating operations at the Kerr-McGee facility	Contaminated sediments or surface water washed into nearby creeks	Dinner Table	People who eat fish caught from nearby creeks	Dermal Ingestion Inhalation	Past Present Future	*No elevated levels of chemicals in tested fish. However, in the future, runoff containing contaminated sediment or surface water may migrate to nearby creeks and contaminate fish*
Buried Soils							
Subsurface Soils	Past releases from wood treating operations at the Kerr-McGee facility	Subsurface soil transported or released from site	Areas of ground excavation or digging; above-ground seeps	Workers or others who contact contaminated subsurface soils	Dermal Ingestion Inhalation	Past Present Future	*No one (except trained workers) coming into contact with below ground sediments. This exposure pathway might exist in the future if buried sediments are excavated or seep to the surface*

Potential Exposure Pathways

Indoor Dust

ATSDR did not have indoor dust samples from residential properties near the Kerr-McGee facility to evaluate. However, we did find a journal article published by Dahlgren *et al.*, 2003, [2] on residential dust collected from people's homes in the area near the Kerr-McGee facility. In our previous document, we included the results of the indoor dust analysis as reported by Dahlgren *et al.* However, because ATSDR is unable to verify the validity or representativeness of the environmental sampling data used by Dahlgren *et al.*, we cannot use the data to draw health conclusions or to make recommendations. Moreover, because the dust samples in Dahlgren *et al* were collected from attics, we are unable to conclude that a completed exposure pathway exists for most residents.

Generally, there are several routes through which people may come into contact with contaminants in dust: accidentally eating it, touching it, or breathing it in. Dust particles cling to hands when people touch dust, such as when children crawl on floors. Accidental ingestion of the dust occurs when people put their hands onto or into their mouth. People breathe in the dust when it is suspended in the air. Factors that affect whether people have contact with contaminated indoor dust include the following:

- location and quantity of the indoor dust
- activities that children engage in daily and where the activities take place
- time spent in contact with the dust
- frequency and method of cleaning activities
- personal habits

Dust in undisturbed or infrequently accessed areas (such as attics) can represent the long-term accumulation of material that has been influenced for many years by the natural movement of air, penetration of outdoor contaminants, accumulation of building material particles and chemicals used indoors, and the eventual deposition of dust on many surfaces [60]. Due to the slower degradation of contaminants indoors than outdoors, contaminants in undisturbed indoor dust can accumulate over time [61]. A study in 1996 concluded that attic dust had dioxin levels 1,000 times higher than that found in the living quarters below [60].

On the other hand, dust on frequently cleaned surfaces (e.g., floors, desk tops, chair tops, etc.) reflects more recent deposits. It has been estimated that as much as 31% of indoor dust in living areas could be from nearby outdoor soil [61]. In addition to fine particles of tracked-in soil, indoor dust may also contain small particles from the indoor environment (i.e., carpet fibers), compounds used in the building (i.e., cleaning compounds and pesticides), skin flakes and clothing fibers.

Surface Water

A potential pathway associated with the site is exposure to contaminated surface water. An extensive network of unlined drainage ditches runs throughout the community. Some receive discharge from the facility and contain standing water.

The facility is located within the drainage basin of the Luxapalila Creek, which is located approximately 0.5 miles east of the facility. The downstream portion of the creek is classified for fish and wildlife support and for incidental recreational use during the months of May through October. No samples were collected from the Luxapalila Creek; therefore, no conclusions can be drawn about potential exposures to humans via the surface water pathway in the Luxapalila Creek.

Sediment contamination has been detected in drainage ditches that drain from the facility toward Luxapalila Creek [19]. In the future, these drainage ditches could receive subterranean seepage of creosote wastes that appear to have infiltrated into the soil. During the public meetings and public availability sessions held by ATSDR, residents expressed concern about coming into contact with contaminated water in the ditches and in the Luxapalila Creek.

If people have contact with contaminated water while playing, swimming or wading, they could be exposed to the contaminants via skin (dermal) contact or via incidental ingestion.

ATSDR received and evaluated only a limited amount of sampling data for surface water. The lack of many creosote constituents, such as PAHs, which have low solubility in surface water, suggests that the PAHs are adsorbed to the sediments.

However, until the on-site contamination is removed or contained, this exposure pathway cannot be eliminated because conditions at the site could change and result in more surface water contamination. (e.g., erosion, on-site containment breaches, etc.).

Drinking Water

Residents near the facility get their drinking water from the municipal supplier in the area, Columbus Light and Water. Yet, some complain of black residues, foul taste and putrid odors emanating from their drinking water. ATSDR requested and received municipal well testing data from Columbus Light and Water and the Mississippi Department of Health to investigate this concern. The submitted data (for years 2000–2006) did not reveal contamination in the municipal supply wells at levels above applicable drinking water standards or EPA's Maximum Contaminant Levels (MCLs). Lead was detected in one well (in year 2000) at a level (16 ppb) that slightly exceeds EPA's action level of 15 parts per billion (ppb) for lead in drinking water. The exceedance appeared to be a one-time event and would not have harmed people's health.

In April 2008, ATSDR conducted an exposure investigation (EI) to determine if resident's drinking water was contaminated with site-related chemicals (The full EI report is available upon request or on our website at http://www.atsdr.cdc.gov/sites/KerrMcGee/.) ATSDR collected and analyzed tap water samples from 13 homes near the site. Homes were selected for testing based on the distance of the home from the site, the age of the home (as an indication of age of the pipes), and the distance of the home from the city water treatment plant.

ATSDR tested the water for chemicals typically found at wood treating plants, including polycyclic aromatic hydrocarbons (PAHs), phenols (including pentachlorophenol (PCP)), and total petroleum hydrocarbons (TPH). Select samples were also tested for chlorinated dioxins and furans. ATSDR tested for things that could cause discoloration or bad odors, including turbidity, pH, iron, manganese, sulfide, and residual chlorine. The results revealed no harmful chemicals in the tested tap water. However, public drinking water remains a future potential exposure pathway because the groundwater in the area is still contaminated. ATSDR recommends that the groundwater contaminant plume be monitored to ensure that the municipal supply wells are not impacted in the future.

Private Wells

Past releases from the Kerr-McGee facility have contaminated groundwater at concentrations above applicable health-based comparison levels [7]. The EPA RCRA investigation identified that the alluvial and Eutaw aquifers underneath the facility are contaminated with chemicals from the wood-treating operations [57]. This pathway is incomplete as a current potential exposure source because no residents in the area are known to use private groundwater wells for potable purposes. Residents near the site are served by the municipal water supply from the City of Columbus.

The Eutaw aquifer is a source of both industrial and domestic water supplies on a regional basis [7]. Future development of the site may require installing a new well or re-commissioning the use of an old well. Therefore, this pathway should be re-evaluated as additional information becomes available about the future development of the site.

Food Chain/Fish

Luxapalila Creek is classified for fish and wildlife support downstream of the facility. Some community members expressed concern about the ditches discharging into the Luxapalila Creek, which is used for recreational fishing. Contaminated sediments or surface water may wash into the Luxapalila Creek and become a source of dioxin and dioxin-like compounds to the food chain. Bioaccumulation of site-related contaminants in fish and other aquatic organisms is possible under this scenario. Since these compounds are concentrated in higher trophic species, there is a potential for exposure.

ATSDR did not have data on the levels of contamination in fish species or in sediments in Luxapalila Creek to evaluate this potential exposure pathway. Therefore, ATSDR conducted an Exposure Investigation (EI) in June 2008 to determine if fish in the Luxapalila Creek have been impacted by site-related contaminants ((The full EI report is available upon request or on our website at http://www.atsdr.cdc.gov/sites/KerrMcGee/.)

During the EI, ATSDR collected channel catfish and spotted bass from the creek to test for dioxins. The fish were collected from a section of Luxapalila Creek that might have received surface water runoff from the Kerr-McGee facility. A second sampling location was near the town of Steens, about 5 miles upstream from the facility.

The analytical results indicate that although a small amount of dioxins were found in the fish tested, the levels were too to cause health problems in those who eat the fish. However, this pathway cannot be eliminated and remains a future potential exposure pathway because conditions at the site could change and result in more contamination reaching the creeks. (e.g., erosion, on-site containment breaches, etc.).

Subsurface Soils

Some community members expressed concern about the city finding subsurface creosote contamination while digging in the drainage ditches near their homes and the city park, Propst Park. Because this contamination is beneath the ground, most people, other than those engaged in earth-moving activities, should not come into contact with this subsurface contamination.

Kerr-McGee excavated and removed sediments in and near Propst Park between September 2006 and November 2007. However, ATSDR now understands that additional buried soils were uncovered in 2009 near the Maranatha Faith Center. Once the buried soil is uncovered, the soil is now available for human contact and becomes surface soil. Exposure to surface soil is a present completed pathway that is evaluated separately in this document.

Subsurface soil cannot be eliminated as a potential exposure pathway so long as the potential exists for residents to uncover the contaminated soil. This pathway remains a future potential pathway because 1) excavation or other earth-moving activities could uncover and expose buried, contaminated soils, 2) naturally-occurring seeps could allow subsurface contamination to move to the surface, and 3) subsurface vapors could infiltrate aboveground structures. This pathway remains a potential pathway until the site is remediated or the contamination is contained.

PUBLIC HEALTH IMPLICATIONS

In this section, ATSDR discusses the health effects that could possibly result from exposures to contaminants at the Kerr-McGee site. For a public health hazard to exist, people must contact contamination at levels high enough and for long enough time to affect their health. The environmental data and conditions at the site revealed completed exposure pathways. Because the contaminants and their concentrations in the work environment were not measured, no estimate of past exposures to workers can be made. The site is currently fenced, which should limit access to on-site soils for most of the public except for the occasional trespasser. Therefore, the on-site soil pathway will be evaluated for potential public health implications to a trespasser. The rest of the following section discusses the public health implications resulting from the off-site soil and sediment pathways.

For chemicals found to exceed comparison values, ATSDR performs calculations referred to as exposure doses (or the amount of a contaminant that gets into a person's body) and cancer risk estimates. These calculations estimate the amount of a chemical an individual may have been exposed to and the likelihood of cancer and non-cancer health effects. The calculations are based on the types of activities that individuals may be involved in that result in contact with contaminated media. (See Appendix B for a detailed discussion of ATSDR's evaluation process.) To estimate exposure doses, ATSDR made several assumptions. Assumptions are based on default values, ATSDR's Public Health Guidance Manual (2005), EPA's Exposure Assessment Handbook (2011), Child-Specific Exposure Factors Handbook (2011), or professional judgment. When available, site-specific information was used.

Uncertainty in Deciding Harmful Effects

Some uncertainty exists in deciding whether harmful effects are expected because uncertainty exists in estimating the chemical dose in people. This uncertainty exists because we are not sure exactly how much soil people ingest daily, although we have a fairly good idea. Some children swallow about 30 milligrams of soil and dust daily while some children may swallow up to 200 mg daily. Similarly, adults may swallow only a few milligrams of soil and dust daily or they may swallow 100 mg or more if they have frequent contact with soil from yard work or gardening. Uncertainty also comes from deciding the weight to use for various age groups. In addition to these factors, uncertainty comes from deciding the chemical concentration in soil to use in estimating dose. These uncertainties result in a range of doses that can be estimated for various age groups. One way to encompass this uncertainty is to use average values to get an estimated dose that represents exposure for most people. For example, to estimate the chemical dose for most children, ATSDR might use 200 milligrams of soil and dust ingested daily. Because ATSDR wants to protect all people from harmful chemicals, it is feasible to sometimes estimate the highest dose that might be expected in a population.

In addition to the uncertainty that comes from estimating a chemical dose, uncertainty could exist in the human and animal studies that identify the doses that cause harmful effects or the doses that cause no harmful effects. This uncertainty varies with each chemical. When an MRL is exceeded or if an MRL is not available, the estimated chemical dose in people is compared to the doses from human and animal studies that cause harmful effects or to doses that show no effect. This comparison along with a review of other information in ATSDR's chemical-specific toxicological profile is used to decide what harmful effects might be expected.

Uncertainty that is specific to the Kerr-McGee site is discussed in detail later in this document.

On-site Surface Soil – Occasional Trespasser (2012 Data)

Exposure Assessment

The on-site trespasser scenario was used to evaluate potential exposure to trespassers during periodic excursions onto the facility property. It should be noted that the facility grounds are fenced and should not be easily accessible to trespassers. However, teenagers and adults might be able to breach the fence and get onto the facility grounds. Therefore, we will evaluate whether an occasional trespasser is likely to suffer adverse health effects from trespassing on the facility property.

ATSDR does not have default exposure factors for human trespassers, thus site specific judgment was used to estimate appropriate exposure inputs that would not underestimate exposures. The exposure assessment assumes that a hypothetical individual trespasses on the site over time - beginning in adolescence (12+) and continuing into adulthood (18+). The trespasser scenario assumes that these trespassing events occur at a frequency of 2 times per week, or 104 days/year, for a total of 30 years. We assumed that the average trespassing adolescent weighs 57 kilograms (kg) and the average trespassing adult weighs 70 kg.

Analytical results for PAHs, PCP, dioxins and arsenic are evaluated for on-site surface soil samples collected in 2012. (The off-site sediment data from the 14^{th} Avenue ditch will be reviewed separately as an off-site exposure scenario.). Average contaminant concentrations are used to calculate exposure doses.

Health Effects Evaluation for On-Site Surface Soil (Trespasser)

Polycyclic Aromatic Hydrocarbons (PAHs) in On-site Surface Soil

Creosote is a complex mixture of many chemical compounds, including PAHs. Because PAHs exist in complex mixtures of different chemicals, the assessment of potential health effects is difficult. One approach that has been used is to calculate benzo(a)pyrene equivalents (BaP equivalents) using the toxicity equivalency factors (TEFs). To calculate the carcinogenic potential of the PAHs, each carcinogenic PAH is assigned a TEF, which is an estimate based on its relative potency to benzo(a)pyrene. The concentration of each PAH is multiplied by its TEF, and the sum of the products is described as the benzo(a)pyrene equivalent (BaP equivalent).

The following toxicity equivalency factors were used in the calculation of the BaP equivalent:

benzo(a)anthracene	0.1
chrysene	0.001
benzo(b)fluoranthene	0.1
benzo(k)fluoranthere	0.01
benzo(a)pyrene	1.0
indeno(1,2,3-cd)pyrene	0.1
dibenz(a,h)anthracene	1.0

US Environmental Protection Agency, Office of Research and Development, Office of Health and Environmental Assessment, *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbon*, July 1993.

The concentration of each PAH is multiplied by its TEF, and the sum of the products is described as the benzo(a)pyrene equivalent (BaP equivalent). For this evaluation, ATSDR used the TEF method to assess potential health effects associated with exposure to PAHs.

Table 13 shows the resulting BaP equivalent exposure doses assuming that PAHs are taken into the bodies of children and adults by both incidental soil ingestion and direct skin contact. The doses were calculated using the average concentrations in surface soils.

Using the average on-site PAH concentration (25 ppm BaP equivalents), we estimated the exposure dose to a trespasser to be 3E-05 mg/kg/day. No acute or chronic Minimal Risk Levels (MRLs) have been derived for PAHs because no adequate human or animal dose-response data are available that identify threshold levels for appropriate non-cancer health effects. However, an intermediate-duration oral MRL of 0.4 mg/kg/day has been derived for fluoranthene and fluorene; both were based on Lowest Observed Adverse Effect Levels (LOAELs) of 125 mg/kg/day for increased relative liver weight in male mice [43]. The estimated child and adult doses are several orders of magnitude lower than the doses that caused liver effects in mice.

The excess cancer risk for trespassers exposed to the average concentration of PAHs is 9E-05. Qualitatively, we interpret this as a low increased lifetime risk of developing cancer. Stated another way, a trespasser on the facility property has an estimated cancer risk of 9 in 100,000. It should be noted that the U.S. EPA generally considers an excess upper-bound lifetime cancer risk to an individual of between 1E-04 (1 in 10,000) and 1E-06 (1 in 1,000,000) as an acceptable range.[6] That means regular exposure to a substance would lead to one additional case of cancer per one hundred thousand people exposed. The excess cancer risk for trespassers at this site is within EPA's accepted risk range of 1E-04 to 1E-06. Therefore, exposure PAHs on-site is not a potential health concern to the trespasser for cancer effects. It should be noted that the estimated cancer risk was calculated using the cancer slope factor (CSF) for benzo(a)pyrene, which may not be directly applicable to risk estimation for the wider range of PAHs included in the

[6] "EPA uses the general 10^{-4} (1 in 10,000) to 10^{-6} (1 in 1,000,000) risk range as a "target range" within which the Agency strives to manage risks as part of a Superfund cleanup.… A specific risk estimate around 10^{-4} may be considered acceptable if justified based on site-specific conditions, including any remaining uncertainties on the nature and extent of contamination and associated risks. Therefore, in certain cases EPA may consider risk estimates slightly greater than 1×10^{-4} to be protective" EPA. 1991. OSWER Directive 9355.0-30. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. http://www.epa.gov/oswer/riskassessment/baseline.htm

derivation of the BaP equivalent calculation [66]. This excess cancer risk level is within the EPA's acceptable risk range of 1.0E-04 to 1.0E-6.

Therefore, trespassers exposed to the average concentration of PAHs on the site should not be at risk for non-cancer health effects and are at a low increased risk for cancer health effects.

The BaP TEF values used to calculate the BaP equivalent values are currently undergoing revision by EPA, albeit as relative potency factors (RPF)[7] rather than TEFs. If adopted, the proposed RPFs will result in higher BaP equivalent concentrations than those calculated here.

PCP in On-site Surface Soil

Pentachlorophenol is a manufactured chemical that does not occur naturally. Pure pentachlorophenol exists as colorless crystals. Impure pentachlorophenol (the form usually found at hazardous waste sites) is dark gray to brown and exists as dust, beads, or flakes. Humans are usually exposed to impure pentachlorophenol (also called technical grade pentachlorophenol). Pentachlorophenol was widely used as a pesticide and wood preservative. Since 1984, the purchase and use of pentachlorophenol has been restricted to certified applicators. It is no longer available to the general public. It is still used industrially as a wood preservative for utility poles, railroad ties, and wharf pilings [41].

ATSDR calculated exposure doses for trespassers using the average concentration detected in on-site soil (See Table 12). The exposure dose is 2E-05 mg/kg/day. The average dose for trespassers is below ATSDR's chronic MRL of 1E-03 mg/kg/day for PCP. Therefore, harmful non-cancer health effects for trespassers exposed to PCP are not likely.

There is weak evidence that PCP causes cancer in humans [41]. Studies of workers exposed to high levels of PCP found a possible association with several types of cancer, specifically Hodgkin's disease, soft tissue carcinoma, and acute leukemia. Other occupational studies did not find these associations. Increases in liver, adrenal gland, and nasal tumors have been found in laboratory animals exposed to high doses of PCP. An increased risk of cancer has been shown in some laboratory animals given large amounts of PCP orally for a long time [41]. The cancer slope factor for PCP is 0.4 mg/kg/day.

ATSDR calculated the estimated excess cancer risk for trespassers to be approximately 3E-06. This risk estimate is within the EPA's acceptable risk range of 1.0E-04 to 1.0E-6 and represents a low increased risk of cancer.

[7] US Environmental Protection Agency. External review draft: development of a relative potency factor (RPF) approach for polycyclic aromatic hydrocarbon (PAH) mixtures. Washington DC: February 2010. Available for download at: http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=194584.

Dioxins in On-Site Surface Soil

Dioxins, or chlorinated dibenzo-*p*-dioxins (CDDs), are a class of structurally similar chlorinated hydrocarbons. The basic structure is comprised of two benzene rings joined via two oxygen bridges at adjacent carbons on each of the benzene rings. Dioxins is a term used interchangeably with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCCD or TCDD). TCDD is the most toxic form of the numerous dioxin compounds. Dioxins are not intentionally produced and have no known use. They are the by-products of various industrial processes (i.e., bleaching paper pulp, and chemical and pesticide manufacture) and combustion activities (i.e., burning household trash, forest fires, and waste incineration) [30].

Not all dioxins have the same toxicity or ability to cause illness and adverse health effects. The most toxic chemical in the group is 2,3,7,8-TCDD. It is the chemical to which other dioxins are compared. The levels of other dioxins measured in the environment are converted to a TCDD-equivalent concentration on the basis of how toxic they are compared to 2,3,7,8-TCDD. These converted dioxin levels are then added together to determine the total equivalent (TEQ) concentration of the dioxins in a sample [30]. Hereafter, TCDD equivalents will be referred to as dioxins.

The EPA has an RfD for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). An RfD is an estimate of a daily oral exposure in the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Because TCDD is so toxic, very small doses can cause harmful effects. The RfD for TCDD is 7 x 10-10 mg/kg/day (or 0.0000000007 mg/kg/day or 0.0007 ng/kg/day). A nanogram (ng) is one millionth of a milligram (mg).

Two human epidemiologic studies were chosen as the basis for deriving the RfD [64]. Both of these studies evaluated a human population exposed to TCDD from a 1976 industrial accident in Seveso, Italy. One study reported increased levels of thyroid stimulating hormone (TSH) in newborns exposed to TCDD *in utero.* An increase in TSH in humans indicates a possible dysregulation of thyroid hormone metabolism. The study authors related TCDD concentrations in maternal plasma to newborn TSH levels using a linear regression model. Based on this regression modeling, EPA defined the LOAEL to be a neonatal TSH level of 5 microunits/milliliter (µU/mL). Using the Emond human PBPK model, the corresponding daily oral intake at the LOAEL is calculated to be 0.020 nanogram (ng)/kg day. Adequate levels of thyroid hormone are essential in the newborn and young infant because this is a period of active brain development. Thyroid hormone disruption during pregnancy and in newborns can lead to neurological deficiencies in newborns, particularly in attention and memory [64].

In another study, Mocarelli *et al*. reported decreased sperm concentrations and decreased motile sperm counts in men who were exposed as boys (1–9 years of age) at the time of the Seveso accident in 1976. The lowest exposure group in the study (68 ppt serum TCDD) is designated as a LOAEL. Using the Emond PBPK model, EPA calculated the LOAEL over the 10 year period to be 0.02 ng/kg/day [64]. The study also reported a lower male to female sex ratio in offspring of men exposed to TCDD less than 20 ng/kg, which supports the findings of reproductive effects involving sperm [64]. EPA divided the LOAEL of 0.02 ng/kg/day from the Baccarelli and Mocarelli studies by an uncertainty factor of 30 to arrive at the RfD of 0.0007 ng/kg/day (or 7 x 10^{-10} or 7E-10 mg/kg/day).

Using the only dioxin concentration (138 ppt) available, we estimated the exposure dose to an on-site trespasser to be 1E-10 mg/kg/day. The estimated dose is less than the RfD of 7E-10 mg/kg/day for dioxin; therefore, harmful non-cancer health effects are not likely.

Several agencies have evaluated the cancer-causing ability of dioxins. The Department of Health and Human Services (DHHS) has determined that it is reasonable to expect that TCDD may cause cancer in humans. The International Agency for Research on Cancer (IARC) also has determined that TCDD can cause cancer in people. Previously, the EPA had determined that TCDD and a mixture of TCDD are probable human carcinogens. However, EPA is currently reviewing their opinion about the carcinogenic effects of dioxins [64].

A cancer slope factor (CSF) method can be used to estimate cancer risk. The California Environmental Protection Agency (CalEPA) has developed a CSF for dioxins, specifically 1.3E5 $(mg/kg/day)^{-1}$. Using CalEPA's CSF, the excess cancer risk for trespasser on the site is 1E-05, which is within EPA's target risk range for range of 1.0E-04 to 1.0E-06. The estimated excess cancer risk could be higher or lower depending on the final CSF derived by EPA.

Therefore, a trespasser exposed to dioxin on-site should not be at risk for non-cancer health effects and is at a low increased risk for cancer health effects.

Arsenic in On-site Surface Soil

Arsenic is a naturally occurring element that is widely distributed throughout the earth's crust and may be found in air, water, and soil [40]. Arsenic in soil exists as inorganic and organic arsenic. Generally, organic arsenic is less toxic than inorganic arsenic, with some forms of organic arsenic being virtually non-toxic. Inorganic arsenic occurs naturally in soil and in many kinds of rock, especially in minerals and ores that contain copper and lead. Arsenic has also historically been used in a variety of industrial applications, including bronze plating, electronics manufacturing, preserving animal hides, purifying industrial gases, and mining, milling and smelting activities. In the past, arsenic was used as a pesticide, primarily on cotton fields and in orchards. Arsenic concentrations in soil range from about 1 to 40 ppm, with an average of 5 ppm. However, soils in the vicinity of arsenic-rich geological deposits, some mining and smelting sites, or agricultural areas where arsenic pesticides had been applied in the past may contain much higher levels of arsenic. People may be exposed to arsenic in soil by accidentally ingesting soil or by direct skin contact [40].

The estimated dose of arsenic for trespassers on the site is 8E-06 mg/kg/day. The estimated dose is lower than the chronic Minimal Risk Level (MRL) of 3E-04 (or 0.0003) mg/kg/day for arsenic; therefore, non-cancer health effects are not likely.

The U.S. Environmental Protection Agency (EPA), the International Agency for Research on Cancer (IARC), and the National Toxicology Program (NTP) classify arsenic as a human carcinogen. The EPA has developed an oral cancer slope factor to estimate the excess lifetime risk for developing cancer. Using EPA's cancer slope factor of 1.5 mg/kg/day, and based on a 30 year exposure scenario to the average arsenic concentration in soil, ATSDR calculated an excess cancer risk range of 5E-06. The U.S. EPA generally considers an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} (1 in 10,000) and 10^{-6} (1 in 1,000,000) as an acceptable range. Therefore, cancer health effects are not expected from exposure to arsenic in on-site soils.

Table 13. On-Site Surface Soil Exposure Pathway: Exposure Factors and Calculated Doses Compared to Health Guidelines
Accidental Ingestion and Direct Skin Contact
Occasional On-Site Trespasser

Chemical	Chemical Concentration (mg/kg)	Daily Intake Rate (mg/day)	Surface Areas Exposed (cm^2/day)	Soil to Skin Adherence Factor (mg/cm^2)	Absorption Factor	Exposure Frequency (days/yr)	Exposure Duration (years)	Conversion Factor	Body Weight (kg)	Averaging Time (days)	Exposure Dose (mg/kg/day)	Health Guideline (mg/kg/day)
BaP Equivalent (ingestion)	25 (AVG)	100	—	—	—	104	6/24	1E-6	57/70	10950	2E-05	None
BaP Equivalent (dermal)		NA	4770/5800	0.07	0.13	104	6/24	1E-6	57/70	10950	1E-05	
TOTAL DOSE BENZO(A)PYRENE - Trespasser											3E-05	
PCP (ingestion)	14 (AVG)	100	—	—	—	104	6/24	1E-6	57/70	10950	1E-05	1E-03 Chronic Oral MRL
PCP (dermal)		NA	4770/5800	0.07	0.24	104	6/24	1E-6	57/70	10950	1E-05	
TOTAL DOSE PCP -Trespasser											2E-05	*Below Health Guideline*
Dioxin (ingestion)	0.000138	100	—	—	—	104	6/24	1E-6	56/70	10950	1E-10	7E-10 Oral RfD
Dioxin (dermal)		NA	4770/5800	0.07	0.03	104	6/24	1E-6	56/70	10950	2E-11	
TOTAL DOSE DIOXIN - Trespasser											1E-10	*Below Health Guideline*
Arsenic (ingestion)	8 (AVG)	100	—	—	—	104	6/24	1E-6	56/70	10950	7E-06	3E-04 Oral RfD
Arsenic (dermal)		NA	4770/5800	0.07	0.03	104	6/24	1E-6	56/70	10950	9E-07	
TOTAL DOSE ARSENIC -Trespasser											8E-06	*Below Health Guideline*

Note: where the numbers are separated by a backslash (/), the top number is the exposure assumption for an adolescent/bottom number is the exposure assumption for an adult

Off-Site Surface Soil – Residential Yards and School Field (2010 and 2012 Data)

<u>Exposure Assessment</u>

To evaluate exposures to off-site surface soils in residential yards, ATSDR used two exposure scenarios. The first scenario considers each residential lawn as a separate exposure unit. The assumption for this scenario is that people, especially children, will be exposed to soil in their yard on a continuing basis. The second residential scenario considers the area where an individual, especially a child, might roam while outdoors in their neighborhood. This scenario assumes that a child will be exposed to soil in their own yard, and possibly to soil in nearby yards or community areas. To estimate these exposures, ATSDR divided the sampled area into 7 exposure zones of approximately 2000 x 1200 feet (See Figure 4). Although some people may access a wider area for play or other outdoor activities, ATSDR assumes that most frequent exposure would occur in proximity to a person's residence.

ATSDR used a separate exposure scenario to evaluate exposures at Hunt Intermediate School. The athletic field at Hunt Intermediate School is designated as a single exposure unit and is evaluated separately.

Residential Exposure Scenario

In the residential exposure setting, exposures could occur to children and adults by accidental ingestion of contaminated soil, dermal contact with contaminated soil and inhaling contaminated fugitive dust particles outdoors. Inhaling fugitive dust is also known as *indirect ingestion* because the majority of dust particles that are breathed in are trapped in the upper respiratory tract and ultimately swallowed (ingested). Because of the large particle size of contaminated soil (diameter greater than 5 micrometers), ingestion accounts for the majority of soil dust exposure during outdoor activities. Therefore, ATSDR considers the ingestion and dermal dose calculations to be adequately inclusive of fugitive dust exposures to SVOCs in surface soils under typical residential conditions.

We consider children to be the most vulnerable population. This exposure is greatest for preschool children because of their frequent hand-to-mouth activity. When chemically contaminated soil is tracked indoors, people also can be exposed to chemicals by swallowing contaminated dust that clings to their hands. Preschool children, on average, swallow more soil and dust than people in any other age group. This is because some preschoolers often have close contact with soil and dust when they play, and because they tend to engage frequently in hand-to-mouth activity.

ATSDR used the exposure parameters listed below to be typical of a child or adult engaging in recreational play or outdoor activities in a nearby residential home. Table 14 outlines the exposure assumptions used for the residential exposure scenario. Other exposure parameters (e.g., body weight, surface area, etc.) appropriate to the age of the receptor were also used.

Table 14. Summary of Exposure Parameters to Calculate **Residential Yard** Soil Exposure Doses					
Exposure Parameter (units)		Child 1 to <6 yrs	Child/Adolescent 6 to <16 yrs	Young adults 16 to < 21 yrs	Adults ≥ 21 yrs
Soil Ingestion (mg/kg)		200	200	100	100
Exposure Frequency (days/year)		350	350	350	350
Exposure Duration (years)		5	10	5	12
Body Weight (kg)		15	44	64	70
Surface Area Exposed (cm^2/day)		2800	4770	5800	5800
Averaging Time (days)		1825	3650	1825	4380
Soil to Skin Adherence Factor		0.2	0.2	0.07	0.07
PAHs Dermal Absorption Factor, ABS		0.13	0.13	0.13	0.13
Dioxin Dermal Absorption Factor,ABS		0.03	0.03	0.03	0.03

Exposure frequency (EF, the number of exposure events per year) is assumed to be equal to 350 days per year for all age groups. Although children will have a smaller total skin surface area (SA) exposed than adults, they are assumed to have a much higher soil to skin adherence factor (AF). Also, children are assumed to engage in higher soil contact activities (e.g., playing in wet soil). ATSDR used the default values for AF of 0.2 for children/adolescents and 0.07 for young adults/adults in the residential exposure scenarios.[68] To calculate the dermal portion, the chemical-specific dermal absorption fraction (ABS) used was 0.13 for PAHs and 0.03 for dioxin.

School Field Exposure Scenario - Hunt Intermediate School

Hunt Intermediate School is located on 20th Street North and consists of the main school buildings, a paved parking area and an athletic field. Most of the sampling was conducted in the field area. The school field is currently being used or was used in the past for various sports-related and recreational activities by the students of the school. Although it is likely that non-student receptors, such as community residents, may also access the school yard (e.g., walking through the school field, spectating at school events, etc.), this assessment focuses on the students because they are assumed to be more highly exposed than other community members.

The ingestion and dermal exposure dose formulas are the same for the school field exposure scenario as for the residential exposure scenario. The exposure routes are similar as well - accidental ingestion of soil, dermal absorption of contaminants from soil, and inhalation of fugitive dust. Table 15 below outlines the exposure assumptions used for the student exposure scenario.

Table 15. Summary of Exposure Parameters to Calculate Student **School Field** Soil Exposure Doses	
Exposure Parameter (units)	Student (Aged 12-14)
Soil Ingestion (mg/kg)	200*
Exposure Frequency (days/year)	180
Exposure Duration (years)	3
Body Weight (kg)	57
Surface Area Exposed (cm^2/day)	4770
Soil to Skin Adherence Factor	0.5**
Averaging Time (days)	540
Dermal Absorption Factor, ABS, PAHs	0.13
Dermal Absorption Factor, ABS, Dioxins	0.03
*Represents the upper percentile soil ingestion of the general population, EPA Exposure Factors Handbook, 2011. **Based on geometric mean soil loadings of children aged 13 to 15 years old playing soccer, *EPA Exposure Factors Handbook*, 2011, Table 5-1.	

The school field exposure parameters, however, vary in terms of age of the receptor as well as frequency and type of contact with soil contamination. In terms of age, students at the intermediate school are in grades 6 – 8, which coincides with an average age of 12 to 14. Because of the nature of school attendance, a time period of 3 years, 5 days/week, 36 weeks/year, was used as the length of time a child would attend the school and could possibly be exposed.

The actual types and intensity of exposure to students who use the school grounds cannot be determined with certainty because of the numerous variability that exists, such as the time spent on the school field by any given student and the specific activities (e.g. sports, playing, etc.) conducted by the student. For example, students of the school who participate in athletic activities associated with the school field can be more highly exposed than students who only have a moderate activity level. Student athletes are assumed to have a heavy activity level, which increases the potential for dust to be disturbed and consequently inhaled during athletic activities. Student athletes are also more likely to have frequent direct contact with soil (i.e., ingestion and dermal absorption). Therefore, in setting the default soil ingestion rate, ATSDR assumed a higher ingestion rate of 200 mg/day (representing the upper percentile of the general population, *EPA Exposure Factors Handbook*, 2011) as reasonable for a student engaged in outdoor sporting activities. ATSDR also assumed a higher skin adherence factor, 0.5, to account for the high activity level of the students. Students who did not participate in athletic activities will have lower exposures than students who participate in athletic activities.

Health Effects Evaluation for Off-Site Surface Soil

ATSDR used the specific exposure dose equations in Appendix B and exposure parameters discussed above to calculate exposure doses for residents living near the Kerr-McGee site and for students playing on the field at the Hunt Intermediate School. The doses are calculated assuming that soil contaminants are taken into people's bodies by both incidental soil ingestion and by direct contact with their skin.

The concentration of PAHs did *not* exceed the applicable comparison value for PAHs in any residential yards. Therefore, ATSDR did not calculate exposure doses for PAHs or evaluate PAHs in individual residential yards. However, we did evaluate PAHs for Hunt Intermediate School where the comparison value for PAHs was exceeded.

For a residential yard assessment, ATSDR typically calculates an exposure dose for each yard using the contaminant concentration in each yard. This approach is used because it is reasonable to assume that a child will spend most of his or her play time in their own yard. Because we so many residential yard samples, we decided to calculate exposure doses for a range of yard concentrations instead of each individual residential yard. We divided the concentrations to represent a low, middle and upper range of yard concentrations to make sure we captured all exposure levels. We attempted to exclude properties that were not residential yards. Dioxins are evaluated using the TEQ approach described in Section 3.B.3.

Note: One residential yard sampled in April 2010 had a dioxin concentration of 260 ppt, which is almost twice the highest concentration (140 ppt) measured in October 2010. This sample is designated as a single sample in Table 16 because there are no other residential yard concentrations between 140 ppt and 260 ppt. Therefore, ATSDR evaluated the 260 ppt yard separately as a maximum value for dioxin in a residential yard.

Table 16. Estimated Exposure Doses
Soil Exposure to Dioxins in Residential Yards (2010 and 2011 Data)

Dioxin Concentration in Residential Yard in ppt		AGE GROUP			
		Child 1 to <6 yrs	Child/Adolescent 6 to <16 yrs	Young Adult 16 to < 21 yrs	Adults ≥ 21 yrs
		Estimated Dose Ranges (mg/kg/day)			
Concentration Ranges	3-35	4.3E-11 5.1E-10	1.6E-11 1.8E-10	5.3E-12 6.1E-11	4.8E-12 5.6E-11
	36-60	5.2E-10 **8.7E-10**	1.9E-10 3.1E-10	6.2E-10 1.1E-10	5.8E-12 9.6E-11
	61-140	**8.8E-10** **2.0E-09**	3.2E-10 **7.3E-10**	1.1E-10 2.5E-10	9.8E-11 2.2E10
	260 (one yard)	**3.8E-09**	**1.4E-09**	4.6E-10	4.2E-10
Dioxin Chronic RfD: 7E-10 mg/kg/day. Bolded text means dose exceeds the RfD.					

For an expanded residential exposure analysis, ATSDR calculated exposure doses for the average concentration from each defined zone (Zones 2-7). As previously stated, the purpose of conducting the expanded analysis is to determine if any areas are more contaminated than others, and to capture a wider area that a child might play and therefore be exposed.

As mentioned above, PAHs are not evaluated in residential yards because none of the concentrations exceeded applicable comparison values. Dioxins are evaluated using the TEQ approach described above.

Table 17. Child and Adult Exposure Doses and Cancer Risks Soil Exposure to Dioxins in Residential Zones (Zones 2-7)							
	Zone	Average Conc.	Child Doses (mg/kg/day)	Child/ Adolescent Doses (mg/kg/day)	Young Adult Doses (mg/kg/day)	Adult Doses (mg/kd/day)	Excess Cancer Risk- Adult (33 years of exposure)
Dioxin, ppt	Zone 2	52	**7.2E-10**	2.6E-10	1.0E-10	9.6E-11	1.5E-05
	Zone 3	17	2.6E-10	9.0E-11	3.1E-11	2.8E-11	5.0E-06
	Zone 4	30	4.4E-10	1.6E-10	5.5E-11	4.8E-11	8.6E-06
	Zone 5	32	4.7E-10	1.9E-10	5.8E-11	5.1E-11	1.0E-05
	Zone 6	9	1.3E-10	4.8E-11	1.6E-11	1.4E-11	2.6E-06
	Zone 7	---	---	---	---	---	
Dioxin Chronic RfD: 7E-10 mg/kg/day; CalEPA Cancer Slope Factor: 1.3E+5 $(mg/k/gday)^{-1}$							

Source: *TCDD oral slope factor*, CalEPA Consolidated Table of OEHHA / ARB Approved Risk Assessment Health Values, May 2012, accessed online September 18, 2012.

ATSDR used the specific exposure dose equations in Appendix B and exposure parameters discussed above to calculate exposure doses for students playing on the field at the Hunt Intermediate School.

Table 18. Student Exposure Doses and Cancer Risks, Soil Exposure to Dioxins and PAHs at School Athletic Field (Zone 1)			
	Average Concentration	Student Dose	Excess Cancer Risk
Dioxin, ppt	53	2E-10	1E-06
PAHs, ppm	0.15	1E-06	3E-07
Dioxin Chronic RfD: 7E-10 mg/kg/day; CalEPA Cancer Slope Factor: 1.3E+5 $(mg/k/gday)^{-1}$			

Source: TCDD oral slope factor, CalEPA Consolidated Table of OEHHA / ARB Approved Risk Assessment Health Values, May 2012, accessed online September 18, 2012.

Dioxins in Off-Site Surface Soil (Residential Yards and Hunt Intermediate School)

ATSDR assessed dioxin concentrations in individual residential yards. Dioxin concentrations in residential yards ranged from 3 to 260 ppt. Dioxin concentrations exceeded the comparison value of 35 ppt in nine residential yards.

As an additional evaluation tool, we divided the sampled area into zones to determine if certain areas are more impacted than others (see Table 6 for a description of each zone). Average dioxin concentrations exceed ATSDR's comparison value of 35 ppt in 5 out of 6 zones for which dioxin concentrations were measured. The highest average concentration is 52 ppt and is in Zone 2. The maximum and average dioxin concentrations for Hunt Intermediate School (Zone 1) are 88 ppt and 53 ppt, respectively.

For individual yards, ATSDR assessed exposures by dividing the yards into low, medium and high dioxin concentration ranges and a maximum concentration found in one yard. As shown in Table 16, some of the estimated doses for children (aged 1 to <6 years) and children/adolescents (aged 6 to <16 years) are greater than the RfD for dioxins. The highest estimated dose for children, 3.8E-09 mg/kg/day, exceeds the RfD by five-fold; the highest estimated adolescent dose, 1.4E-09 mg/kg/day, exceeds the RfD by two-fold. The RfD for dioxin is 7E-10 mg/kg/day. As a reminder, the RfD is an estimate of a daily oral exposure in the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

None of the young adult (aged 16 to < 21 years) or adult (aged 21+) doses exceed the RfD for dioxins. Also, only one of the residential zones (Zone 2) and none of the student doses from the Hunt Intermediate School athletic field exceeded the RfD for dioxin. Therefore, young adults, adults and students are not at risk of harmful, non-cancerous health effects.

Because some of the child and adolescent doses exceed the RfD for dioxin, a further evaluation was conducted to determine the risk for harmful health effects to children and adolescents. As part of the more thorough evaluation, ATSDR compared the estimated child and adolescent doses to effect levels that are reported to cause harmful effects. In the case of dioxins, we used the critical studies that were used to derive the RfD. The studies derived a Lowest Observed Adverse Effect Level (LOAEL) of 2E-08 mg/kg/day. Because, by definition, LOAEL doses cause adverse health effects, exposures that approach or exceed a LOAEL are of concern.

A useful tool for comparing the estimated dose with an effect level, such as the LOAEL, is the use of the margin of exposure. A margin of exposure is the difference between the estimated dose and the dose that causes harmful effects. The margin of exposure provides insight into how close an estimated dose is to the dose that causes harmful effects. For example, a margin of exposure of 5 means that the estimated dose is five times below levels that have been shown to cause harmful effects.

The formula to derive the margin of exposure is as follows:

$$\textit{Margin of Exposure} = \frac{\textit{Lowest Observed Adverse Effect Level (LOAEL) in mg/kg/day}}{\textit{Estimated Dose in mg/kg/day}}$$

Using the above formula, ATSDR calculated the margin of exposures for children and adolescents.

Table 19. Margin of Exposure in children and adolescents Exposed to Dioxin in residential soil					
	Residential Yard Concentration, ppt	Child (1 to <6 years) Doses (mg/kg/day)	Margin of Exposure	Child/Adolescent (6 to < 16 years) Doses (mg/kg/day)	Margin of Exposure
Dioxin	3-35	4.3E-11 5.1E-10	465 - 39	1.6E-11 1.8E-10	1250 - 111
	36-60	5.2E-10 8.7E-10	38 – 22	1.9E-10 3.1E-10	105 – 64
	61-140	8.8E-10 2.0E-09	23 – 10	3.2E-10 7.3E-10	63 - 27
	260 (one yard)	3.8E-09	5	1.4E-09	14
Dioxin Lowest Observed Adverse Effect Level (LOAEL) = 2E-08 mg/kg/day					

The estimated doses for children are from 5 to 465 times below the levels that are thought to cause harmful effects in humans, 2E-08 mg/kg/day. The doses for adolescents are 14 to 1250 times below the harmful effect level. Children have the greatest risk of experiencing harmful effects from exposure to dioxin in their yards because their estimated doses are closest to the effect level, especially at higher concentrations of dioxin. Adolescents might also be at risk for harmful, non-cancerous health effects.

Because TCDD is so toxic, very small doses can cause harmful effects [71]. The epidemiological studies detailed above report that exposure to TCDD *in utero* can cause neurological problems in newborns, such as problems with memory and attention. In addition, exposure to TCDD *in utero* or as young boys can cause health effects later in life, such as:

- Decreased sperm concentration,
- Decrease in motile sperm count, and
- Fewer male offspring by exposed males.

Human studies have shown that TCDD can cause liver cancer and might be associated with lung, colon, prostrate, breast, lymphatic, and hematopoietic cancers [71]. Rodent studies have confirmed that TCDD can cause cancer at multiple sites, including the liver, lung, mouth, and thyroid [30,71].

The California Environmental Protection Agency (CalEPA) has developed a CSF for dioxins, specifically 1.3E+5 $(mg/k/gday)^{-1}$. Using CalEPA's CSF and the maximum concentration of dioxin in yards (260 ppt), ATSDR calculated the following excess cancer risks:

Table 17a. Excess Cancer Risks from Exposure to Maximum Dioxin Concentration in Residential Yards				
Maximum Dioxin Concentration (ppt)	Child 1 to <6 yrs	Child/Adolescent 6 to <16 yrs	Young Adult 16 to < 21 yrs	Adults ≥ 21 yrs
260	3.5E-05	2.6E-05	4.3E-06	9.4E-06
CalEPA Cancer Slope Factor: 1.3E+5 $(mg/k/gday)^{-1}$				

The estimated excess cancer risk for children is 4E-05, or 4 extra cases of cancer for every 100,000 children exposed. The cancer risk for adolescents is 3E-05, or 3 extra cases of cancer for every 100,000 adolescents exposed. For a young adult, the excess cancer risk is 4E-06. For adults exposed for 33 years (21 years as a child and 12 years as an adult), the excess cancer risk is 8E-05. All of the excess cancer risks are within EPA's acceptable risk range of 1.0E-04 and 1.0E-06. Because the excess cancer risks were calculated using the maximum dioxin concentration found in a residential yard, it follows that lower dioxin concentrations will yield lower cancer risk levels.

All of the excess cancer risks in Zones 2 – 7 (Table 17) and for students at Hunt Intermediate School (Table 18) are within EPA's acceptable risk range of 1.0E-04 to 1.0E-06. Therefore, the excess cancer risk for children, adolescents, young adults, adults and students exposed to dioxin in soil is low.

PAHs in Off-Site Surface Soil (Hunt Intermediate School)

ATSDR calculated exposure doses for students at Hunt Intermediate School exposed to PAHs in soil. Mice fed high concentrations of BaP during pregnancy (and/or their offspring) had difficulty reproducing, birth defects, and decreased birth weights. Studies of other animals have shown that BaP causes harmful effects on skin, intestinal mucosa (enzyme alterations), and immune system deficiencies. Similar effects could occur in people but have not been documented. No acute or chronic Minimal Risk Levels (MRLs) have been derived for PAHs because no adequate human or animal dose-response data are available that identify threshold levels for appropriate non-cancer health effects. However, an intermediate-duration oral MRL of 0.4 mg/kg/day has been derived for fluoranthene and fluorene; both were based on Lowest Observed Adverse Effect Levels (LOAELs) of 125 mg/kg/day for increased relative liver weight in male mice [43]. The estimated child, student and adult doses are several orders of magnitude lower than the doses that caused liver effects in mice. However, it is worth noting that this conclusion is based upon limited data for PAHs in residential soil.

ATSDR also estimated excess cancer risks from exposure to PAHs in school soils near the Kerr-McGee facility. The estimated excess cancer risk is 3E-07. This cancer risk estimate is lower than the EPA acceptable risk range of 1.0E-04 to 1.0E-6 and represents a low increased risk of cancer. However, it should be noted that the estimated excess cancer risks are calculated using the CSF for benzo(a)pyrene, which may not be directly applicable to risk estimation for the wider range of PAHs included in the derivation of the BaP equivalent calculation [66].

Note: As stated above, the BaP TEF values used to calculate the BaP equivalent values are currently undergoing revision by EPA.

Health Effects Evaluation for Creosote Waste Pile on Church Property

The creosote waste material at the church property on Waterworks Road was unsecured and accessible to public since it was unearthed in 1998. Levels of PAHs up to 88 ppm were detected in the waste pile. If a child or adult were exposed to the creosote waste pile for 13 years (the amount of time the pile was uncovered and unsecured), the child (9.5E-04 mg/kg/day) and adult (1.3E-04 mg/kg/day) exposure doses are orders of magnitude less than the BaP dose that caused liver toxicity in mice [43]. However, dermatological effects cannot be ruled out if people contacted the waste material. The estimated excess cancer risk would be 1E-03. This estimated cancer risk is greater than EPA's acceptable risk range of 1.0E-04 to 1.0E-6. Therefore, based on potential dermatological and excess cancer risks, exposure to the creosote waste material at the church property was a health concern. In 2011, EPA removed the waste pile, which reduces future exposures to the church members or to others on the property.

Summary of Clean Up Activities Reduce Exposure to Off-site Contaminated Surface Soil

Moss Street Residential Property

EPA excavated soil at a residential property on Moss Street. The area of excavation included the northeastern portion of the property to a depth of 1 foot bgs, except shallower within 2 feet of the house foundation and beneath the drip line of trees to avoid damaging the foundation or trees. A total of approximately 148.6 tons of soil were removed from the location and transported off-site for disposal. EPA collected one five-point composite confirmation soil sample from the bottom of the excavation and one sample from the surface of the driveway. After clean up, the results confirmed that no contaminants were present at concentrations exceeding EPA's RALs for the site. Restoration activities including backfilling, spreading of grass seed, and other erosion control measures were conducted at the both locations.

Hunt Intermediate School

In April 2011, EPA conducted a removal action at two properties where benzo(a) pyrene concentrations exceeded the designated screening value, or 1.5 ppm benzo(a)pyrene as the Removal Action Level (RAL). Two properties – Hunt Intermediate School and a property on Moss Street – were selected for removal activities.

EPA excavated an area measuring approximately 50 x 50 feet in the former football field to a depth of 1 foot below ground surface (bgs). A total of approximately 99.14 tons of soil were removed from the location and transported off-site for disposal. EPA collected one five-point composite confirmation sample from the bottom of the excavation. The analytical results confirmed that no contaminants were present at concentrations exceeding EPA's Removal Action Levels for the site.

Creosote Waste Pile

In February 2011, EPA initiated an emergency response to clean up the creosote waste pile at the Maranatha Faith Center. EPA excavated and disposed of approximately 30.93 tons of contaminated soil from the church property. After the waste material was removed, the dioxin concentration was 1.8 ppt, down from 850 ppt prior to removal. The PAH concentration was 88 ppm BaP equivalents prior to removal, but reduced to 0.08 ppm after the waste pile was removed.

Off-site Sediments – Neighborhood Drainage Ditches (Data from 1996 – 2002, 2010)

Exposure Assessment

Sediment in off-site drainage ditches and discharge outfalls has been contaminated by runoff from the Kerr-McGee facility. ATSDR used data collected by Kerr-McGee in their investigations from June 1996 to February 2002 to determine contaminant concentrations in sediment. In 2004, Kerr-McGee excavated and removed contaminated sediment from the drainage ditches bordering the facility. This removal action cleaned up some, but not all, of the contamination. The sediment not removed during this removal action is referred to as the residual contamination, and represents the most current data ATSDR had to evaluate sediment concentrations in the greater community drainage ditches near the site. As mentioned above, the flood and erosion events in 2010 could have caused the redistribution of contaminants in the ditches. EPA collected new sediment data in April 2010 from the drainage ditches and in 2012 from the 14th Avenue Ditch Area. However, the new data are limited to only a small section of the total ditch drainage system in the area. ATSDR will use the data available from 2010 to add to our evaluation of drainage ditches and the data from 2012 to evaluate the 14th Avenue ditch area only. The community ditch sediment data and the 14th Avenue Ditch Area sediment data are discussed separately.

People may be exposed to contaminants in sediment while doing outdoor work or while playing in nearby ditches. They can accidentally swallow small amounts of contaminated sediment that cling to their hands, and they can absorb contaminated sediment when it comes into contact (dermal) with their skin. (Dermal absorption of chemicals from sediment depends on the area of contact with exposed skin, the duration of contact, the chemical and physical attraction between the contaminant and the sediment, the ability of the chemical to penetrate the skin, and other factors.)

To estimate how much of a chemical a person might be exposed to in contaminated sediments, ATSDR calculated exposure doses for children and adults using the formulas in Appendix B.

For purposes of this evaluation, ATSDR assumed that adults would be exposed for 182 days (6 months) per year for a total of 30 years. Children were also assumed to be exposed to sediment in ditches for 182 days (6 months) per year for a total of 7 years. The exposure period is based upon the assumption that adults or children might work outdoors near or play in the ditch every other day instead of every day. The actual time spent working or playing may be more or less than that assumed by ATSDR.

ATSDR assumes that the average child accidentally ingests 100 milligrams of sediment per day and an adult accidentally ingests 100 milligrams of sediment per day. For average body weight, 30 kg (approximately 66 pounds) was used for a child and 70 kg (approximately 157 pounds) was used for an adult. The mean and maximum sediment concentrations were used for each calculation because it was difficult to determine appropriate exposure units with the available data. Therefore, we assumed that a person might be exposed to either the high or the mean contaminant concentration.

For the dermal contact pathway, ATSDR assumed that the surface area available in a child for direct skin contact is 2,800 cubic centimeters per day (cm^2/day); the surface area available in an adult is 5,800 cm^2/day.

A soil to skin adherence factor of 0.07 milligrams per square centimeter (mg/cm^2) was used for adults and 0.2 (mg/cm^2) was used for children. An absorption factor (ABS) of 0.06 was used for dioxin, 0.10 for PAHs and 0.24 for pentachlorophenol. Absorption factors are used to reflect the desorption of the chemical from soil and the absorption of the chemical across the skin and into the bloodstream.

Health Effects Evaluation for Off-Site Sediments (1996-2002)

PAHs in Off-site Ditch Sediment

Table 20 shows the resulting BaP equivalent exposure doses assuming that PAHs are taken into the bodies of children and adults by both incidental soil ingestion and direct skin contact. The doses were calculated using the average and highest concentrations in sediment. The child exposure doses ranged from 2E-05 to 1E-04 mg/kg/day. The adult doses ranged from 9E-06 to 6E-05 mg/kg/day.

Mice fed high concentrations of BaP during pregnancy (and/or their offspring) had difficulty reproducing, birth defects, and decreased birth weights. Studies of other animals have shown that BaP causes harmful effects on skin, intestinal mucosa (enzyme alterations), and immune system deficiencies. Similar effects could occur in people but have not been documented [38].

No acute or chronic Minimal Risk Levels (MRLs) have been derived for PAHs because no adequate human or animal dose-response data are available that identify threshold levels for appropriate non-cancer health effects. However, an intermediate-duration oral MRL of 0.4 mg/kg/day has been derived for fluoranthene and fluorene; both were based on Lowest Observed Adverse Effect Levels (LOAELs) of 125 mg/kg/day for increased relative liver weight in male mice [38]. The estimated child and adult doses are several orders of magnitude lower than the doses that caused liver effects in mice.

During our meetings with the community, many community members complained of finding dermatological effects after exposure to creosote. The dermatological system is particularly vulnerable to the effects of creosote; therefore, some dermatological effects could be associated with exposure to creosote-contaminated soil. Creosote workers report skin rash symptoms as their most frequent complaint, as well as a high rate of photosensitivity [38]. Skin is particularly vulnerable to the effects of creosotes [38]. In an industrial health survey involving 251 employees at 4 wood preservative plants where coal tar creosote and coal tar is used, there were 82 reported instances of dermal effects, ranging from mild skin irritation, eczema, and folliculitis (inflammation of the hair follicles) to non-cancerous skin growths such as warts [38]. Skin irritation was described as a redness like a sunburn, lasting 2 to 3 days, along with photosensitivity that has been reported by workers who handle coal tar pitch products outdoors [38]. Dermal effects were also noted as part of a site surveillance program conducted by the Texas Department of Health involving residents living in a housing development that was built on part of an abandoned creosote wood treatment plant (Koppers Company, Texarkana, Texas) [39]. Residents reported a much higher prevalence of skin rashes in general (27.9%) during the first year of the survey compared to the prevalence of the control neighborhood (4.9%). Rashes were most often associated with digging in the yard, having contact with the soil, or wading in or having contact with a creek in the area. Most of these rashes were associated with significant itching or burning. The contaminant levels found in sediments at the Kerr-McGee site are below the levels that caused dermatological effects in these studies. However, exposure to higher concentrations found in creosote-contaminated product in the subsurface could cause some of the dermatological effects described above.

Several PAHs, including benzo(a)pyrene, have been found to cause tumors in laboratory animals when the animals breathed these substances in air (lung and respiratory cancer), or ate them (gastric tumors), or had long periods of skin contact with them (skin cancer). Occupational studies showed that workers who breathed or had skin contact with PAHs for long periods developed cancer. Workers who had long-term skin contact with creosote, especially during wood treatment or manufacturing processes, reported increases in skin cancer and cancer of the scrotum. Cancer of the scrotum has been associated with long-term exposure to soot and coal tar creosotes in chimney sweeps. Animal studies have also shown an association between creosote exposure and skin cancer [38].

The ATSDR calculated estimated excess cancer risks from 70 year exposures to the concentration of PAHs in sediment at the site. Site-specific exposure doses are multiplied by EPA's cancer slope factor (CSF) to estimate an estimated excess cancer risk.

The CSF for BaP (7.3 mg/kg/day) is based on the geometric mean of four different dose response models using multiple species and both sexes. The EPA considers the available human cancer data to be inadequate to determine carcinogenic effect. However, multiple animal studies in many species demonstrate BaP to be carcinogenic following administration by numerous routes. [67]. The CSF used in this evaluation is specifically applicable to evaluation of BaP cancer risk and is inferred for evaluation of BaP equivalent cancer risks.

ATSDR calculated the lifetime estimated cancer risk to be 4E-05 (average concentration) to 3E-04 (maximum concentration). The maximum risk estimate is greater than the EPA acceptable risk range of 1.0E-04 to 1.0E-6 and represents a moderate increased estimated risk of cancer (for skin and stomach cancers). However, it should be noted that the estimated lifetime cancer risks are calculated using the CSF for benzo(a)pyrene, which may not be directly applicable to risk estimation for the wider range of PAHs included in the derivation of the BaP equivalent calculation [66]. Also, the risk calculation assumes that 100% of the BaP ingested is absorbed and probably overestimates the actual dose and resulting cancer risk.

Table 20. Sediment Exposure Pathway: Exposure Factors and Calculated Doses Compared to Health Guidelines
Accidental Ingestion and Direct Skin Contact - High and Average Exposures
PAHs, Kerr-McGee Data, 1996-2002

Chemical	Chemical Concentration (mg/kg)	Daily Intake Rate (mg/day)	Surface Areas Exposed (cm^2/day)	Soil to Skin Adherence Factor (mg/cm^2)	Absorption Factor	Exposure Frequency (days/yr)	Exposure Duration (years)	Conversion Factor	Body Weight (kg)	Averaging Time (days)	Exposure Dose (mg/kg/day)	Health Guideline (mg/kg/day)
BaP Equivalent (ingestion)	51 (MAX)	100	—	—	—	182	30	1E-6	70	10950	4E-05	None
BaP Equivalent (dermal)		NA	5,800	0.07	0.10	182	30	1E-6	70	10950	2E-05	
TOTAL HIGH DOSE PAHs- Adult											6E-05	*N/A*
BaP Equivalent (ingestion)	9 (AVG)	100	—	—	—	182	30	1E-6	70	10950	6E-06	None
BaP Equivalent (dermal)		NA	5,800	0.07	0.10	182	30	1E-6	70	10950	3E-06	
TOTAL AVERAGE DOSE PAHs -Adult											9E-06	*N/A*
BaP Equivalent (ingestion)	51 (MAX)	100	—	—	—	182	7	1E-6	30	2555	8E-05	None
BaP Equivalent (dermal)		NA	2,800	0.2	0.10	182	7	1E-6	30	2555	4E-05	
TOTAL HIGH DOSE PAHs - Child											1E-04	*N/A*
BaP Equivalent (ingestion)	9 (AVG)	100	—	—	—	182	7	1E-6	30	2555	1E-05	None
BaP Equivalent (dermal)		NA	2,800	0.2	0.10	182	7	1E-6	30	2555	8E-06	
TOTAL AVERAGE DOSE PAHs -Child											2E-05	*N/A*

PCP in Off-site Ditch Sediment

ATSDR calculated exposure doses for PCP using the average and highest concentrations detected in sediment (See Table 22). The child exposure doses ranged from 1E-05 mg/kg/day to 5E-05 mg/kg/day. The adult doses for PCP ranged from 4E-06 mg/kg/day to 2E-05 mg/kg/day. The exposure dose for children and adults is below ATSDR's chronic MRL of 1E-03 mg/kg/day for PCP. Therefore, harmful non-cancer health effects from exposure to PCP are not likely.

The cancer slope factor for PCP is 0.4 mg/kg/day. ATSDR calculated the estimated excess cancer risk to be approximately 3E-06 (average concentration) to 1E-05 (maximum concentration). This risk estimate is within the EPA acceptable risk range of 1.0E-04 to 1.0E-6 and represents a low increased risk of cancer.

Table 20 continued. Sediment Exposure Pathway: Exposure Factors and Calculated Doses Compared to Health Guidelines
Accidental Ingestion and Direct Skin Contact – High and Average Exposures
PCP, Kerr-McGee Data, 1996-2002

Chemical	Chemical Concentration (mg/kg)	Daily Intake Rate (mg/day)	Surface Areas Exposed (cm2/day)	Soil to Skin Adherence Factor (mg/cm2)	Absorption Factor	Exposure Frequency (days/yr)	Exposure Duration (years)	Conversion Factor	Body Weight (kg)	Averaging Time (days)	Exposure Dose (mg/kg/day)	Health Guideline (mg/kg/day)
Pentachlorophenol (ingestion)	3 (AVG)	100	—	—	—	182	30	1E-6	70	10950	2E-06	1.0E-03 Chronic Oral MRL
Pentachlorophenol (dermal)		NA	5,800	0.07	0.24	182	30	1E-6	70	10950	2E-06	
TOTAL AVERAGE DOSE PENTACHLOROPHENOL - Adult											4E-06	*Below Guideline*
Pentachlorophenol (ingestion)	15 (MAX)	100	—	—	—	182	30	1E-6	70	10950	1E-05	1.0E-03 Chronic Oral MRL
Pentachlorophenol (dermal)		NA	5,800	0.07	0.24	182	30	1E-6	70	10950	8.E-06	
TOTAL HIGH DOSE PENTACHLOROPHENOL - Adult											2E-05	*Below Guideline*
Pentachlorophenol (ingestion)	3 (AVG)	100	—	—	—	182	7	1E-6	30	2555	5E-06	1.0E-03 Chronic Oral MRL
Pentachlorophenol (dermal)		NA	2,800	0.2	0.24	182	7	1E-6	30	2555	6E-06	
TOTAL AVERAGE DOSE PENTACHLOROPHENOL – Child											1E-05	*Below Guideline*
Pentachlorophenol (ingestion)	15 (MAX)	100	—	—	—	182	7	1E-6	30	2555	2E-05	1.0E-03 Chronic Oral MRL
Pentachlorophenol (dermal)		NA	2,800	0.2	0.24	182	7	1E-6	30	2555	3E-05	
TOTAL HIGH DOSE PENTACHLOROPHENOL - Child											5E-05	*Below Guideline*

Health Effects Evaluation for Off-Site Sediments (2010)

It is worth nothing that although analyzed for, the analytical results for dioxin in sediment were not reported. Therefore, ATSDR was not able to perform an evaluation of health effects for dioxin in neighborhood ditches using the 2010 data. EPA did note that 7 samples exceeded EPA's provision regional screening level (RAL) of 72 ppt for dioxin in residential soil and none of the samples exceeded EPA's Office of Solid Waste and Emergency Response's (OWSER) residential removal action level (RAL) of 1,000 ppt [75]. ATSDR's current comparison value for dioxin is 35 ppt.

PAHs in Off-site Ditch Sediment (2010)

Using the same exposure parameters as used above, ATSDR calculated exposure doses for children and adults exposed to PAHs in sediment in neighborhood ditches. The sediment data were collected during EPA's April 2010 sampling event. The doses were calculated using the average and highest concentrations in sediment.

Table 21 shows the resulting BaP equivalent exposure doses assuming that PAHs are taken into the bodies of children and adults by both incidental soil ingestion and direct skin contact. The child exposure doses ranged from 2E-06 to 1E-05 mg/kg/day. The adult doses ranged from 1E-06 to 6E-06 mg/kg/day.

No acute or chronic Minimal Risk Levels (MRLs) have been derived for PAHs because no adequate human or animal dose-response data are available that identify threshold levels for appropriate non-cancer health effects. However, an intermediate-duration oral MRL of 0.4 mg/kg/day has been derived for fluoranthene and fluorene; both were based on Lowest Observed Adverse Effect Levels (LOAELs) of 125 mg/kg/day for increased relative liver weight in male mice [43]. The estimated child and adult doses from the 2010 sediment data are several orders of magnitude lower than the doses that caused liver effects in mice.

ATSDR also estimated excess cancer risks from exposure to PAHs in the neighborhood ditches. The estimated excess cancer risks are 5E-06 (average) and 3E-05 (maximum). These cancer risk estimates are lower than the EPA acceptable risk range of 1.0E-04 to 1.0E-6 and represent a low increased risk of cancer.

It is worth noting that these conclusions are based upon limited data from the neighborhood ditches. Also, as stated above, the BaP TEF values used to calculate the BaP equivalent values are currently undergoing revision by EPA.

Table 21. Sediment Exposure Pathway: Exposure Factors and Calculated Doses Compared to Health Guidelines
Accidental Ingestion and Direct Skin Contact - High and Average Exposures
PAHs, 2010 Data

Chemical	Chemical Concentration (mg/kg)	Daily Intake Rate (mg/day)	Surface Areas Exposed (cm^2/day)	Soil to Skin Adherence Factor (mg/cm^2)	Absorption Factor	Exposure Frequency (days/yr)	Exposure Duration (years)	Conversion Factor	Body Weight (kg)	Averaging Time (days)	Exposure Dose (mg/kg/day)	Health Guideline (mg/kg/day)
BaP Equivalent (ingestion)	5.2(MAX)	100	—	—	—	182	30	1E-6	70	10950	4E-06	None
BaP Equivalent (dermal)		NA	5,800	0.07	0.10	182	30	1E-6	70	10950	2E-06	
TOTAL HIGH DOSE PAHs- Adult											6E-06	N/A
BaP Equivalent (ingestion)	1 (AVG)	100	—	—	—	182	30	1E-6	70	10950	7E-07	None
BaP Equivalent (dermal)		NA	5,800	0.07	0.10	182	30	1E-6	70	10950	3E-07	
TOTAL AVERAGE DOSE PAHs -Adult											1E-06	N/A
BaP Equivalent (ingestion)	5.2(MAX)	100	—	—	—	182	7	1E-6	30	2555	8E-06	None
BaP Equivalent (dermal)		NA	2,800	0.2	0.10	182	7	1E-6	30	2555	4E-06	
TOTAL HIGH DOSE PAHs - Child											1E-05	N/A
BaP Equivalent (ingestion)	1(AVG)	100	—	—	—	182	7	1E-6	30	2555	1E-06	None
BaP Equivalent (dermal)		NA	2,800	0.2	0.10	182	7	1E-6	30	2555	9E-07	
TOTAL AVERAGE DOSE PAHs -Child											2E-06	N/A

Off-Site Sediments in the 14th Avenue Ditch (Data from 2012)

<u>Exposure Assessment</u>

This evaluation is specific for the sediment data collected in July and September 2012 as part of the interim remedial investigation (RI) of the 14th Avenue Ditch Area. The previous evaluation of sediment included data from drainage ditches throughout the community near the Kerr-McGee facility. These data are limited to the the 14th Avenue Ditch Area, which is an approximately 1,830-foot long stormwater ditch adjacent to the Kerr-McGee facility along the northern border. Additional sampling is recommended to determine the nature and extent of contamination throughout the greater area ditch drainage system.

For purposes of this evaluation, ATSDR used many of the assumptions used in the previous evaluation of off-site sediments. We assumed that adults would be exposed for 182 days (6 months) per year for a total of 30 years. Children were also assumed to be exposed to sediment in ditches for 182 days (6 months) per year for a total of 7 years. The exposure period is based upon the assumption that adults or children would work outdoors near or play in the ditch every other day instead of every day. The actual time spent working or playing may be more or less than that assumed by ATSDR.

ATSDR assumes that the average child between accidentally ingests 100 milligrams of sediment per day and an adult accidentally ingests 100 milligrams of sediment per day. For average body weight, 30 kg (approximately 66 pounds) was used for a child and 70 kg (approximately 157 pounds) was used for an adult. The mean sediment concentration was used for each dose calculation because the data from this segment of the ditch allows greater characterization of exposures. The one sample result for dioxin was used to calculate the exposure dose for dioxin.

<u>Health Effects Evaluation for Sediment in 14th Avenue Ditch, 2012</u>

PAHs in 14th Avenue Ditch Sediment

Table 22 shows the resulting BaP equivalent exposure doses assuming that PAHs are taken into the bodies of children and adults by both incidental soil ingestion and direct skin contact. The doses were calculated using the average concentrations in sediment. The child exposure dose is 3E-06 mg/kg/day. The adult dose is 1E-06 mg/kg/day. BaP equivalents do not have an applicable non-cancer health guideline or MRL. However, an intermediate-duration oral MRL of 0.4 mg/kg/day for fluoranthene and fluorene is sometimes used. The estimated child and adult doses are several orders of magnitude lower than the intermediate doses that caused liver effects in mice [43].

ATSDR also estimated excess cancer risks from exposure to PAHs in the 14th Avenue Ditch area. The estimated cancer risk is 5E-06. This risk estimate is within the EPA acceptable risk range of 1E-04 to 1E-6 and represents a low increased risk of cancer.

Dioxins in 14th Avenue Ditch Sediment

The child exposure dose for dioxin in sediment is 6E-10 mg/kg/day. The adult exposure dose is 2E-10. Both the child and adult doses are lower than the EPA RfD of 7E-10 mg/kg/day for dioxin [64]. Therefore, non-cancer health effects are not likely from exposure to dioxin in sediments in the 14th Avenue ditch.

ATSDR calculated that the excess cancer risk from exposure to dioxin in sediment is 2E-05. The excess cancer risks are within EPA's accepted risk range of 1E-04 to 1E-06.

Arsenic in 14th Avenue Ditch Sediment

The estimated dose of arsenic for children who might come into contact with sediment in the 14th Avenue ditch is 6E-06 mg/kg/day. The estimated adult dose is 2E-06 mg/kg/day. The estimated doses for children and adults are lower than the chronic Minimal Risk Level (MRL) of 3E-04 (or 0.0003) mg/kg/day for arsenic; therefore, non-cancer health effects are not likely.

Using EPA's cancer slope factor of 1.5 mg/kg/day, ATSDR calculated excess cancer risk for arsenic in sediment would be 2E-06. The U.S. EPA generally considers an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} (1 in 10,000) and 10^{-6} (1 in 1,000,000) as an acceptable range. The cancer risk is within EPA's accepted risk range; therefore, cancer health effects are not likely.

Table 22. Sediment Exposure Pathway: Exposure Factors and Calculated Doses Compared to Health Guidelines
Accidental Ingestion and Direct Skin Contact
14th Avenue Ditch Area, 2012

Chemical	Chemical Concentration (mg/kg)	Daily Intake Rate (mg/day)	Surface Areas Exposed (cm2/day)	Soil to Skin Adherence Factor (mg/cm2)	Absorption Factor	Exposure Frequency (days/yr)	Exposure Duration (years)	Conversion Factor	Body Weight (kg)	Averaging Time (days)	Exposure Dose (mg/kg/day)	Health Guideline (mg/kg/day)
BaP Equivalent (ingestion)	1.3 (AVG)	100	—	—	—	182	30	1E-6	70	10950	9E-07	None
BaP Equivalent (dermal)		NA	5,800	0.07	0.13	182	30	1E-6	70	10950	4E-07	
										DOSE PAHs - Adult	1E-06	
BaP Equivalent (ingestion)	1.3 (AVG)	100	—	—	—	182	7	1E-6	30	2555	2E-06	None
BaP Equivalent (dermal)		NA	2,800	0.2	0.13	182	7	1E-6	30	2555	1E-06	
										TOTAL DOSE PAHs – Child	3E-06	
Dioxin (ingestion)	0.000279	100	—	—	—	182	30	1E-6	70	10950	2E-10	7E-10 Oral RfD
Dioxin (dermal)		NA	5,800	0.07	0.03	182	30	1E-6	70	10950	2E-11	
										TOTAL DOSE Dioxin - Adult	2E-10	*Below Guideline*
Dioxin (ingestion)	0.000279	100	—	—	—	182	7	1E-6	30	2555	5E-10	7E-10 Oral RfD
Dioxin (dermal)		NA	2,800	0.2	0.03	182	7	1E-6	30	2555	7E-11	
										TOTAL DOSE Dioxin – Child	6E-10	*Below Guideline*

Table 22 continued. **Sediment Exposure Pathway: Exposure Factors and Calculated Doses Compared to Health Guidelines Compared to Health Guidelines**
Accidental Ingestion and Direct Skin Contact
14^{th} Avenue Ditch Area, 2012

Chemical	Chemical Concentration (mg/kg)	Daily Intake Rate (mg/day)	Surface Areas Exposed (cm2/day)	Soil to Skin Adherence Factor (mg/cm2)	Absorption Factor	Exposure Frequency (days/yr)	Exposure Duration (years)	Conversion Factor	Body Weight (kg)	Averaging Time (days)	Exposure Dose (mg/kg/day)	Health Guideline (mg/kg/day)
Arsenic (ingestion)	3 (AVG)	100	—	—	—	182	30	1E-6	70	10950	2E-06	3E-04 Oral RfD
Arsenic (dermal)		NA	5,800	0.07	0.03	182	30	1E-6	70	10950	2E-07	
TOTAL AVERAGE DOSE Arsenic - Adult											2E-06	*Below Guideline*
Arsenic (ingestion)	3 (AVG)	100	—	—	—	182	7	1E-6	30	2555	5E-06	3E-04 Oral RfD
Arsenic (dermal)		NA	2,800	0.2	0.03	182	7	1E-6	30	2555	8E-07	
TOTAL AVERAGE DOSE Arsenic– Child											6E-06	*Below Guideline*

COMMUNITY HEALTH CONCERNS

During our visits, ATSDR obtained information from residents regarding their site-specific health concerns. In addition, ATSDR received several feedback forms, letters, and telephone calls regarding health concerns from residents after meetings, public availability sessions, or site visits. The entire list of health concerns received from residents is in Appendix C. ATSDR was unable to address all of the health concerns because 1) adequate scientific information on the particular health effect is limited or not available or 2) the available scientific data are insufficient to assess whether the specific health effect is related to exposure to a particular chemical. Where feasible, ATSDR addressed the health concerns identified by the community. Below is a summary of community health concerns and ATSDR's response to those concerns.

1. *I know that the Kerr-McGee facility used creosote and creosote coal tar solutions in wood processing. Yet they tested for other chemicals but did not test for creosote. Why didn't they test for creosote and why didn't ATSDR look at the health effects of creosote*?

Creosote is a mixture of many chemicals. Between 300 and 10,000 individual chemicals may be present. A single test cannot determine the presence of creosote. Instead, creosote is identified by its many chemical components. Some of the main chemicals in creosote are PAHs (polycyclic aromatic hydrocarbons). Therefore, ATSDR has evaluated exposure to PAHs at this site.

2. *What health effects are associated with creosote*?

Creosote is a complex mixture of many chemical compounds, including PAHs. Some of these substances are known to be carcinogens (cancer-causing) and others are known to cause conjunctivitis (an infection of the eye) as well as skin effects such as rashes, burns, and phototoxic (a reaction when exposed to the sun) effects. For the specific health effects associated with creosote at this site, please refer to question 6 below.

3. *What health effects are associated with PCP*?

Long-term exposure in the workplace to large amounts of PCP can cause damage to the liver, kidneys, blood, and nervous system. Studies in animals also suggest that the endocrine system and immune system can be damaged following long-term exposure to low levels of PCP. There is weak evidence that PCP causes cancer in humans. For the specific health effects associated with PCP at this site, please refer to question 6 below.

4. *Is exposure to site chemicals causing rashes and other skin effects*?

It is possible that in the past some of the chemicals in the soil were at levels high enough to cause health effects. Direct, unprotected contact with creosote materials might result in rashes and other skin effects. However, rashes have many causes and should be evaluated by your physician. If residents notice creosote material in their yards, they should not touch it. They should contact the appropriate local agency or EPA.

5. *I live near the site and want to know if I am likely to experience respiratory problems such as asthma, lung infections, or other sinus problems*.

Currently the site is inactive so no chemicals from operational processes are being released into the air. However, small amounts of naphthalene could be released when it rains because rainwater fills the pore spaces in the soil and pushes the vapors out. These levels are much lower than most instruments can detect. The unpleasant odors themselves are known to be linked to a sense of low quality of life and contribute to lowered immune response. Therefore, if you smell odors in your neighborhood, you should contact the appropriate local agency or call EPA.

In the past, while the facility was active, chemicals were emitted into the air. To address whether potential health effects are expected from these past air emissions, ATSDR prepared a document entitled "Air Exposures to Wood Treatment, Kerr-McGee Chemical Corporation." This document focuses on air exposures only. Based on the findings of this evaluation, long-term respiratory health effects from these past releases into the air are not expected. However, naphthalene released into the air while the creosote treatment process was occurring posed a risk for respiratory irritation. African-American children appear to be uniquely susceptible to acute exposure effects.

6. *I have lived near the site for decades. I am worried that I might get cancer or other health effects. Do the chemicals at the site cause cancer or other diseases*?

The chemicals of concern at this site include dioxins and PAHs. High exposures to dioxins and PAHs may increase a person's risk for developing cancer. Studies in humans suggest that exposure to dioxins increases the overall risk of developing cancer. Human studies also showed that workers who breathed or had skin contact with high PAHs for long periods may also develop cancer.

The levels of PAHS were high enough in some of the ditches near the Kerr-McGee facility to pose a potential public health hazard for children. They may experience skin effects such as rashes and irritation. Children might also be at increased risk for developmental and reproductive effects from exposure to dioxins. Individuals who had frequent contact with sediments in the ditches have an increased estimated cancer risk. If you are concerned about your health or the health of your child, you should contact your physician.

7. *I live near the site and have noticed a tar-like or greasy material in my yard. What is this and what do I do about it*?

Wood creosote is a colorless to yellowish greasy liquid with a smoky odor and burnt taste. Coal tar creosote is a thick, oily liquid that is typically amber to black in color. Coal tar and coal tar pitch are usually thick, black, or dark-brown liquids or semisolids with a smoky odor. Since it is unknown if the material in your yard is from the site or from some other source, the most prudent measure is to not touch the material and to contact EPA for identification and possible removal.

Residents who are concerned about site related contaminants in their yard should contact the appropriate local authority or EPA.

8. *My home is connected to the municipal water system. However, I noticed black residues and foul odors in my tap water. Is the public drinking water safe*?

Yes. The Columbus City Water System supplies residents with water for use at their homes. The water from the system is routinely monitored to ensure that it meets bacteriological and chemical health standards. When ATSDR checked, the years for which we received chemical sampling and analysis data met all federal requirements for safe drinking water as well. The chemical sampling includes metals, pesticides, herbicides, volatile organic compounds, trihalomethanes, radiological material, and sanitary chemicals (iron, sodium and other aesthetic secondary requirements).

In addition, ATSDR conducted an exposure investigation (EI) in April 2008 because people were concerned that pollutants from the former Kerr McGee site were getting into the public water line or the pipes that bring water to their homes. ATSDR tested several selected homes near the former Kerr McGee site. Based on this investigation, no chemicals were found in residential tap water at levels that could harm your health. Therefore, the public water system appears to be safe for drinking and other household uses.

9. *Is it safe to eat vegetables that I grow in my garden*?

The sampling results from residential yards show that levels of contaminants that can cause adverse health effects. Therefore, as a general precaution, you should remove excess soil from vegetables grown in the ground before taking them into your home. Vegetables should be washed thoroughly before being eaten. As a specific precaution, you should not grow vegetables in areas where there is visible contamination or areas that are prone to flooding.

10. *Do the chemicals at the site cause learning disabilities or attention deficit disorder (ADD)*?

The scientific information is unclear. Limited animal studies have shown some behavioral impact following dioxin exposure, but human studies are uncertain. Exposures associated with the Kerr-McGee site are less than those observed in animal studies; however, these effects may be possible in humans. To err on the side of caution, ATSDR has recommended that efforts be taken to reduce or eliminate harmful exposures to contaminants associated with this site.

11. *Do the chemicals at the site cause strokes, high blood pressure, or heart problems*?

Based on current information, we believe the concentrations of the chemicals in soil at this site are too low to cause a stroke or heart-related problems.

12. *Do the chemicals at the site cause reproductive problems*?

High exposure to dioxins has been associated with reproductive effects, including endometriosis (abnormal growth of the mucous membrane lining the uterus) and reproductive problems. Mice fed high concentrations of PAHs during pregnancy (and their offspring) had difficulty reproducing, birth defects, and decreased birth weights. It is possible that people near this site were exposed to levels of dioxin and PAHs high enough to cause reproductive effects.

HEALTH OUTCOME EVALUATION

The community has expressed concerns about community cancer rates and birth defects. In fact, the original petition to ATSDR requested an "epidemiological study" of the community. ATSDR *can consider* health outcome data, such as mortality and morbidity data, as part of the public health assessment process. ATSDR evaluates the following criteria when determining if whether undertaking a study of health outcome data is reasonable:

- Presence of a completed human exposure pathway,
- great enough contaminant levels to result in measurable health effects,
- sufficient people in the completed pathway for the health effect to be measured, and
- the existence of a health outcome database where disease rates for populations of concern can be identified.

This site does not meet the criteria for health statistics review for the following reason:

- Not enough people in the completed pathway for the health effect to be measured.

CHILD HEALTH CONSIDERATIONS

Children are exposed to chemicals in the same way as adults; that is, they inhale, ingest, or absorb the chemicals through their skin. However, children require a special health consideration. They should not be viewed simply as small adults. Their unique physiology as well as their behavior can have a profound influence on their exposure risk. Based on body weight, children will eat more and drink more than their adult counterparts. While playing or at rest, children breathe more rapidly and inhale more pollutants per pound of body weight than do adults. In addition, airway passages in children are narrower, with irritation secondary to a pollutant resulting in proportionally greater airway obstruction. Behaviorally, children have a strong inclination toward hand-to-mouth activity, placing possible contaminated objects in their mouths or ingesting soil or dust. They may even chew on such objects as treated wood pieces used in fences or railings. Children also spend much more time outdoors, often while being more physically active than adults. They tend to be more adventurous by nature and often play in remote or potentially dangerous areas, such as contaminated creeks or ditches, without the benefit of maturity to permit the exercise of good judgment. It is important to remember that sensitive populations, such as children, are considered when MRLs and other health-based comparison values are developed.

This PHA considered exposures to and health outcomes for children. For each appropriate exposure scenario, ATSDR evaluated the likelihood for children to be exposed to site contaminants at levels of health concern. In some instances, we found that children could be exposed to contaminants in soil and sediment at levels high enough to result in health effects. Where appropriate, we recommended that actions be taken to reduce these exposures.

UNCERTAINTIES AND LIMITATIONS

There are sources of uncertainty that affect our ability to assess if exposure to chemicals causes harm. Major sources of uncertainty include:

- Some uncertainty exists in estimating the chemical dose in people. We are not sure exactly how much soil people might accidentally ingest, although we may have a fairly good idea based on population studies. As mentioned previously, studies indicate most children swallow about 50 milligrams of soil and dust daily while some children may swallow up to 200 mg daily; pica children may swallow up to 5,000 mg of soil per day. Similarly, adults may accidentally swallow a few milligrams of soil and dust daily or they may swallow 100 mg or more, for instance, if they frequently contact soil.
- Uncertainty also comes from deciding which body weight to use for various age groups. Higher body weights correspond to lower contaminant dose estimates.
- In addition to the uncertainty that comes from estimating a chemical dose, uncertainty could exist in the human and animal studies that identify the doses that cause harmful effects or the doses that cause no harmful effects. This uncertainty varies with each chemical. When an MRL is exceeded or if an MRL is not available, the estimated chemical dose in people is compared to the doses from human and animal studies, when available. This comparison along with a review of other information in ATSDR's chemical-specific toxicological profile is used to decide what harmful effects might be expected.
- Uncertainty exists that is specific to the Kerr-McGee site. First, uncertainty exists from using soil samples that were collected so many years ago. This uncertainty is especially important to highlight at this site because ATSDR is aware that certain on-site containment procedures failed and potentially allowed contaminants to migrate off-site. If certain areas were re-contaminated, or if previously uncontaminated areas are now contaminated, then our conclusions may not reflect the current conditions at the site.
- Uncertainty also comes from not knowing how much chemical contamination is below the surface (subsurface) that will eventually come to the surface soil during earth-moving activities or natural erosion.
- As noted, ATSDR could not locate established exposure factors for the number of times per week children contacted sediments in the ditch. If the frequency of contact was different from what ATSDR assumed, exposure doses calculated could have been higher or lower.
- ATSDR assumed in some cases that individuals were exposed to the maximum concentration of a chemical for extended periods of time (up to 30 years for noncancer and 70 years for cancer). As is true with most sites, assuming long-term contact with the maximum concentration is not always reasonable; therefore, any conclusions based on this exposure scenario should be viewed as an overestimation of the true risk.

- This document does not evaluate all potential exposure pathways associated with the site. This PHA evaluates only those exposures associated with incidental ingestion and dermal exposures associated with soil/sediments in nearby ditches. An analysis of the air pathway associated with the site is addressed in a separate public health consultation for the site.

- For non-cancer effects, ATSDR utilized the most sensitive toxicologic endpoints (i.e., toxic effects that were caused by the lowest doses) to interpret the significance of the toxicologic effect of the doses estimated [40].

- The TEFs used for PAHs are based on relative carcinogenic potency [43]. Interactions between PAHs toxicity is complex and poorly understood. Also, EPA is reviewing and updating the TEFs for the carcinogenic PAHs and has added more cancer slope factors for various PAHs. The final document is pending.

CONCLUSIONS

Based on available information, ATSDR has reached seven conclusions in this health assessment:

1. *ATSDR concludes that contact with dioxin in surface soil in some residential yards could harm people's health. This is a current public health hazard*. Surface soil samples collected from residential yards in 2010 and 2011 revealed the presence of 2,3,7,8-TCDD (dioxins) at levels that might cause children to experience non-cancer health effects. ATSDR recommends that proper measures be taken to reduce people's exposure to dioxin in soil in residential yards or public places where the levels represent a hazard.
2. *ATSDR concludes that frequent contact with contaminated sediment in neighborhood ditches could harm people's health. This is a past public health hazard; current public health implications could not be determined*. Sediment samples collected from the ditches near the Kerr-McGee facility from 1999 to 2002 revealed the presence of PAHs at levels high enough to cause a moderate increased risk of cancer (skin and stomach cancers). This conclusion is based on contamination levels after the removal activities in 2004 – 2009, but before the erosion and flood events of 2010. The erosion and flooding might have caused the contamination in the ditches to migrate to other locations, or it might have moved new contamination into the ditches.
3. *ATSDR concludes that there is a lack of information regarding current contaminant levels in off-site ditches. Therefore, we were not able to evaluate the current public health implications of this pathway.* The previous conclusion regarding the health hazards from exposure to sediment in ditches is based on sampling conducted before significant erosion and flooding events in 2010. Flooding and erosion may have caused on-site contamination to migrate to the drainage ditches and altered contaminant levels in the ditches. Therefore, current conditions could not be accurately assessed. ATSDR recommends additional sampling to determine the nature and extent of contamination to the greater community drainage ditch area as a result of flood and erosion events.
4. *ATSDR concludes that contact with sediments in the 14th Avenue drainage ditch will not harm people's health.* This conclusion does not include the greater community ditch system. In July and September 2012, EPA collected sediment samples as part of an interim remedial investigation (RI) at the 14th Avenue Ditch Area. The levels of contaminants in the ditch were too low to harm people's health. The 14th Avenue Ditch Area is only part of a larger drainage system in the community. Additional sampling is needed to evaluate current conditions and to determine the nature and extent of contamination throughout the greater drainage ditch system.
5. *ATSDR concludes that occasional trespassing on the Kerr-McGee property (on-site) is not expected to harm people's health*. Trespasser's exposure to PAHs, dioxin and PCP in on-site soil is not expected to cause harmful cancer or non-cancer health effects. However, ATSDR recommends that people not trespass on the facility property and that officials continue efforts to prevent trespassing on the facility property.
6. *ATSDR concludes that students who played on the athletic field at Hunt Intermediate School are unlikely to experience harmful health effects*. The levels of dioxin and PAHs detected in the soil of the athletic field were too low to cause harmful health effects in students. Cleanup activities have already been completed at the Hunt Intermediate School

athletic field. The soil excavation activities at the athletic field will reduce exposures to students.

7. *ATSDR concludes that frequent exposure to the creosote waste pile on the property of the Maranatha Faith Center could cause harmful health effects. This was a past public health hazard*. A child or adult exposed to the creosote waste pile for 13 years (the amount of time the pile was uncovered and unsecured) might experience dermatological effects and a moderately increased excess cancer risk. In February 2011, EPA excavated and disposed of approximately 31 tons of contaminated soil from the church property. After the removal of the waste pile, the residual contamination is no longer a public health hazard.

RECOMMENDATIONS

1. ATSDR recommends that proper measures be taken to reduce or eliminate human exposures to contaminants in sediments and soils around the facility. Continue to remove/contain on-site sources that contribute to off-site migration of contaminants, and off-site soils/creosote-contaminated materials that people might contact as a result of erosion or through digging or other excavation activities.

2. ATSDR recommends that proper measures be taken to reduce exposures to surface soil in residential yards or public places where the dioxin levels represent a health hazard.

3. ATSDR recommends determining the extent of contamination to drainage ditches as a result of recent flood and erosion events. Take proper measures to prevent people from contacting impacted drainage ditches.

4. ATSDR recommends that proper measures be taken to ensure that people are not exposed to on-site contamination.

PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) contains actions to be taken by ATSDR or other governmental agencies at the Kerr-McGee site. The purpose of the PHAP is to ensure that this PHA not only identifies public health hazards, but also provides an action plan to mitigate and prevent adverse human health effects resulting from past, present, and/or future exposures to hazardous substances at or near the site.

Public Health Actions Completed:

- ATSDR has hosted health education workshops for the community. The following two presentations were made at the workshop:

  "*Creosote Health Effects and How to Prevent Exposure*" and

  "*Drinking Water Quality in Your Community*" presented by the Mississippi Department of Health, Drinking Water Program.

- ATSDR conducted an Exposure Investigation (EI) in response to residents' concerns about their water quality. Tap water was tested from 13 homes near the Kerr-McGee facility. No chemicals of concern were detected in any of the tap water sampled.

- ATSDR conducted an Exposure Investigation (EI) to determine if fish in the Luxapalila Creek have been impacted by site-related contaminants. ATSDR collected fish samples from locations upstream and downstream of the site. The fish were analyzed for dioxins. The levels of dioxin in fish were not elevated in the fish sampled.

- ATSDR has prepared a separate document which evaluates health effects related to air ambient air exposures. This document complements the current document and discusses potential impacts related to past air emissions from the site. A copy of this document is available by calling 1-800-CDC-INFO or by viewing on our website at http://www.atsdr.cdc.gov/sites/KerrMcGee/.

Public Health Actions Planned:

- As needed, ATSDR will evaluate new data and/or develop reports to reflect the most current sampling results and site remediation activities in relation to any completed or potential exposure pathways.

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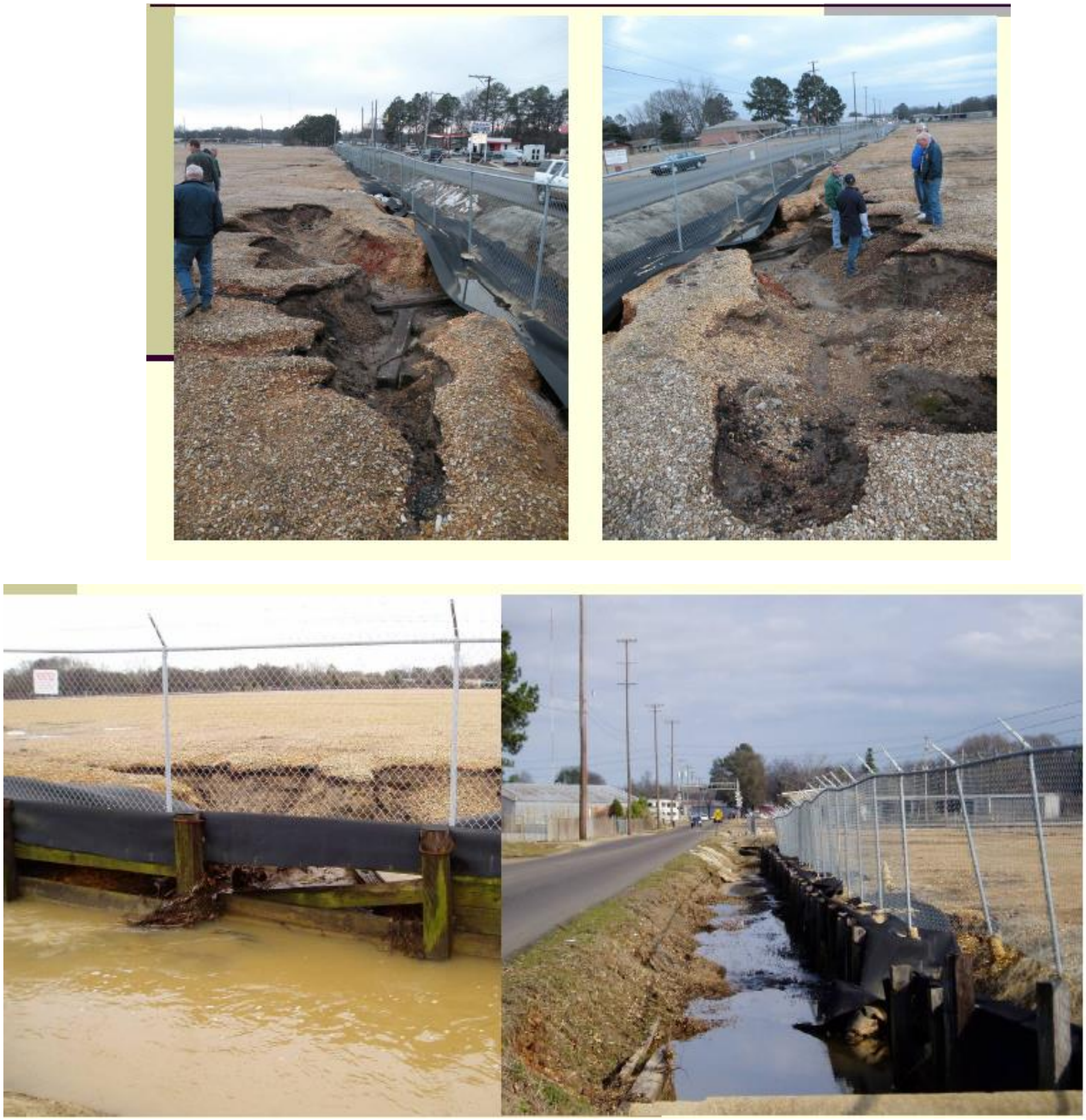
APPENDIX A: SITE-RELATED PHOTOS

Photo 1: Proximity of Homes to Drainage Ditches near Kerr-McGee Facility

Photo 2. Proximity of Homes to Drainage Ditches near the Kerr-McGee Facility

Source: USEPA, On-site and Off-site Photography of Priority Items from EPA RCRA Site Team Trip (January 20-21, 2010), Tronox LLC, Columbus, MS

Photo 3. Erosion Along 14th Avenue



Source: USEPA, On-site and Off-site Photography of Priority Items from EPA RCRA Site Team Trip (January 20-21, 2010), Tronox LLC, Columbus, MS

Photo 3 con't. EROSION ALONG 14^{th} AVENUE

Source: USEPA, On-site and Off-site Photography of Priority Items from EPA RCRA Site Team Trip (January 20-21, 2010), Tronox LLC, Columbus, MS

APPENDIX B:
ATSDR'S EVALUATION PROCESS
AND
EXPOSURE DOSE CALCULATIONS

ATSDR's EVALUATION PROCESS

Comparison Values and the Screening Process

To evaluate the available data, ATSDR used comparison values (CVs) to determine which chemicals to examine more closely. CVs are the contaminant concentrations found in a specific media (for example: air, soil, or water) and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water, or soil that someone may inhale or ingest each day. CVs are generated to be conservative. These values are used only to screen out chemicals that do not need further evaluation; CVs are not intended as environmental clean-up levels or to indicate that health effects occur at concentrations that exceed these values.

CVs can be based on either carcinogenic (cancer-causing) or non-carcinogenic effects. Cancer-based comparison values are calculated from the U.S. Environmental Protection Agency's (EPA's) oral cancer slope factor (CSF) or inhalation risk unit. CVs based on cancerous effects account for a lifetime exposure (70 years) with an acceptable estimated excess lifetime cancer risk of 1 new case per 1 million exposed people. Non-cancer values are calculated from ATSDR's Minimal Risk Levels (MRLs), EPA's Reference Doses (RfDs), or EPA's Reference Concentrations (RfCs). When a cancer and non-cancer CV exists for the same chemical, the more conservative of the values is used in the comparison.

LIST OF COMPARISON VALUES USED IN THIS DOCUMENT

- A **Cancer Risk Evaluation Guide (CREG)** is a concentration at which excess cancer risk is not likely to exceed one case of cancer in a million persons exposed over a lifetime. A CREG is calculated using EPA's cancer slope factor (CSF). The CREG is a very conservative value. An environmental contaminant concentration equal to or less than the CREG is defined as an insignificant risk and is an acceptable level of exposure over a lifetime.

- An **Environmental Media Evaluation Guide (EMEG)** is an estimated contaminant concentration that is not expected to result in adverse non-carcinogenic health effects based on ATSDR evaluation. EMEGs are based on ATSDR MRLs and conservative assumptions about exposure, such as intake rate, exposure frequency and duration, and body weight.

- A **Reference Dose Media Evaluation Guide (RMEG)** is a concentration in water or soil at which daily human exposure is unlikely to result in adverse non-carcinogenic effects. ATSDR derives RMEGs from EPA's oral reference doses, which are developed based on EPA evaluations.

- EPA's **Soil Screening Level (SSL)** is an estimate of a contaminant concentration not expected to result in non-carcinogenic health effects during a specified duration of exposure (similar to EMEGs), or to be associated with no more than an estimated one excess cancer in a million (10^{-6}) persons exposed during a 70 year life span (similar to

CREGs). SSLs are derived by calculating exposure equations and pathway models to estimate an "acceptable" level of a contaminant in soil via ingestion, dermal, and inhalation pathways.

- An EPA Region 9 **Preliminary Remedial Goal (PRG)** is a concentration in environmental media (soil, air, and water) that is considered by EPA to be health protective of human exposures (including sensitive groups), over a lifetime. Chemical concentrations above these levels would not automatically trigger a response action. However, exceeding a PRG suggests that further evaluation of the potential risks that may be posed by site contaminants is appropriate.

- An EPA Region 3 **Risk-Based Concentration (RBC)** is a guideline used to assess the potential for harm from chemicals found at a hazardous waste site. They were developed by combining a substance's toxicological properties with "standard" scenarios for encountering the substance. EPA Region 3 emphasizes that RBCs are not intended to be used as regulatory cleanup goals; however, they can be used as an initial screening of substances found in site media.

Evaluation of Public Health Implications

The next step in the evaluation process is to take those contaminants that are above their respective CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Separate child and adult exposure doses (or the amount of a contaminant that gets into a person's body) are calculated for site-specific exposure scenarios, using assumptions regarding an individual's likelihood of accessing the site and contacting contamination. A detailed explanation of the calculation of estimated exposure doses is presented in Appendix F. Calculated doses are reported in units of milligrams per kilograms per day (mg/kg/day). Separate calculations have been performed to account for non-cancer and cancer health effects, if applicable, for each chemical based on the health impacts reported for each chemical. Some chemicals are associated with non-cancer effects while the scientific literature may indicate that cancer-related health impacts are not expected from exposure.

The doses calculated for exposure to each individual chemical are then compared to an established health guideline, such as a MRL (Minimal Risk Level) or RfD (Reference Doses), in order to assess whether adverse health impacts are expected. These health guidelines, developed by ATSDR and EPA, are chemical-specific values that are based on the available scientific literature and are considered protective of human health. Non-carcinogenic effects, unlike carcinogenic effects, are believed to have a threshold; that is, a dose below which adverse health effects will not occur. As a result, the current practice for deriving health guidelines is to identify, usually from animal toxicology experiments, a No Observed Adverse Effect Level (or NOAEL), which indicates that no effects are observed at a particular exposure level. This is the experimental exposure level in animals (and sometimes humans) at which no adverse toxic effect is observed. The NOAEL is then modified with an uncertainty (or safety) factor, which reflects the degree of uncertainty that exists when experimental animal data are extrapolated to the general human population. The magnitude of the uncertainty factor considers various factors such as sensitive subpopulations (for example; children, pregnant women, and the elderly), extrapolation from animals to humans, and the completeness of available data. Thus, exposure doses at or below the established health guideline are not expected to result in adverse health effects because these values are much lower (and more human health protective) than doses which do not cause adverse health effects in laboratory animal studies. For non-cancer health effects, the health guidelines are described below in more detail. It is important to consider that the methodology used to develop these health guidelines does not provide any information on the presence, absence, or level of cancer risk. Therefore, a separate cancer evaluation is necessary for potential cancer-causing chemicals detected in samples at this site.

Minimal Risk Levels (MRLs) – developed by ATSDR
ATSDR has developed MRLs for contaminants commonly found at hazardous waste sites. The MRL is an estimate of daily exposure to a contaminant below which non-cancer, adverse health effects are unlikely to occur. MRLs are developed for different routes of exposure, such as inhalation and ingestion, and for lengths of exposure, such as acute (less than 14 days), intermediate (15-364 days), and chronic (365 days or greater). At this time, ATSDR has not developed MRLs for dermal exposure. A complete list of the available MRLs can be found at http://www.atsdr.cdc.gov/mrls.html.

References Doses (RfDs) – developed by EPA
An estimate of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause non-cancerous health effects. RfDs consider exposures to sensitive sub-populations, such as the elderly, children, and the developing fetus. EPA RfDs have been developed using information from the available scientific literature and have been calculated for oral and inhalation exposures. A complete list of the available RfDs can be found at http://www.epa.gov/iris.

If the estimated exposure dose for a chemical is less than the health guideline value, the exposure is unlikely to result in non-cancer health effects. Non-cancer health effects from dermal exposure were evaluated slightly differently than ingestion exposure. Since health guidelines are not available for dermal exposure, the calculated dermal dose was compared with the oral health guideline value (RfD or MRL). If the calculated exposure dose is greater than the health guideline, the exposure dose is compared to known toxicological values for the particular chemical and is discussed in more detail in the text of the PHA. The known toxicological values are doses derived from human and animal studies that are presented in the ATSDR Toxicological Profiles and EPA's Integrated Information System (IRIS). A direct comparison of site-specific exposure doses to study-derived exposures and doses found to cause adverse health effects is the basis for deciding whether health effects are likely to occur. This in-depth evaluation is performed by comparing calculated exposure doses with known toxicological values, such as the no-observed adverse-effect-level (NOAEL) and the lowest-observed-adverse-effect-level (LOAEL) from studies used to derive the MRL or RfD for a chemical.

How Non-Cancer Health Effects are Evaluated

The amount of chemical that is swallowed or gets absorbed through the skin is called a dose. The resulting chemical dose is in milligrams of chemicals per kilogram body weight per day (mg/kg/day). A range of chemical doses are possible because different values can be used for various parameters in the chemical dose equation. For example, the amount of soil ingested varies from about 50 mg for most children to 200 mg for some [63,64]. Weight can also vary from 10 kg for a 1-year-old child to 35 kg for an elementary aged child, and from 60 kg for women and 80 kg for men. Since site-specific information is not available, we assume that all of the chemical that is swallowed will cross the gut into the body. Therefore, because of differences in weight and differences in soil intake, the estimated dose of a chemical can vary within an age group and between age groups.

Calculated exposure doses were compared with the available health guidelines to determine whether the potential exists for adverse non-cancer health effects. ATSDR compares the estimated chemical dose to our Minimal Risk Levels (MRLs) or EPA's Reference Dose (RfD) values. MRLs are developed for three exposure periods: acute (less than 2 weeks), intermediate (2 weeks to 1 year), and chronic (1 year or more). MRLs are available for oral exposure and for inhalation exposure.

An MRL is a chemical dose below which noncancerous harmful effects are not expected. It is important to remember that MRLs cannot be used to evaluate cancer. RfDs are an estimate of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause non-cancerous health effects. RfDs consider exposures to sensitive sub-populations, such as the elderly, children, and the developing fetus.

MRLs are derived by reviewing animal and human studies to identify either the lowest level known to cause harmful effects or a level that not result in harmful effects. Most MRLs are set anywhere from 3 to 1,000 times below these effect or no effect levels. Therefore, when an MRL is exceeded, it does not mean that harmful effects will occur but rather that more toxicological evaluation is needed to determine if harmful effects might be possible. This additional toxicological evaluation involves comparing the estimated chemical dose to effect and no effect levels and reviewing additional toxicological information to decide if harmful effects might be expected. EPA RfDs are developed using information from the available scientific literature and have been calculated for oral and inhalation exposures. The RfD is intended for use in risk assessments for health effects known or assumed to be produced through a nonlinear (presumed threshold) mode of action. It is expressed in units of mg/kg-day.

In the event that calculated exposure doses exceed established health guidelines (e.g., MRLs or RfDs), an in-depth toxicological evaluation is necessary to determine the likelihood of adverse health effects. For this evaluation, the doses are compared to known toxicological values, starting with the Lowest Observed Adverse Effect Level (LOAEL) used to derive the MRL.

The chronic, oral MRL was used as a guide because the principle routes of exposure at the Kerr-McGee site are from accidentally swallowing soil. MRLs for contact with soil are not available. Residential exposures are likely to occur for many years, so a chronic exposure period was used in the evaluation. When a chronic MRL is not available, an acute or intermediate MRL may be used as a guide.

<u>How Cancer Risk is Evaluated</u>

Information about the increased risk of cancer from exposure to these chemicals is also provided in each exposure scenario. Cancer is a complex subject and some background information is provided before discussing cancer evaluations of specific chemicals. The probability that residents of the United States will develop cancer at some point in their lifetime is 1 in 2 for men (44.9 %) and 1 in 3 (38.5%) for women. Stated another way, half of all men and one-third of all women will develop some type of cancer in their lifetime. This is based on medical data collected on all types of cancer, regardless of whether the cause was identified, the case was successfully treated, or the patient died (directly or indirectly) from the cancer.

Factors that play major roles in cancer development include:

- lifestyle (what we eat, drink, smoke; where we live);
- natural (including sunlight) and medical radiation;
- workplace exposures;
- drugs;
- socio-economic factors; and
- chemicals in our air, water, soil, or food.

Infectious diseases, aging, and individual susceptibility such as genetic predisposition are also important factors in cancer development.

We rarely know environmental factors or conditions responsible for the onset and development of cancer. For some occupational exposures or for the use of specific drugs, we do have some understanding of cancer development. Overall cancer risks can be reduced by eating a balanced diet, getting regular exercise, having regular medical exams, and avoiding high risk behaviors, such as tobacco use and excessive alcohol consumption. Proper safety procedures, appropriate personal protective equipment, and medical monitoring programs can decrease cancer risks in the workplace.

To calculate a population cancer estimate, ATSDR uses a quantitative risk assessment method. By this method, site-specific cancer doses and concentrations are multiplied by EPA's cancer slope factor (CSF). (Some cancer slope factors are derived from human studies. Others are derived from laboratory animal studies involving doses much higher than people encounter in the environment. Use of animal data requires extrapolation of the cancer potency obtained from these high dose studies down to exposures most people might experience. This process involves much uncertainty.) The resulting risk of cancer is called an estimated excess cancer risk because it is the risk of cancer above the already existing background risk of cancer. This additional estimated cancer risk estimate from chemical exposures is often stated as 1E-04 (is the same as 1×10^{-4}), 1E-05, or 1E-06. Therefore, one interprets the excess cancer risk as being between 0 and some number for every 10,000 or 100,000 or 1,000,000 exposed people. For example, an estimated cancer risk of 2E-06 represents a possible 2 excess cancer cases in a population of 1 million. Using 2×10^{-6} again, it means that a population of one million people exposed to a carcinogen over a lifetime (70 years) to a specific dose may have one additional case of cancer because of the exposure. The "one-in-a-million" risk level is generally regarded as a very low risk. If the exposed population is small, it is difficult to prove that cancer cases in a community are the result of chemical exposures, especially given the large number of people can get the same type cancer from other causes besides chemical exposure.

An estimated additional estimated cancer risk of 1×10^{-4} means that a population of 10,000 people exposed for a lifetime (70 years) to a certain chemical dose may have between zero and one additional cancer case. Although a “one-in-ten thousand” risk level may be viewed as an increased level of risk, it is good to understand the exposure assumptions that went into estimating this risk.

Exposure Dose Formulas

The exposure dose formula for accidental ingestion of chemicals in soil or sediment is:

$$\textit{Exposure Dose (ED)} = \frac{\boldsymbol{C \times IR \times EF \times ED \times CF}}{\boldsymbol{BW \times AT}}$$

Where:

ED *= exposure dose in milligrams per kilogram per day (mg/kg/day)*
C *= concentration of contaminant in soil in milligrams per kilogram (mg/kg or ppm)*
IR *= ingestion rate in milligrams per day (mg/day)*
EF *= exposure frequency (days/year)*
ED *= exposure duration (years)*
CF *= conversion factor (10^{-6} kg/mg)*
BW *= body weight (kg)*
AT *= averaging time, days (ED x 365 days/year)*

The exposure dose formula for dermal absorption of chemicals in soil or sediment is:

$$\textit{Exposure Dose (ED)} = \frac{\boldsymbol{C \times SA \times AF \times ABS \times EF \times ED \times CF}}{\boldsymbol{BW \times AT}}$$

Where:

ED *= exposure dose in milligrams per kilogram per day (mg/kg/day)*
C *= chemical concentration (mg/kg)*
SA *= surface area exposed (square centimeters/day or cm^2/day)*
AF *= soil to skin adherence factor (milligrams per square centimeters or mg/cm^2)*
ABS *= Absorption factor (unitless)*
EF *= exposure frequency (days/year)*
ED *= exposure duration (years)*
CF *= conversion factor (10^{-6} kg/mg)*
BW *= body weight (kg)*
AT *= averaging time (days)*

To derive a total dose, ATSDR adds the total ingestion and dermal doses as follows:

Total Dose (TD) = ***ID + DD***

Where:

TD *= total soil ingestion and dermal non-carcinogenic dose*
ID *= Soil ingestion non-carcinogenic dose (mg/kg/day)*
DD*= Soil dermal non-carcinogenic dose (mg/kg/day)*

The following equation is the calculation for excess cancer risk:

$$\text{Lifetime Average Daily Dose (LADD)} = \frac{\text{Exposure Dose (mg/kg/day)} \times \text{Exposure Duration (years)}}{\text{70 years}}$$

Estimated Excess Cancer Risk = LADD x Cancer Slope Factor

APPENDIX C
Health Concerns Identified by the Community

Respiratory Effects
Asbestosis
Chronic obstructive pulmonary disease
Respiratory problems
Sinus problems
Sinus congestion due to allergies
Sleep apnea
Breathing problems
Shortness of breath
Lung problem
Chronic cough
Idiopathic pulmonary fibrosis
Asthma
Hospitalization due to lung infection
Bronchitis

Cardiovascular Effects
Heart Disease (unspecified)
Congestive Heart failure
Stroke
High Blood Pressure
Atherosclerosis

Immune System Effects
Lupus
Severe allergies
Severe rheumatoid arthritis

Gastrointestinal Effects
Severe stomach problem
Bowels trouble
Spastic colon
Gall Bladder surgery/removal
Hiatal hernia
Upset stomach
Stomach sickness

Hematological Effects
Hemolysis
Bone marrow dysfunction

Musculoskeletal Effects
Weakening of the legs

Hepatic Effects
Taking medicine for Liver
Liver problems

Renal Effects
Taking medicine for kidney
Kidney problems
Kidney stones

Dermatological/Ocular Effects
Loss of Hair
Skin Disease/Rash
Skin disorder
Eye problems
Burning of eyes
Dryness and itching of skin

Other System Effects
Diabetes
Increased mortality in young adults
Sarcoidosis
Arthritis
Labyrinthitis
Sore throat
Short toes
Antifungal
Thyroid
Growth on right leg
Weak a lot
Prostate problems
Leg problems (trouble walking)
Aching muscles
Severe pain not being able to walk
Leg problems
Blood in throat
Pain – so bad can't walk
Cramps and swelling in legs
Bad drainage of throat sometime with blood in it.
Chest hurts at times

Neurological Effects
Nerve Problems
Fainting spells
Depression
Parkinson's Disease
Headaches
Autism
Speech/Language impediments

Reproductive Effects
Multiple Miscarriages
"Cannot have children"

Developmental Effects
Birth defect – extra fingers on hands

Cancers
Cancer
Lump behind ear

Note: These health concerns were recorded by ATSDR from conversations or other communications with community members. This list does not represent a determination by ATSDR that the listed health effect will occur from exposure to chemicals from the Kerr-McGee facility. This list is a summary of the communications with community members.

APPENDIX D:
SUMMARY OF THIRD PARTY DATA
LUNDY & DAVIS

The environmental data submitted by a third party and by Lundy & Davis LLC, attorney for the plaintiff, are summarized here. ATSDR determined that the data are not appropriate for making public health decisions because of the lack key QA/QC documentation regarding the data.

From 1999 to 2001, Lundy & Davis conducted several investigations (Phases I through V) to characterize off-site contamination near the Kerr-McGee facility. During these investigations, Lundy & Davis collected soil and sediment from several locations surrounding the facility, including residential areas. Lundy & Davis analyzed for dioxin and furans in a selected number of samples.

Table 1 contains all contaminants detected in sediment during the various sampling events conducted by Lundy & Davis, and shows whether the contaminants exceed their respective comparison value. PAHs (up to 40 ppm BaP equivalents) and dioxins (up to 10.1 ppb TEQ or 0.01 TEQ ppm) were detected above applicable comparison values. PCP was detected in one sample at a level below its comparison value.

Table 2 contains all contaminants detected in surface soil during the various sampling events. PAHs (up to 1.2 ppm) and lead (up to 432 ppm) were detected in surface soil samples at concentrations that exceed their applicable comparison values.

The dioxin sediment data reported by Lundy & Davis are the only dioxin data from the drainage ditches. Therefore, that data will be evaluated below. The PAH contamination in sediments has already been reviewed by ATSDR using data from Kerr-McGee Corp. (see Health Effects evaluation above). The PAH levels detected by Lundy & Davis are similar to those detected by Kerr-McGee so no additional evaluation is needed.

It is important to note that in 2004, Kerr-McGee removed contaminated sediment from 4 areas within the drainage ditches bordering the site. The evaluation that follows is for sediment samples collected before the 2004 removal action; therefore, the evaluation applies to past exposures and potential health effects. After the removal action, residual concentration of dioxin in sediment ranged from non-detect to 4.6 ppb TEQ, a concentration still above EPA's residential screening value for dioxin (currently 35 ppt). The flood and erosion events of 2010 likely changed the distribution of contamination in the ditches. However, ATSDR is unable to make any conclusions regarding the nature and extent of contamination in the ditches since 2010 because we have no ditch sediment data after that time.

<u>Sediments - Dioxins</u>

Dioxins - The analysis for non-carcinogenic effects yields exposure doses for children of $5x10^{-9}$ mg/kg/day (average concentration) and $3x10^{-8}$ mg/kg/day (maximum concentration). Both of these estimated exposure doses exceed EPA's RfD of $7x10^{-10}$ mg/kg/day for TCDD. The calculated adult doses are $2x10^{-9}$ (average concentration) and $8x10^{-9}$ mg/kg/day (maximum concentration), which also exceed the RfD [67]. When an RfD is exceeded, it does not mean that harmful effects will occur but rather that more toxicological evaluation is needed to determine if harmful effects might be expected.

A useful tool for comparing the estimated dose with a health guideline, such as the RfD, is the use of hazard quotients (HQs). An HQ is defined as a ratio of the estimated dose divided by the health guideline--the RfD in this case. If the HQ is greater than 1, then the estimated dose exceeds the RfD and further toxicological evaluation is needed. If the HQ is less than 1, the estimated dose is below the RfD and non-cancer harmful effects are not expected.

The formula for determining the HQ is:

$$HQ = \frac{\textit{estimated child or adult dose in mg/kg/day}}{\textit{RfD in mg/kg/day}}$$

Using the above formula, ATSDR calculated the HQs for children as ranging from 7 to 42; the HQs for adults ranged from 3 to 11. In all instances, the HQs exceed 1. Therefore, a further evaluation for possible harmful health effects was conducted for children and adults.

As part of our more thorough toxicological evaluation, ATSDR compared the child and adult doses to effect levels that are reported in the critical studies used to derive the RfD. In the case of TCDD, the doses were compared to the Lowest Observed Adverse Effect Level (LOAEL) of 2.0×10^{-8} mg/kg/day. Because, by definition, LOAEL doses cause adverse health effects, exposures that approach or exceed a LOAEL are of concern.

EPA's reassessment of TCDD's non-cancer health effects was published in February 2012. The key data supporting the RfD are two epidemiologic studies in humans. Both studies are of human populations exposed to TCDD through an industrial accident. The LOAEL of 2.0×10^{-8} mg/kg/day was developed based on decreased sperm count and motility in men exposed to dioxin as boys and thyroid hormone disruption in neonates. An uncertainty factor of 30 was applied to account for use of a LOAEL instead of a No Observed Adverse Effect Level (NOAEL) and to account for human variability [64].

EPA assigned a high level of confidence to the studies used to derive the RfD; therefore, more weight can be put the effects being true [64]. In addition, other studies describe an extensive range of harmful health effects, such as weight loss, liver damage, and disruption of the endocrine system in studies of animals that were exposed to low levels of dioxin compounds. In many species of animals, TCDD weakens the immune system and causes a decrease in the system's ability to fight bacteria and viruses. In other animal studies, exposure to TCDD has caused reproductive damage and birth defects. The offspring of animals exposed to dioxins during pregnancy often had birth defects including skeletal deformities, kidney defects, weakened immune responses, and neurodevelopmental effects [30].

The most noted health effect in people exposed to high concentrations of TCDD is chloracne. Chloracne is a severe skin disease with acne-like lesions that occur mainly on the face and upper body. Other effects to the skin, such as erythema or red skin rashes, discoloration, and excessive body hair have been reported following exposure to dioxins. Changes in blood and urine that may indicate liver damage also are seen in people. Exposure to high concentrations of dioxins may induce long-term alterations in glucose metabolism and subtle changes in hormonal levels [30].

Using an analysis similar to the one above, ATSDR compared the child and adult doses to the LOAEL used to derived the RfD. However, this time we used a health guideline that has been shown to cause harmful effects, the LOAEL. Our goal is to see how close the estimated doses are to known harmful effect levels. To illustrate this point, we calculate the ratio of the LOAEL divided by the estimated dose. The formula is expressed as:

$$\frac{LOAEL}{\textit{Estimated exposure dose}}$$

The greatest risk is from exposures that approach or exceed the LOAEL. Therefore, the smaller the resulting number, the greater the risk of experiencing harmful effects (because the estimated dose is close to the effect level).

The calculated child doses are approximately 4 to 0.6 times less than the LOAEL, which means that the LOAEL is only 0.6 times greater than the maximum exposure dose for children. The child doses are close to the effect level of 2.0×10^{-8} mg/kg/day; therefore, children exposed to TCDD at the site may experience harmful health effects.

The calculated adult doses are approximately 10 and 2.5 times less than the LOAEL, which means that the LOAEL is only 2.5 times greater than the maximum adult exposure dose. The adult doses are close to the effect level of 2.0×10^{-8} mg/kg/day; therefore, adults exposed to TCDD at the site may also experience harmful health effects.

Dioxin and Cancer Risk[8]

Based on the available information, dioxins are believed to have the potential to cause a wide range of adverse effects in humans, including cancer. Several studies suggest that exposure to TCDD increases the risk of cancer in people. Animal studies have also shown an increased risk of cancer from exposure to TCDD. An increased risk for all cancers was found in highly exposed workers. The evidence is weaker, but some data suggests a possible relationship between soft-tissue sarcoma, non-Hodgkin's lymphoma, and respiratory, thyroid, and liver cancer with TCDD exposure. Many of the available studies found small relative risks and did not control for the possible impact of confounding factors [30].

Estimated cancer risks were evaluated for dioxins at this site. Estimated cancer risk is estimated by multiplying the estimated dose by a cancer potency factor, also known as the cancer slope factor. Some cancer potency factors are derived from human studies. Others are derived from laboratory animal studies involving doses much higher than people encounter in the environment. Use of animal data requires extrapolation of the cancer potency obtained from

[8] EPA's reanalysis of dioxin (February 2012) did not include an evaluation for potential human carcinogenicity. The cancer reassessment, which is scheduled for release at a later date, was not available at the time of the publication of this document.

these high dose studies down to exposures most people might experience. This process involves much uncertainty.

Estimated cancer risk estimates for adults ranged from 1 x 10^{-4} (1 additional cancer estimated per 10,000 people exposed to 5 x 10^{-4} (5 additional cancers estimated per 10,000 people exposed). Stated another way, an adult who lives at their property with the maximum concentration of dioxin in sediment for 70 years, has an estimated cancer risk of up to 5 in 10,000.

It should be noted that the U.S. EPA generally considers an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} (1 in 10,000) and 10^{-6} (1 in 1,000,000) as an acceptable range. That means regular exposure to a substance would lead to one additional case of cancer per ten thousand to one additional case of cancer per one million people exposed. At this site, the estimated excess cancer risk from exposure to dioxins in sediment can be defined as low to moderate.

Table 1. Chemicals Detected in Nearby Sediments (Lundy-Davis Data, 1999-2001)
PRE-REMOVAL CONCENTRATIONS

Chemical	Frequency Detected	Average Result (ppm)	Maximum Result (ppm)	Comparison Value (CV) (ppm)	Type of CV
2-Methylnaphthalene	11/53	1.9	37.7	2,000	cEMEG
Acenaphthene	20/64	3.6	63.2	3,000	RMEG
Acenaphthylene	16/64	0.2	2.0	NONE	NONE
Anthracene	29/64	3.7	71.4	20,000	RMEG
Arsenic	6/13	3.0	8.3	20	cEMEG
Barium	13/13	65.4	288.0	10,000	cEMEG
Benzo(a)anthracene	38/64	3.8	70.0	NONE	NONE
Benzo(a)pyrene	**35/63**	**1.9**	**24.5**	**0.1**	**CREG**
Benzo(a)pyrene Eqv	**42/63**	**2.9**	**40.1**	**0.1**	**CREG**
Benzo(b)fluoroanthene	41/64	3.9	67.9	NONE	NONE
Benzo(g,h,i)perylene	18/63	0.5	7.9	NONE	NONE
Benzo(k)fluoranthene	39/64	3.5	67.9	NONE	NONE
Benzyl butyl phthalate	1/43	0.3	0.4	10,000	RMEG
Bis(2-ethylhexyl)phthalate	7/53	0.5	4.4	50	CREG
Cadmium	3/13	0.3	0.4	10	cEMEG
Chromium	13/13	8.3	19.4	NONE	NONE
Chrysene	41/64	3.8	61.5	NONE	NONE
Dibenzo(a,h,)anthracene	6/63	0.1	1.7	NONE	NONE
Dibenzofuran	14/53	3.7	49.5	NONE	NONE
Di-n-butyl phthalate	1/43	0.2	0.7	5,000	RMEG
Dioxins (TEQ, WHO Eqv)	**9/12**	**0.002**	**0.01**	**0.000035**	**cRMEG**
Fluoranthene	45/64	16.5	378.0	2,000	RMEG
Fluorene	23/64	5.0	66.4	2,000	RMEG
Indeno(1,2,3-c,d)pyrene	27/64	0.8	10.5	NONE	NONE
Lead	12/13	14.0	40.3	400	PRG
Mercury	2/13	0.1**	0.05	23	SSL
Napthalene	8/60	2.7	95.7	NONE	NONE
Pentachlorophenol	1/43	0.7**	0.3	6	CREG
Phenanthrene	29/64	17.7	299.0	NONE	NONE
Phenol	1/43	0.3**	0.1	20,000	RMEG
Pyrene	38/64	12.0	238.0	2,000	RMEG
Selenium	2/13	2.2	0.5	300	cEMEG

Bolded text indicates that the maximum concentration exceeds the comparison value (CV) for that chemical.
Averages were calculated using ½ the reported detection limit for non-detects (NDs).
**The calculated average is higher than the maximum detected concentration due to including ½ the detection limit in the calculation.

Table 2. Chemicals Detected in Nearby Surface Soil (Lundy-Davis Data, 1999-2001)
PRE-REMOVAL CONCENTRATIONS

Chemical	Frequency Detected	Average Result (ppm)	Maximum Result (ppm)	Comparison Value (CV) (ppm)	Type of CV
Acenaphthene	1/26	0.003	0.07	3,000	RMEG
Acenaphthylene	2/26	0.01	0.2	NONE	NONE
Anthracene	5/26	0.02	0.1	20,000	RMEG
Arsenic	14/26	2.6	14.2	20	cEMEG
Barium	25/26	100	389	4,000	RMEG
Benzo(a)anthracene	6/26	0.06	0.8	NONE	NONE
Benzo(a)pyrene	**7/26**	**0.08**	**0.9**	**0.1**	**CREG**
Benzo(a)pyrene Equivalents	**13/26**	**0.1**	**1.2**	**0.1**	**CREG**
Benzo(b)fluoroanthene	5/26	0.1	1.3	NONE	NONE
Benzo(g,h,i)perylene	5/26	0.04	0.3	NONE	NONE
Benzo(k)fluoranthene	5/26	0.1	1.0	NONE	NONE
Benzyl alcohol	1/16	0.01	0.2	18,000	PRG
Benzyl butyl phthalate	3/26	0.05	0.7	10,000	RMEG
bis(2-chloroisopropyl) ether	1/26	0.01	0.3	2,000	RMEG
bis(2-ethylhexyl) phthalate	21/26	0.4	1.8	50	CREG
Cadmium	10/26	0.2	1.8	10	cEMEG
Chromium	22/26	9.2	35.4	80,000	RMEG
Chrysene	7/26	0.1	1.1	NONE	NONE
Fluoranthene	13/26	0.2	2.1	2,000	RMEG
Hexachloroethane	1/26	0.008	0.2	50	CREG
Indeno(1,2,3-c,d)Pyrene	4/26	0.03	0.3	NONE	NONE
Lead	**25/26**	**73.5**	**432**	**400**	**SSL**
Mercury	18/26	0.1	0.8	23	SSL
Phenanthrene	8/26	0.1	1.0	7,800	SSL
Phenol	1/26	0.008	0.2	20,000	RMEG
Pyrene	12/26	0.2	1.7	2,000	RMEG
Selenium	7/26	0.1	0.7	10	cEMEG
Silver	11/26	0.7	6.0	300	RMEG

Bolded text indicates that the maximum concentration exceeds the comparison value (CV) for that chemical
Averages were calculated using ½ the reported detection limit for non-detects (NDs).
**The calculated average is higher than the maximum detected concentration due to including ½ the detection limit in the calculation

APPENDIX E: RESPONSE TO PUBLIC COMMENTS

ATSDR received over 1400 pages of comments and accompanying documentation during the public comment period for the Kerr-McGee Chemical Corporation PHA. Comments were submitted and accepted until March 2009. New sampling data was submitted from a third party and addressed below as a public comment. General and specific comments were received. The general comments are reproduced in their entirety below. Specific comments were edited for brevity.

Several noteworthy developments have impacted our assessment since the initial public release. The major development includes the addition of the site to the National Priorities List (NPL) list of hazardous waste sites. As a result, EPA is identifying the levels and extent of contamination in the community surrounding the site. ATSDR's initial assessment recommended additional off-site sampling to determine the nature and extent of contamination, in order to determine if people are coming into contact with contaminants at levels of potential health concern. Therefore, the sampling results obtained by EPA during the NPL process should help address ATSDR's concerns regarding exposures in the community.

Another relevant development of importance to our assessment has been the release (February 2012) of EPA's dioxin reanalysis report. This dioxin report is EPA's response to key comments and recommendations made by the National Academy of Sciences (NAS) on the draft dioxin reassessment (2003, 2010). Among other things, EPA's report includes significant new analyses on potential non-cancer human health effects that may result from exposures to dioxins, and includes a new oral reference dose (RfD) for what is considered to be the most toxic of the dioxin-like compounds. The assessment has been in progress for many years and raises health issues of interest to many stakeholders, including ATSDR. The final dioxin assessment was released by EPA in February 2012. Where applicable, ATSDR incorporated key findings from the dioxin reanalysis.

The dioxin questions raised by commenters resulted in an extended fact-finding effort by ATSDR to ensure the use of the best available science in our decision-making process. We also wanted to evaluate whether the new assessment might impact critical findings in our document. Until the dioxin cancer reassessment is finalized, ATSDR will continue to use the Toxicological Profile for Chlorinated-p-Dioxins (1998) for scientific guidance. Once the reassessment is finalized, ATSDR will determine whether the findings of this document need to be updated to ensure our conclusions and recommendations are protective of human health.

Below ATSDR responds to the issues or question posed during the comment period. We also indicate if changes or additions were made to the text. For comments that questioned the validity of statements made in the PHA, ATSDR verified or corrected the statements.

1**. Comment**:

Section 1.0, Background and Statement of Issues, would benefit from the inclusion of a "Regulatory History and Activities" subsection, in accordance with Section 3.1.1.3 of the

***Public Health Assessment Guidance Manual* (PHAGM) (ATSDR). As documented in a number of official reports, the Facility has been investigated extensively and has performed numerous corrective actions under the auspices of the Resource Conservation and Recovery Act (RCRA). All this work was done under the supervision and approval of the Region 4 (off-site and on-site activities) and/or the Mississippi Department of Environmental Quality (MSDEQ) (on-site and limited off-site activities). Compilation of this information in a Site Summary Table (Section 3.4 of the PHAGM) would be useful in this regard. In addition to providing important information about the facility and its compliance with applicable regulations, such a section would assist the reader in evaluating the available data and would establish a more accurate conceptual site model (CSM).**

ATSDR Response:

The inclusion of a "Regulatory History and Activities" subsection is not required for all PHAs. The main goal of including such a section is to assist with evaluating how a site's regulatory activities affect how people might be exposed. As stated in Section 3.1.1.3 of the PHAGM, certain (but not all) information about a site's regulatory history may assist in evaluating a site's public health implications. One may have to sort through many regulatory documents, focusing on information that is relevant to public health exposures. According to the PHAGM, activities associated with environmental releases, site investigations, and remedial actions will be most pertinent.

We believe that the PHA contains information on regulatory history and activities that are of significance from a public health standpoint. For example, the Pathways Analysis section contains a subsection entitled "Actions Taken to Reduce Exposures to On-Site Soils" and "Actions Taken to Reduce Exposures to Off-Site Sediments". These sections refer specifically to actions deemed relevant to assist in understanding exposures, and why certain exposures are more or less than expected. We also mention in several locations in the PHA that the facility is currently closed, and that several investigations (Section 2.3 Environmental Sampling) and corrective actions have been undertaken at the site. We believe these statements will allow readers to gain a general understanding of the facility operations and to relate these operational processes to the environmental contamination at the site.

Any effort to detail the regulatory history and activities of a site where many activities have occurred is subject to error and omissions. It would involve sorting through volumes of documents from federal, state and local agencies that have been involved in these activities. ATSDR would have to request information from these agencies and then parse through each document for what may amount to a little bit of relevant information. Because this action would involve so many agencies and documents, we run the risk of leaving out relevant information or producing questions over what qualifies as relevant information. We believe that our time can be better served by detailing those events taken specifically to address a public health issue or an area that we have identified as being of potential public health significance. A more detailed analysis of regulatory history and activities can be gathered from documents produced by applicable regulatory agencies.

__2. Comment__:

Readers' understanding of the data discussed in the PHA, and its correct interpretation, would be facilitated by early presentation of key information regarding the sources and environmental distribution of the major chemicals of concern – arsenic (discussed later), pentachlorophenol, PAHs, and PCDDs/PCDFs. Relegation of key information to later sections could create confusion as non-technical readers may gain the impression that these chemicals are unique to KMCC, and would not otherwise be detected. In addition to the facts mentioned in various places in the PHA that (1) dioxins and furans arise from many sources, (2) are ubiquitous in the environment, including human bodies, and (3) are not present at elevated concentrations in the long-time facility neighbors examined by Dahlgren *et al*. (2003a), it should also be emphasized that soil is a very minor contributor to the human body burden of these compounds. For example, EPA has determined that food is the major source of human exposure to dioxin-like compounds (more than 90%), while soil contributes perhaps 1%. This finding is corroborated by many studies demonstrating a lack of relationship between tissue levels and physical proximity to environmental sources, including several conducted by ATSDR. For example, a recent investigation by the ATSDR found no significant correlation between blood dioxin/furan concentration and the concentrations of soil or house dust. Similarly, a recent detailed examination of environmental factors that influence serum levels of dioxin-like chemicals in Michigan communities showed that age, sex, body mass index, and demographic factors are by far the most influential factors, while levels in soil and house dust were not important contributors (Garabrant 2006, 2008). The repeated demonstration that yard soil is not a significant contributor to the observed dioxin/furan levels measured in individuals who reside on the property provides important perspective on the data presented in the PHA, and should be reassuring to Columbus residents.

ATSDR Response:

Information about the chemicals of concern has been moved to an earlier section in the document. We have removed reference to the Dahlgren *et al*. article related to this issue, particularly since the article did not discuss how persons sampled could have been exposed to dioxin-like compounds from the Kerr-McGee facility, or what other potential exposures to dioxins could have existed in their lifetimes.

__3. Comment__:

This PHA indicates that arsenic is a constituent of concern for the community. Arsenic has not been used at the facility and any arsenic found in the environment in the area around the facility is unrelated to KMCC. There are multiple sources of arsenic including the natural environment and other industries. This PHA should indicate that the arsenic is not related to KMCC activities and should remove the discussion of arsenic from this PHA.

ATSDR Response:

Although we agree that arsenic can be naturally occurring and has multiple potential sources, it is ATSDR's policy to evaluate each chemical of potential health concern, regardless of the source.

4. Comment:

The data quality evaluation briefly described in Section 2.0, Environmental Data appears inadequate and incomplete. The types of environmental and biological data relied upon for the site should be summarized, data quality objectives should be defined clearly and data should be evaluated as rigorously as possible in accordance with the guidelines set forth in Section 5.1 of the PHAGM. In particular, the PHA completely fails to mention the key attribute of representativeness (See Section 5.1.3 of the PHAGM). Certainly, the data collected by Tronox under regulatory oversight and in accordance with approved work plans meet all major quality criteria. However, because these data were collected with a deliberate bias toward known or suspected impacted areas, their representativeness for purposes of evaluating community exposures should be evaluated.

In contrast and as acknowledged in the PHA, the quality and hence usability for risk assessment of the data collected by the plaintiffs' law firm Lundy & Davis LLC in connection with litigation at this facility cannot be ascertained. There is no indication that ATSDR reviewed any of the underlying laboratory data or assessed the validity of the collection or analytical procedures, due to a lack of essential quality assurance/quality control (QA/QC) information. Although such unverified data cannot be used to support scientifically defensible conclusions, the data form the basis for several of ATSDR's major conclusions in the PHA. For example, the discussion of PAHs in Section 4.0 Subsection A1 *Ditch Sediment-Pre-Removal Health Implications* is dependent on the flawed analyses and biased opinions of the plaintiffs' expert James Dahlgren in connection with this litigation (Dahlgren *et al*. 2003b). Moreover, the lack of detailed information regarding PCDD/PCDF furan congeners in ditch sediment samples is problematic given the high degree of uncertainty surrounding toxicity equivalency factors (TEFs), especially for the limited profile of higher-chlorinated congeners potentially associated with technical PCP, the assumed source material used at the facility. This difficulty is exacerbated by the inability to evaluate the impact of recent changes in TEFs. Because the quality of the data collected on behalf of the Lundy and Davis litigation cannot be ascertained, Tronox believes that it is improper for ATSDR to propagate them as objectively informative with respect to community exposures and health concerns in the PHA.

ATSDR Response:

In the current PHA, ATSDR evaluated the Lundy & Davis data (See Appendix D) but did not use the data to make public health decisions because of the lack of documented QA/QC information.

5. Comment:

Four lines of evidence, including data collected by the plaintiffs in past litigation, support the conclusion that drainage ditches are not a source of contamination to adjacent residential yards.

a. **Investigations of drainage ditches conducted by Environmental Resources Management (ERM) (2001a, 2001b, 2005) have shown that sedimentation has been occurring, with no visual evidence of scouring and transport. The actual observed natural processes reveal that sediments or other materials that would have left the site during its operations have been capped by this sedimentation, burying any potentially impacted material. A low velocity "backwater effect" was also observed, where Luxapalila Creek backs up into the ditch, creating ponding of runoff waters that cannot flow into the full ditch. Under these conditions, ditch sediments are not transported onto the adjacent land, but remain capped in place.**

b. **The highly conservative exposure evaluation presented in the PHA indicated that none of the available residential soil samples present a known public health hazard.**

c. **Given that a major source of household dust is exterior soil, it is reasonable to assume that household dust data are reflective of yard soil. The PHA concludes that household dust data from homes near the site presented in Dahlgren *et al.* (2003a) showed PAH levels were at or near background concentrations and that maximum PCDD/PCDF levels were below background, is therefore indicative of the absence of site contaminants in residential yards. The household dust data support the conclusion that residential yards are not a potential sink for constituents of concern associated with the facility.**

d. **As discussed in the PHA, the concentrations of PCDD/PCDF furan congeners in blood samples from ten adult plaintiffs described by Dahlgren et al (2003s) as long-time (over 25 years) facility neighbors are similar to levels measured in the general population of adult African Americans 25 years of age and older. Because biomonitoring is considered the most reliable indicator of actual exposure to these compounds, the fact that these residents had no elevated exposures strongly argues against the presence of elevated concentrations in residential areas.**

ATSDR Response:

ATSDR strongly believes that drainage ditches remain a potential source of contamination to adjacent properties. We have seen such transport at similar sites, and are unaware of any containment or control procedures that would prevent a similar scenario from occurring here. The limited data we evaluated did not rule out the possibility of overland transport from the site or outfalls/drainage ditches to adjacent properties. In fact, recent erosion along 14th Avenue may have resulted in additional transport of on-site/drainage ditch contaminants to off-site locations.

If, as the commenter suggests, materials that would have left the site during operation of the facility have been capped by sedimentation and buried, then the ditches remain a potential source of on-going contamination as erosion and other high velocity events that turn the sediment occur. Further, the commenter's statement is based on the premise that on-site sources that contribute to off-site migration have been properly contained. We believe this to be in error because recent erosion events along 14th Avenue show that on-site containment/stability has not been achieved.

The commenter also suggests that the low velocity backwater effect causes ditch sediments to remain capped in place and not get transported onto nearby land. The low velocity backwater effect is where current velocities decrease such that flows are no longer capable of supporting sediment transport; entrained sediment becomes redeposited. We believe that overbank sediment transport from creek/ditch channels into adjoining yards is still a possibility at this site.

According to the Federal Emergency Management Agency (FEMA) flood maps, the area in and around the Luxapalila Creek and its tributaries is a designated flood hazard area. According to long-time residents and the local newspapers, the Luxapalila Creek overflows during heavy rains. The ditches near the facility also have been known to overflow. If the ditch overflows its banks due to either high precipitation, backwater effects from tides or downstream flooding, etc., then sediment transport is likely to occur. If the sediment in the ditches is disturbed at all under such conditions, the sediments will go everywhere the flooding goes. Keep in mind that current velocities will be highest in channels (ditches/creeks). Finally, even if under "backwater" flooding conditions the ditch sediments are not disturbed, there are likely to be other types of flooding conditions that would disturb them (high precipitation in the ditch's drainage area, for example).

We disagree with the commenter's statement that backwater flooding cannot, due to "low velocity backwater flooding," transport sediment out of the ditch and that sediment transport can only go downstream under such quiescent flooding conditions. Farmers have depended on sediment deposition in "low-velocity" flooding conditions for centuries. We believe that sediment transport from ditches onto nearby properties is possible.

<u>6. Comment</u>:

Tronox's review of the PHA identified two major issues with the calculation methodology presented in Appendix E:

a. **The description of calculation methodology in Appendix E is incomplete. All input values and equations, their rationale and sources should be presented so that the doses and risks presented in Tables 9 and 10 can be understood and verified by readers.**

b. **Several of the exposure parameter values appear to be unreasonably high based on both site conditions and current EPA exposure assessment guidance:**

1. **In its Main Drainage Ditch Risk Assessment Report (ERM 2001a), ERM noted that some segments of the ditch were unattractive and difficult to access. In addition, no children were seen in the areas where data were collected. Thus, the assumptions that not only children of all ages, but also adults would spend half of every year (182 days) for their lifetimes in the ditch are both highly implausible.**

2. **In their Main Ditch Risk Assessment Report (ERM 2001a), ERM assumed an overly conservative exposure frequency of 45 days per year for ten years.**

c. **The sediment ingestion rates assumed are inappropriately high. The currently recommended default mean soil ingestion rate is 50 mg/day for both children over one year of age (EPA 2008) and adults (EPA 1997). The recommended ingestion rate for both soil and indoor dust is 100 mg/day for children older than one year of age (EPA 2008). These EPA rates would still overestimate oral exposure to sediment because there is no reason to suppose that all soil ingested in a day would be derived from the ditch.**

d. **Intake estimates were not adjusted for the well-known reduction in oral bioavailability of soil-associated chemicals, including arsenic, PAHs, and PCDDs/PCDFs**.

ATSDR Response:

The formulas and exposure assumptions used to calculate exposure doses and estimated cancer risks are presented in Appendix E. To assist the reader, all input and output data have been compiled into tables.

In the absence of site-specific exposure metrics, ATSDR uses best practices/default values, other specific guidance sources (e.g., EPA's Exposure Factors Handbook), or anecdotal evidence from residents familiar with residential customs/practices in the area. Several conservative assumptions were used at this site to be protective of public health. Residents who live near the site commented that children play in and around the ditches most of the year. ATSDR conservatively assumed that children could play in the ditches for six months out of the year based on the weather conditions for the area.

As for the comment that adults are not likely to spend half of the year in the ditches, we agree. In fact, we did not include adults playing in the ditch as a plausible scenario when evaluating this site. ATSDR did deem it plausible for an adult to be exposed to soil and/or sediment while gardening, doing yard work or other outdoor activities.

The amount of soil that people ingest daily is somewhere between 30 milligrams to 200 milligrams. Studies on children with soil pica behavior have shown that they can eat up to 5,000 milligrams of dirt. Preschool children, on average, swallow more soil and dust than people in any other age group. This is because some preschoolers often have close contact with soil and dust when they play, and because they tend to engage frequently in hand-to-mouth activity. These preschoolers might get exposed from swallowing dirt tracked indoors or from swallowing contaminated dust that clings to their hands. Since we did not consider it a likely that a preschool child (1-2 years old) would play in the ditches, where the highest exposures would occur, ATSDR focused on the elementary aged child. We revised the ingestion rate in some instances from 200 mg/day to 100 mg/day for older children and adults to reflect the current recommended rates for that age group.

In the absence of site-specific information, ATSDR assumes that all of the chemical that is swallowed will cross the gut into the body. Therefore, a default gastrointestinal absorption fraction of 1 is used to ensure protectiveness. (This value is consistent with current EPA dioxin guidance, which is based on the assumption that soil-bound dioxins are absorbed to the same extent as dioxins administered in the studies used to establish the cancer slope factor or reference dose for dioxin.)

7. Comment:

The PHA does not include an in-depth discussion of toxicity in accordance with Section 8 of the PHAGM. This omission is particularly problematic in the case of dioxins given the National Academy of Sciences' (NAS's) recent highly critical comments on EPA's latest reassessment of dioxin toxicity (NAS 2006). In particular, the PHA should contain information that addresses the NAS's unanimous conclusion that dioxin-induced carcinogenesis has a threshold – a conclusion that would preclude calculation of slope factors and probabilistic cancer risks. Risk assessment for chronic exposures to dioxins performed by the World Health Organization (WHO) (2002) and several other major international regulatory agencies have all developed toxicity values in the range of 1 to 4 picograms per kilogram per day (pg/kg/day) that are protective for health effects, including cancer. As discussed in several recent publications by ATSDR scientists, the most appropriate available toxicity criterion for dioxin-like chemicals is the chronic Minimal Risk Level (MRL), which is one to two orders of magnitude below any effect levels demonstrated either experimentally or in epidemiologic studies for both cancer and non-cancer health end-points (Pohl *et al*, 2002, 2007).

ATSDR Response:

This public health assessment was prepared in accordance with Section 8 of the PHAGM. The discussion on dioxins is in accordance with the latest science according to EPA's latest reassessment of dioxin toxicity. The appropriate health-based comparison value selected was EPA's RfD for dioxin in a residential setting.

8. Comment:

The PHA contains inconsistencies and omissions that are in part due to the separate publication of the two PHA (September 22, 2008) for the Kerr-McGee facility. These

reports should be evaluated together and combined into one document with a consistent interpretation and analysis of data, conclusions, and recommendations based upon the sum of the data. This will reduce the inconsistencies currently found among these documents and facilitate public understanding of the totality of results.

ATSDR Response:

ATSDR addressed the air pathway separately from other pathways in the interest of addressing the community's concerns quickly and accurately. The public comment period provides an opportunity to address any statements that may appear to be contradictory or any for other issues arising from the assessment.

9. Comment:

Re: Demographics and Land Use, page 4.

Tronox acknowledges that ATSDR mentions additional industrial properties are located in the vicinity. These industrial properties historically had, and may currently have, the potential for the release of the same constituents of concern associated with the facility as well as additional chemical constituents. In fact, on pages 22 and 23 of the PHA ATSDR indicates that:

"The source of the polychlorinated aromatic hydrocarbon (PAH) contamination is less certain, since these ditches are located near roadways and motor vehicle traffic, asphalt paving, and other man-made sources that can contribute to PAH loading near roadways."

Also, the PHA states:

"The source of dioxin and dioxin-like compounds is also difficult to determine with complete certainty."

These statements clearly indicate that the ATSDR is aware of the potential for additional contamination not related to the KMCC facility. Releases from other industrial operations are not addressed as a potential health risk for persons in this community. It is recommended that ATSDR acknowledge early in the PHA that alternative sources of potential contamination are found in the area to provide the public a more complete assessment of their community.

ATSDR Response:

Our focus at ATSDR is not to identify sources of contamination. That responsibility is more appropriately assigned to the regulatory agencies. Our goal is to evaluate the potential health risks associated with each identified contaminant, regardless of the source.

10. Comment:

Re: 1.4 Natural Resources, b. Luxapalila Creek, page 5

While the distance from the KMCC facility to Luxapalila Creek is approximately 0.5 miles, surface water from the southernmost outfall of the site (Outfall 004) must flow approximately 1.3 miles to reach Luxapalila Creek. Within those 1.3 miles of ditch, there are many unregulated discharge pipes and culverts that contribute flow to the ditch. In addition, there are many well documented sources of contaminants to Luxapalila Creek located both upstream and downstream of the unnamed ditch that discharges into the creek. Impacts to Luxapalila Creek, if any, can not be attributed to the KMCC facility with any reasonable confidence.

ATSDR Response:

ATSDR re-classified the surface water pathway from a completed exposure pathway to a potential exposure pathway. We made this change because the number of surface water samples was small and the level of contamination detected in surface water was minimal.

We had no surface water samples from the Luxapalila Creek. Therefore, no conclusions were drawn regarding impacts to the Luxapalilia Creek. As previously stated, identifying sources of contamination is not a major part of ATSDR's role at this and other hazardous waste sites.

11. Comment:

Re: 2.1 Data Quality Evaluation, page 6

Tronox disagrees with ATSDR's assessment that some of the Lundy & Davis LLC data, specifically Dahlgren et al. 2003a and 2003b, and the private third party data, TestAmerica, are valid for use in the health assessment based solely on the inclusion of a portion of the data in submittals by Lundy & Davis LLC. While no specific comment is made by ATSDR regarding QA/QC of the TestAmerica data, the PHA does state that: "The exact sampling locations and methods were not included in the submitted report." The portion of data that was reported by Dahlgren et al. (2003a and 2003b) without full QA/QC supporting materials and by TestAmerica with unreported QA/QC and methodology descriptions should not be used by ATSDR until quality can be evaluated and confirmed. Conclusions based upon that data set(s) should be withdrawn from the evaluation. In addition, Tronox understands Lundy and Davis LLC to be a law firm, not an employer of scientists, whereas ERM is an environmental firm that does not employee full-time scientists utilizing appropriate data gathering and assessment practices.

The TestAmerica data were collected from Maranatha Faith Center's property by drilling through a concrete drainage structure installed on this property and collecting samples from beneath the concrete. Only one of the samples reported any detections of PAH constituents. Because there is no potential for persons to be exposed to any sediments

beneath the concrete drainage structure, these samples should not be considered as part of the PHA.

ATSDR Response:

ATSDR evaluated the Lundy & Davis data (See Appendix D) but did not use the data to make public health decisions because of the lack of documented QA/QC information.

The third party data from TestAmerica included in this document were collected from 3 locations in the ditch near the Maranatha Faith Center. It is possible that a concrete drainage structure once existed or still exists in the location the samples were taken. Once the concrete structure was breached, damaged or removed, a potential exposure pathway opened up as the sediments beneath the concrete became exposed for human contact. As indicated in our exposure pathways section, subsurface sediments are eliminated as a potential exposure pathway so long as the sediments remain buried. Once the buried sediments are uncovered during digging or during other earth-moving activities, these sediments must now be evaluated as would any other exposed medium.

12. Comment:

Re: Environmental Sampling, Private Third Party Environmental Data, page 7

Tronox recommends that this paragraph describing the TestAmerica sampling (TestAmerica 2008) and conclusions drawn from it be removed from the PHA. As previously stated, ATSDR indicated that sampling methods and locations were not included in the submitted report. However, it is known that the samples were taken from the ditch below a concrete drainage structure as described above. Without knowledge of how the samples were collected, reliable conclusions cannot be made from these data. Specifically, without documentation that proper sampling protocols were followed, it is impossible to confirm that the samples were taken with appropriate precautions to avoid the introductions of contamination.

ATSDR Response:

As previously stated, ATSDR did not use third party data to draw public health conclusions or recommendations. However, the third party data from TestAmerica included in this document were collected from 3 locations in the ditch near the Maranatha Faith Center. The exact locations were not included. However, the narrative accompanying the results indicates that the sampling locations were in the ditch near the Maranatha Faith Center. The physical location coincides with the location of a 2009 excavation in which EPA documents contained the following statements:

> *….Reverend Jamison used a backhoe to remove the concrete paving along a portion of the storm drainage ditch that traverses his church property. In doing so, Reverend Jamison also excavated sediment from the ditch invert. The broken*

concrete and spoils were strewn along the field of the church property. This area is open to community member ingress and egress. Single family and multi-family residential properties surround the church. EPA was notified that children were playing in the excavated spoils. The excavation occurred on or around July 7, 2009.

<u>13. Comment</u>:

Re: 3.2 Exposure Pathway Analysis, Table A. Completed and Potential Exposure Pathways, page 14

Tronox recommends adding information to the introductory discussion that acknowledges that sources other than the KMCC site are expected to contribute the same "contaminants of concern" to the "source" identified in Table A.

<u>ATSDR Response</u>:

ATSDR has included additional information about the contaminants of concern that addresses, among other things, potential sources (man-made and natural, if applicable) for each chemical.

Again, our focus at ATSDR is not to identify sources of contamination; that responsibility is more appropriately assigned to the regulatory agencies. Our goal is to evaluate the potential health risks associated with each identified contaminant, regardless of the source.

<u>14. Comment</u>

Re: 3.2 Completed Exposure Pathways, page 15, b. Ditch Sediments

Because PAHs and PCDDs/PCDFs are ubiquitous and arise from many sources, the former KMCC facility cannot be assumed to be their sole source in ditch sediments. Tronox therefore suggests moving (or repeating) the discussion of this subject in Section 4.0, Subsection A1, pages 22-23 of the PHA to this earlier position in the document. It should also be noted that PCP was historically one of the most widely used pesticides in the U.S. and was used in numerous capacities in addition to wood treatment (ATSDR 2001), including applications to railroad rights-of-way. As a result, it has been found in all environmental media (Thompson and Treble 1996; ATSDR 2001). Therefore, it is also inappropriate to assume that KMCC was the only source of PCP detected in ditch sediments.

As stated by ATSDR, there is insufficient evidence to conclude that specific contamination from the former KMCC site has impacted residential yards through flooding. Based on investigations of the main drainage ditch conducted by ERM on behalf of KMCC, the shallow sediment samples from the ditch were similar to those for other urban areas (ERM, *Main Drainage Ditch Risk Assessment Report 2001a; Urban Runoff Study Report*

2001b). The upper layer of surface sediment gets thicker over time due to rain events, during which sediment-laden runoff washes into the ditch bottom from adjacent land. The sedimentation has been occurring in the ditch and no visual evident of scour-inducted excavation of deeper sediments was observed. This sediment capping effect was again confirmed by observation during the ditch remediation presented in ERM's *Interim Measures Report*, (2005). Therefore, contact with "…creosote material that collects in the bottom of the ditches" is unlikely. In addition, the likelihood of contaminants being transported onto the residential yards is low due to the capping effect. This position is further supported by the low velocity "backwater effect." Ditchwater does not actually flow out of the ditch but runoff water ponds because it cannot flow into the ditch, causing a backwater effects as the Luxapalila Creek backs up into the ditch. Under these conditions, ditch sediments are not transported onto the adjacent land. Therefore, conclusions in the ATSDR report based on the assumption that exposures have occurred due to flooding from the ditches into the residential yards should be withdrawn.

The unsightly nature of the ditch traversing the community was documented in ERM's report and the PHA report quotes attendees from the public meeting describing the ditches closest to the site as "dirty" and "malodorous". Various types of debris (tires, lawnmowers, trash, can, roofing tar, oil filter, etc.) observed in the ditch by residents and ERM have nothing to do with the KMCC facility, but may be sources of many of the same chemicals. It is certainly not accurate to imply that the dirty and malodorous conditions were caused only by the KMCC facility. During the ATSDR's site visit in November 2006, no children or adults were reported to be observed in the ditch, which seems to confirm the observations of others that the ditches are undesirable areas to play or congregate. With regard to the reported flooding events, Tronox requests clarification of whether residents reported contamination from flooding or if that portion of the flooding statement is based on conjecture.

ATSDR Response:

ATSDR has included additional information about the contaminants of concern that addresses, among other things, potential sources (man-made and natural, if applicable) for each chemical.

Our focus at ATSDR is not to identify sources of contamination; that responsibility is more appropriately assigned to the regulatory agencies. Our goal is to evaluate the potential health risks associated with each identified contaminant, regardless of the source.

ATSDR strongly believes that drainage ditches remain a potential source of contamination to adjacent properties. We have seen such transport at similar sites, and are unaware of any containment or control procedures that would prevent a similar scenario from occurring here. The limited data we evaluated, including off-site surface soil data, did not rule out the possibility of overland transport from the site or outfalls/drainage ditches to adjacent properties. In fact, recent erosion along 14th Avenue may have resulted in additional transport of on-site/drainage ditch contaminants to off-site locations.

If, as the commenter suggests, materials that would have left the site during operation of the facility have been capped by sedimentation and buried, then the ditches remain a potential source of on-going contamination as erosion and other high velocity events that turn the sediment occur. Further, the commenter's statement is based on the premise that on-site sources that contribute to off-site migration have been properly contained. We believe this to be in error because recent erosion events along 14th Avenue show that on-site containment/stability has not yet been achieved. See images in Appendix A.

The commenter also suggests that the low velocity backwater effect causes ditch sediments to remain capped in place and not get transported onto nearby land. The low velocity backwater effect is where current velocities decrease such that flows are no longer capable of supporting sediment transport; entrained sediment becomes redeposited. We believe that overbank sediment transport from creek/ditch channels into adjoining yards is still a possibility at this site.

According to the Federal Emergency Management Agency (FEMA) flood maps, the area in and around the Luxapalila Creek and its tributaries is a designated flood hazard area. According to long-time residents and the local newspapers, the Luxapalila Creek overflows during heavy rains. The ditches near the facility also have been known to overflow. If the ditch overflows its banks due to either high precipitation, backwater effects from tides or downstream flooding, etc., then sediment transport is likely to occur. If the sediment in the ditches is disturbed at all under such conditions, the sediment will go everywhere the flooding goes. Keep in mind that current velocities will be highest in channels (ditches/creeks). Finally, even if under "backwater" flooding conditions the ditch sediments are not disturbed, there are likely to be other types of flooding conditions that would disturb them (high precipitation in the ditch's drainage area, for example).

The commenter's suggestion that backwater flooding cannot, due to "low velocity backwater flooding", transport sediment out of the ditch and that sediment transport can only go downstream under such quiescent flooding conditions is very tenous. Farmers have depended on sediment deposition in "low-velocity" flooding conditions for centuries. Therefore, we believe that sediment transport from ditches onto nearby properties is still a likely event.

ATSDR makes no claims regarding the validity of the statements made by residents. We report the statements because responding to community concerns is an integral part of our public health assessment process. We appropriately attributed such claims to the correct source to allow the reader to distinguish between conclusive statements made by the Agency and claims made by residents.

15. Comment:

Re: Completed Exposure Pathways, b. Ditch Sediments, page 16, Actions Taken to Reduce Exposures

Tronox concurs that the removal of sediment reduced the potential risk in the areas to acceptable levels in the removal areas. The removal also reduced the potential for the removed sediments from those areas to be carried downstream or be deposited via flood waters.

Between September 2006 and November 2007 additional remediation activities including excavating affected soil from the storm drainage ditch were conducted near and within Propst Park.

> ATSDR Response:
>
> ATSDR has included the additional remediation activities near and within Propst Park in the current document. We did not, however, have post-remediation confirmatory sampling results. Therefore, no conclusions can be made about the potential health effects related to these activities.

16. Comment:

Re: Completed Exposure Pathway, c. Surface Water, page 16

While the plant was still operating, seven surface water samples were collected by ERM in the main drainage ditch in 2000 (Main Drainage Ditch Risk Assessment Report ERM 2001a). The surface water sample locations spanned from 14th Avenue North to just before the ditch enters Luxapalila Creek. Surface water samples were analyzed for semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH), and pesticides. No constituents were reported with concentrations above EPA or MDEQ screening levels.

Tronox understands that there are no data indicating the presence of chemicals from KMCC in the surface water of Luxapalila Creek. While it is true that the Creek is located approximately 0.5 miles east of the former KMCC facility, the southernmost outfall of the site (Outfall 004) is approximately 1.3 miles upstream (upditch) from Luxapalila Creek. Along those 1.3 miles, many unregulated discharge pipes and culverts contribute to the ditch. Despite the potential for contamination of the ditch from discharge points or from residual concentrations in sediment, surface water data collected from the ditch in 2000 and 2001 by ERM indicate that no unacceptable risk exits from contact with surface water. In addition, there are many documented sources of chemicals that could enter Luxapalila Creek located both upstream and downstream of the unnamed ditch that discharges into the creek. There is no evidence to support ATSDR's assumption that persons contacting surface water in Luxapalila Creek were exposed to compounds from the former KMCC facility; therefore, Tronox requests that this discussion be withdrawn from the report. Tronox also requests that if surface water in the ditches is mentioned in this report, it is

clarified that no unacceptable risk is expected based on available data. The surface water exposure pathway should be removed from Table A – Completed Exposure Pathways (on page 14).

ATSDR Response:

As suggested, ATSDR re-classified the surface water pathway from a completed exposure pathway to a potential exposure pathway. We made this change because the number of surface water samples was small and the level of contamination detected in surface water was minimal and of no significant health concern. Additional sampling would be needed to eliminate this pathway from further consideration, especially in light of the recent on-site erosion event which may have allowed contamination to enter nearby surface waters.

We had no surface water samples from the Luxapalila Creek. Therefore, no conclusions were drawn regarding exposures to people contacting surface water from the Luxapalilia Creek. ATSDR added the following statement to alert the reader to this fact:

> *No samples were collected from the Luxapalila Creek; therefore, no conclusions can be drawn about potential exposures to humans via the surface water pathway in the Luxapalila Creek.*

The document also contains the following statements regarding potential exposure to surface water:

> *During the public meetings and public availability sessions held by ATSDR, residents expressed concern about coming into contact with contaminated water in the ditches and in the Luxapalila Creek.*
>
> *People could be exposed to contaminants in surface water if they come into contact with contaminated water in the ditches or in an impacted body of water. If people have contact with the water in the ditches or other body of water during activities such as playing, swimming or wading, they could be exposed to the contaminants via skin (dermal) contact or via incidental ingestion.*

These statements merely report the comments from residents regarding their concerns about water in the Luxapalila Creek. ATSDR makes no claim that persons contacting surface water in the Luxapalila Creek were exposed to compounds from the former KMCC facility.

17. Comment:

Re: 3.2 Completed Exposure Pathway, c. Surface Water, page 17

A review of the cited table (Table 8 in Appendix B) indicates that only indeno(1,2,3-c,d)pyrene exceeded its comparison value. Tronox agreed with ATSDR's earlier assertion

(on page 9 of the PHA) that the indeno(1,2,3-c,d)pyrene was likely due to suspended sediments in the surface water as the maximum concentration was greater than the solubility of indeno(1,2,3-c,d)pyrene in water. Therefore, the PHA concluded that the indeno(1,2,3-c,d)pyrene was not dissolved and "…the level would not result in any additional risk or health effect other than what was previously assessed in sediments."

In addition, seven surface water samples were collected by ERM in the main drainage ditch in 2000 (ERM, 2001, Main Drainage Ditch Risk Assessment Report). These samples do not appear to be included in this PHA. The main ditch surface water sample locations spanned from 14th Avenue North to just before the ditch enters Luxapalila Creek. Surface water samples were analyzed for SVOCs, VOCs, TPH, and pesticides. With the exception of the TPH-Diesel and di-n-butylphthalate, which were detected below the reporting limit (i.e., J-qualified), all constituents were reported as not detected. Both detected constituents were reported at low levels that are not expected to pose unacceptable risk in surface water.

Based on the combined surface water data, Tronox recommends that surface water be changed from a completed exposure pathway to a potential exposure pathway.

ATSDR Response:

See above response to comment 16. ATSDR re-classified the surface water pathway from a completed exposure pathway to a potential exposure pathway. We made this change because the number of surface water samples was small and the level of contamination detected in surface water was minimal and of no significant health concern. Additional sampling would be needed to eliminate this pathway from further consideration, especially in light of the recent erosion events which may have allowed contamination to enter nearby surface waters.

The table has been corrected to show that two contaminants were detected in surface water above their respective comparison values - bis(2-chloroisopropyl)ether and indeno(1,2,3-c,d)pyrene.

18. Comment:

Re: 3.2 Potential Exposure Pathways, a. Residential (off-site) Surface Soils, page 18

As explained above, the likelihood of contaminants being transported onto the residential yards is very low due to the capping effect. This position is further supported by the low velocity "backwater effect." The ditchwater does not actually flow out of the ditch but runoff water ponds because it cannot flow into the ditch, causing a backwater effect as the Luxapalila Creek backs up into the ditch. Under these conditions, ditch sediments are not transported onto the adjacent land. Therefore, conclusions in the ATSDR report based on the assumption that exposures have occurred due to flooding events transported impacted sediments from the ditch bottom to residential yards should be withdrawn.

The PHA indicates that exposure to residential soil should not cause adverse health effects. In addition, the comment above in this document and data reported in the PHA indicate that residential dust comes in large part from yard soil. As such, household dust data from homes near the site presented in Dahlgren *et. al* (2003a) indicated that the PAH levels were at or near background and maximum PCDD/PCDF levels were below background. Thus, the available data supports a conclusion that residential yards are not impacted from site constituents.

ATSDR Response:

As stated above, ATSDR strongly believes that drainage ditches remain a potential source of contamination to adjacent properties. We have seen such transport at similar sites, and are unaware of any containment or control measures that would prevent a similar scenario from occurring here. The limited off-site surface soil data did not rule out the possibility of overland transport from the site or outfalls/drainage ditches to adjacent properties. In fact, recent erosion along 14th Avenue (See Photos 3 in Appendix A) may have resulted in additional transport of on-site/drainage ditch contaminants to off-site locations. Therefore, we believe that sediment and surface water transport from ditches onto nearby properties is still a possibility.

Most surface soil samples were not collected from areas likely to be impacted in flooding events. With so few samples from potentially impacted areas, ATSDR was not able to rule out this potential exposure pathway.

19. Comment:

Re: Potential Exposure Pathways, a. Residential (off-site) Surface Soils, page 18

Tronox agrees that making conclusions about the presence of contamination is difficult using only aerial photographs. Tronox disagrees with ATSDR's assumption that the ponds received runoff from the former KMCC facility. The aerial photos do not show drainage ditches connecting the KMCC facility to the ponds. In fact, the general surface water flow observed in the area is to the southeast (also the direction to which the ditches drain) and not to the north or northwest where the historical ponds were located. The ground water flow direction in the area is also away (generally to the southeast) from the upgradient historical ponds and a very unlikely source to the ponds. These relevant facts are not presented in the ATSDR's text and Tronox requests that the text be revised to include them.

During operations, the site had permitted discharge points that were monitored to reduce the potential for off-site contamination and none were used to discharge waste into the community. In fact, ATSDR correctly stated in the introduction that the site historically used an on-site surface impoundment as part of their wastewater treatment system. Multiple organic smells are commonly encountered when digging in soil. These odors are likely from natural biological processes. The ponds that were reportedly filled-in would have contained organic materials that can product noticeable odors if the fill material is

disturbed. There is no basis to state that the ponds are a potential source of site constituents.

<u>ATSDR Response</u>:

ATSDR makes no claims that off-site ponds received runoff from the former Kerr-McGee facility. The claims regarding ponds receiving contaminated runoff are properly attributed to residents who expressed such a concern. As stated above, reporting community concerns is an integral part of ATSDR's public health assessment process. We revised the text slightly to avoid confusion on this matter.

20. Comment:

Re: Potential Exposure Pathways, A. Residential Dust, page 18

Tronox suggests that a revised Residential Dust section be moved to Section 3.4, Eliminated Exposure Pathways. Relevant information regarding residential dust in Section 4.0 Subsection D, pages 29-30 of the PHA should be presented in this section, as they justify elimination of residential dust as a potential exposure medium. It is important to note that the bulk dust samples reported by Dahlgren *et. al*. (2003a) were collected from attics, not living spaces. The use of attic dust sample results to determine health risks is not appropriate since the potential for exposure to attic dust is much more limited.

As noted by ATSDR in a recent exposure investigation in Louisiana,

> ***Attic dust samples cannot be used to determine or estimate human exposures to dioxin because no applicable exposure estimates are available for inhalation or ingestion of attic dust contaminants. To assume similar exposure to soil in indoor dust – because attics are infrequently accessed and not part of the typical indoor environment – is inappropriate.***

Due to being protected from natural weathering and attenuation processes, concentrations of chemicals in dusts from infrequently accessed and inaccessible areas are typically elevated compared to living spaces. This concept has been demonstrated in the scientific literature with dioxins in dust from homes and office buildings, and has been noted by the ATSDR:

> ***Attic dust had the highest concentrations for all environmental media sampled. This was expected, given that attics act like passive air samplers. That is, particulates that enter the attic settle to the floor and remain until disturbed through remodeling, cleaning or other infrequent activities. Environmental weathering (e.g., wind, rain, sunlight) and human foot traffic are not applicable to the breakdown, dilution, or removal of contaminants in attic spaces (Rasmussen 2001; Ilacqua 2003). Because, however, no attic dust comparison values are available, it is difficult to evaluate the public health significance of these dioxin sampling results.***

And,

> ***Dust in undisturbed or infrequently accessed areas can represent the long-term accumulation of material that has been influenced for many years by the natural movement of air, penetration of outdoor contaminants, accumulation of building material particles and chemicals used indoors, and the eventual deposition of dust on many surfaces [1, 8]. Due to the slower degradation of contaminants indoors than outdoors, contaminants in undisturbed indoor dust can accumulate over time.***

Tronox notes that the individual PAH data for dust samples SD-10 and MG-8 presented in Tables 11 and 12 of Appendix B of the PHA are not presented in the cited reference, Dahlgren *et. al*. (2003a). The origin of these data should be specified. As stated in the discussion on pages 29-30 of the PHA, the attic dust in Tables 11 and 12 lack reference comparisons, but are generally within published ranges in soil and house dust. Similarly, the dioxin dust results were below background levels found in urban and rural soils. As such, these data indicate a lack of potential for elevated exposure to PAHs and PCDDs/PCDFs via attic dust – and therefore an incomplete exposure pathway. It is recommended that the background levels found in urban and rural air, dust, and urban soils should also be shown in the Appendix B table(s), as some are in the text, for purposes of comparison.

ATSDR Response:

ATSDR believes that the residential indoor dust pathway remains a viable potential exposure pathway. As previously stated, the lack of soil samples from potentially impacted residential areas prevents a thorough evaluation of the potential for indoor contamination. It is estimated that as much as 31% of indoor dust in living areas could be from nearby outdoor soil. Additionally, as pointed out by the commenter, the bulk dust samples reported by Dahlgren *et. al*. (2003a) were collected from attics, not living spaces. Without residential soil samples or indoor dust samples collected from living areas, the likelihood of an indoor dust pathway cannot be eliminated.

ATSDR has amended the pathways discussion to include text which describes the shortcomings of an exposure analysis which uses dust samples taken from attics. The text now includes the following statements:

> *Because the referenced dust samples were collected from attics, we are unable to conclude that a completed exposure pathway exists for most residents. Dust in undisturbed or infrequently accessed areas (such as attics) can represent the long-term accumulation of material that has been influenced for many years by the natural movement of air, penetration of outdoor contaminants, accumulation of building material particles and chemicals used indoors, and the eventual deposition of dust on many surfaces. Due to the slower degradation of contaminants indoors than outdoors, contaminants in undisturbed indoor dust*

can accumulate over time. A study in 1996 concluded that attic dust had dioxin levels 1,000 times higher than that found in the living quarters below.

<u>21. Comment</u>:

Re: 3.4 Eliminated Exposure Pathways, b. Groundwater/Private Wells, page 21

The ground water contamination that underlies the facility is well known, has been reported to the appropriate agencies, is being addressed in accordance with a program approved by MDEQ and data are publically available. Based on those data and reports, it is highly improbable that a new development on the site would choose to install a potable water well when the city has an existing water delivery system. In fact, the ATSDR drinking water EI indicated that there were no health risks to the general population from the City of Columbus' drinking water.

<u>ATSDR Response</u>:

ATSDR believes it prudent to alert the public to this future potential health risk, however remote the commenter believes the threat to be. This future potential pathway will exist so long as the groundwater remains contaminated and people might be exposed to the it.

<u>22. Comment</u>:

Re: 3.4. Eliminated Exposure Pathways, c. Biota, page 21

While the distance of 0.5 miles between Luxapalila Creek and the site is correct as a straight line measurement, it is not appropriate for connecting possible site conditions to creek conditions because the connecting ditch between the two locations is approximately 1.3 miles in length. It is implausible that the fish and aquatic organisms are crossing the 0.5 mile wide terrestrial barrier between the site and the creek.

<u>ATSDR Response</u>:

The distance measurements are taken from public records. We correctly attribute the concern regarding contamination to the creek as a community concern held by the residents. As suggested by the commenter, we revised the statement to avoid confusion by the reader.

<u>23. Comment</u>:

Re: 3.4. Eliminated Exposure Pathways, d. Buried Sediments, page 21

Tronox supports the conclusion that buried sediments are an incomplete exposure pathway. As further mitigation of this exposure pathway, additional remediation activities

including excavating affected soil from the drainage ditch were conducted near and within Propst Park between September 2006 and November 2007.

ATSDR Response:

ATSDR revised the text in this section to address the remediation activities near and within Propst Park in 2006 and 2007, and the discovery of additional buried contaminated sediments near the Maranatha Faith Center in 2009.

24. Comment:

Re: 4.0 Public Health Implications, page 21

As stated above, Tronox does not agree that contact with surface water is a completed exposure pathway for members of the community. As such, Tronox recommends that contact with surface water be removed as a completed exposure pathway.

ATSDR Response:

The surface water pathway has been reclassified as a potential exposure pathway. We made this change because the number of surface water samples was small and the level of contamination detected in surface water was minimal and of no significant health concern. Additional sampling would be needed to eliminate this pathway from further consideration, especially in light of the recent erosion events which may have allowed contamination to enter nearby surface waters.

25. Comment:

Re: 4.0 Public Health Implications

A typographical error occurs in the table citation. The summaries indicated in the last line of this paragraph are in Table 9 and 10 in Appendix B.

ATSDR Response:

The error has been corrected. The tables are now correctly referenced in Appendix E.

26. Comment:

Re: 4.0 Public Health Implications, A1. Ditch Sediment: Pre-Removal Health Implications

As stated above, Tronox conducted further remediation activities between September 2006 and November 2007.

ATSDR Response:

ATSDR revised the text in this section to address the remediation activities near and within Propst Park in 2006 and 2007:

> *In September 2004, Kerr-McGee removed contaminated sediment from four areas within the drainage ditches bordering the facility. Between September 2006 and November 2007, Kerr-McGee excavated and removed sediments in and near Propst Park, although this removal action is not likely to have an impact on the analysis here because ATSDR had no samples from that area to evaluate. This section evaluates sediment samples gathered after Kerr-McGee completed the 2004 removal activities.*

27. Comment:

Public Health Implications, A1. Ditch Sediment: Pre-Removal Health Implications

The data do not support the conclusion that chemicals potentially and solely associated with the former KMCC facility are present in sediment samples. Multiple sources of contamination are noted as potential contributors of PAH constituents; therefore, a direct connection to the site has not been made for these data. Tronox further disagrees that the site is the only possible source of PCP. PCP was historically used in numerous capacities in addition to wood treatment pesticide and insecticide applications (ATSDR 2001) on, among other things, railroad right-of-way. Based partially on PCP's use as one of the most widespread pesticides in the U.S., it is now widespread in environmental media (Thompson and Treble 1996; ATSDR 2001). As such, conjecture and conclusions based on the assumption that PCP in sediment samples is from the former KMCC facility should be withdrawn. Tronox agrees that the source of the PAHs is uncertain and that multiple sources are found in the vicinity of the former KMCC facility.

ATSDR Response:

ATSDR has removed any reference regarding the source of PAHs and PCP at this site.

Our focus at ATSDR is not to identify sources of contamination; that responsibility is more appropriately assigned to the regulatory agencies. Our goal is to evaluate the potential health risks associated with each identified contaminant, regardless of the source.

28. Comment:

Re: 4.0 Public Health Implications, A1. Ditch Sediment: Pre-Removal Health Implications

This information providing important context for understanding the ubiquity and multiple sources of the chemicals of concern in the PHA would be most helpful to readers if positioned in the beginning of the document.

Tronox supports the observation that the sources of the dioxins are uncertain and could be related to common activities in the vicinity of the former KMCC facility such as the burning of trash and tires. In fact, vehicles including trains, are recognized contributors of dioxins in the environment. Upstream and downstream of the KMCC facility, the ditches cross and parallel two historical railroad lines which have been in existence since at least 1937 (based on historical aerial photographs). Tronox requests that the text attributing the dioxins as associated with releases of PCP from the former KMCC facility be removed because this linkage is unsubstantiated. Further, Tronox disagrees with the stated comparison to another company's wood-treating site that has contaminated residential yards, because this has not been shown in the data collected in the vicinity of the former KMCC facility.

ATSDR Response:

Our focus at ATSDR is not to identify sources of contamination; that responsibility is more appropriately assigned to the regulatory agencies. Our goal is to evaluate the potential health risks associated with each identified contaminant, regardless of the source.

29. Comment:

Re: 4.0 Public Health Implications, A1. Ditch Sediment: Pre-Removal Health Implications

Tronox believes that the lack of essential information should disqualify these data from quantitative consideration from the PHA. Tronox agrees that the conversion of the data from WHO 1998 TEFs to WHO 2005 TEFs may result in small differences. Potentially much more significant is the inability to determine congener-specific detection limits, and substitution method was used for non-detect results. TCDD-equivalents are typically calculated using either ½ the detection limit or zero for non-detects, as is done elsewhere in the document. The calculation method should be indicated if it is known, or if it is not, that should be stated in this document. Depending on the congener-specific results, the two different substitution methods could result in significantly different values for a TCDD-equivalent.

ATSDR Response:

Because of concerns regarding lack of critical documentation for the third party data, ATSDR determined that the data are not appropriate for making public health decisions. The data are discussed in Appendix D, but were not used to draw final public health conclusions or recommendations.

30. Comment:

Re: 4.0 Public Health Implications, A1. Ditch Sediment: Pre-Removal Health Implications

The statement regarding Päpke *et. al.'s* (1992) paper is confusing as to both content and relevance. These authors compared blood levels of PCDD/PCDF congeners in six groups of workers involved in production of various chlorinated chemicals, including PCP, decades ago in Europe. Naturally, the concentrations of various congeners in these individuals were quite high compared to modern background levels. Of the six groups, PCP production workers had the lowest levels of TCDD, only slightly greater than background.

It is not clear why ATSDR believes that OCDD *was found higher than average* and 1,2,3,6,7,8-HxCDD is elevated in the Columbus residents sampled by Dahlgren *et al*. (2003a). Because age is the single most important predictor of serum PCDD/PCDF levels in non-occupationally exposed people (e.g., Ferriby *et al*. 2006), the fact that Dahlgren *et al*. (2003a) did not report the Columbus subjects' ages complicates comparison with much larger population samples such as National Health and Nutrition Examination Survey (NHANES) that include young people. The range of OCDD concentrations in African-American adults (>25) in the 1999-2000 NHANES data set is 385 to 24,582 ppt, with a calculated 90 percentile of 5,740 ppt compared with the Columbus range of 277.5 to 2,152.7 ppt.

As noted in CDC (2005), "…the 1,2,3,6,7,8-hexachlorodibenzo-p-dioxin often demonstrates multifold higher concentrations than the other two hexachlorodibenzo-p-dioxins, about six-fold higher than the NHANES 2001-2002 subsample." Nonetheless, the reported range of this congener in Columbus residents is 25 to 79.1 ppt (Dahlgren *et al*. 2003a), while 90th percentile values for African-Americans (including younger people) are listed as 62.8 ppt (95% confidence interval = 48.0 – 79.2) in the 1999-2000 data set, and 93.9 ppt (95% confidence interval = 78.5 – 132) in the 2001 – 2002 data set (minimum age 20) (CDC 2005). Thus, the maximum detected concentration of 1,2,3,6,7,8-HxCDD in Columbus residents is within the range of 90th percentile values.

It is also not clear what site-specific data caused ATSDR to believe that further sampling in residential yards is necessary. Biomonitoring provides the best indication of exposure to PCDDs/PCDFs, and none of the congeners in Dahlgren's (Dahlgren *et al* 2003a) subjects ATSDR were above the 90th percentile of general population. This is compelling evidence that these individuals, described as "…nearby residents of the plant and who were chosen at random from the initial study cohort of 1,269 nearby residents based upon their having lived in the neighborhood for over 25 years" (Dahlgren *et al* 2003a), had not experienced greater exposure to PCDDs/PCDFs than the general population. The conjecture from ATSDR appears to be that dioxin-like compounds may have impacted residential soil via flooding, but such a link has not been established and in fact, is unlikely. Therefore, residential yards were unlikely impacted by ditch flooding, and no additional sampling is warranted on that basis. Also of importance to this question is the fact that soil is an insignificant exposure medium for PCDDs/PCDFs, which are overwhelmingly supplied via the diet (EPA 2006a). Therefore, Tronox does not concur with and believe all lines of evidence contradict ATSDR's position that more yard sampling is needed.

ATSDR Response:

All discussions regarding Päpke *et. al.'s* (1992) paper and Dahlgren's blood dioxin sample results have been removed. Because Dahlgren does not discuss how people might have been exposed to dioxin-like compounds from the site, ATSDR cannot assume that the people selected are representative of most residents who might be exposed to contaminants near the Kerr-McGee facility.

The site-specific information ATSDR relied upon to recommend further sampling in residential yards can be found in Section 5.4 of the PHAGM. This section deals with critical data gaps in cases where available site documentation is insufficient for drawing public health conclusions. In this instance, we need more information to determine to what substances and at what concentrations people could be exposed. As stated above, ATSDR strongly believes that residential yards could be impacted by ditch flooding. The recent erosion events and ditch flooding make this potential exposure pathway even more important to our assessment of human exposure.

31. Comment:

Re: Public Health Implication, A1. Ditch Sediments: Pre-Removal Health Implications, 1. Dioxin.

The ditch sediment evaluation apparently did not use all available dioxin sediment data. In the Main Drainage Ditch Risk Assessment Report by ERM (2001a), dioxin data collected by ERM in 2000 were evaluated and found to pose no health risk when compared to EPA's residential clean-up criterion of 1 ppb.

In addition, ATSDR made errors in the calculating the relative exceedances of the LOAEL. It appears that the LOAEL was divided by the dose, instead of the dose divided by the LOEL (which is how it should be calculated). Therefore, the values provided (i.e., 1 to 4 times greater than the LOAEL for the child, and 3 to 16 times greater than the LOAEL for the adult) are actually inverse of the true ratio. In fact, all of the doses for child and adult are below the LOAEL, and therefore suggest that no public health hazards existed for children or adults relative to dioxin in the ditch sediment.

It is noted that the input concentration data used to calculate dioxin Toxic Equivalents (TEQs) were not provided in the tables, and therefore the dose calculations cannot be easily reproduced/confirmed. The original dioxin congener data should be provided in the PHA. Following identification that "ATSDR's MRL is about one to two order of magnitude below any effect levels…", it is recommended that a statement be added to identify that doses exceeding the MRL do not necessarily indicate a risk of adverse effects (PHAGM, Appendix F).

Overall, Tronox recommends that the PHA include more information and specifics regarding the calculation of risk levels, including: putting the maximum and average concentrations on the table along with the calculated doses, specifying what toxicity criteria were used, and providing the raw data in attachments. Also, tables should be added providing post-remediation risk estimates and dose calculations, as they are representative

of current and future risk. These additions would aid the reader in determining the risk independently, if they chose to do so.

2,3,7,8-TCDD and several related compounds have been shown to be carcinogenic in laboratory rodents. Despite its potency in certain animal species, evidence of human carcinogenicity of TCDD remains equivocal. As stated in a recent review, "…the carcinogenic effect [in humans], even at very high exposures, is weak and borderline detectable, with a high degree of uncertainty" (Schwarz and Appel 2005). Despite only "limited" evidence of human carcinogenicity, the International Agency on Research on Cancer (IARC) classified TCDD as Group 1 (known human carcinogen) (IARC 1997). However, all the other PCDDs and PCDFs, including those that may be trace contaminants of PCP, are classified as Group 3 (not classifiable as to their carcinogenicity to humans).

The EPA has no consensus weight-of-evidence classification or toxicity criteria for TCDD at this time. Its "dioxin reassessment" has been in progress for more than 20 years. The most recent iteration, revised in response to substantive comments by the Science Advisory Board (EPA 2001) (among others), was published in December 2003 (EPA 2003). At EPA's request, the 2003 draft was reviewed by the 18-member Committee on EPA's Exposure and Human Health Reassessment of TCDD and Related Compounds convened by the National Research Council (NRC). Specific charges to the committee included evaluation of (1) the scientific evidence for classifying dioxin as a human carcinogen; and (2) the validity of the non-threshold linear dose-response model and the cancer slope factor calculated by EPA through the use of this model.

The NRC report, published in 2006 by the EPA, underwent extensive, independent, external review overseen by the NRC's Report Review. With regard to carcinogenicity classification, the committee found that "…the argument provided by EPA in the 2003 Reassessment to support its position that the epidemiological data met the criterion of "strong evidence of an association" between dioxin exposure and cancer risk was 'unconvincing." With regard to the more practically critical issue of dose-response modeling, the committee's conclusion was unambiguous:

> ***After reviewing EPA's 2003 Reassessment and additional scientific data published since completion of the Reassessment, the committee unanimously agreed that the current weight of scientific evidence on the carcinogenicity of dioxin is adequate to justify the use of nonlinear methods consistent with a receptor-mediated response to extrapolate below the POD [point of departure].***

Scientists at the ATSDR have also been critical of EPA's approach (Pohl et al. 2002):

> ***We think USEPA's model of the dose response for cancer is inconsistent with the recommendations of the President's Committee on Risk Assessment and Management for cancers thought to be elicited by nongenotoxic mechanisms.***
>
> ***Further, we question USEPA' assumption that dioxin effects are linear and, therefore, have no threshold.***

We conclude that USEPA's reassessment of dioxin and related compounds may place too much confidence in the ability to accurately predict cancer risks at low doses. This approach dramatically increases cancer risk estimates that are not based on compelling new data but rather on the application of statistical models applied to results of occupationally exposed cohorts that have been associated with significant uncertainty regarding actual exposure. This is further confounded by the fact that these models are not yet fully validated and that we still have knowledge gaps with respect to the mechanism of action and interaction for the dioxin-like group of chemicals.

Risk assessments for chronic exposures to dioxins performed by WHO (2002), and several other major international regulatory agencies have developed toxicity values in the range of 1 to 4 pg/kg-day that are protective for all health effects. For example, ATSDR's MRL of 1 pg/kg/day is about one to two orders of magnitude below any effect levels demonstrated either experimentally or in epidemiologic studies for both cancer and non-cancer health end points (Pohl et al. 2002, 2007). As such, it is considered protective of both non-cancer and cancer effects.

In view of the growing consensus against application of EPA's slope factor approach to PCDDs/PCDFs, and the fact that EPA has no consensus slope factor value at this time, the most scientifically defensible toxicity criterion for risk assessment purposes is the MRL. Tronox therefore suggests that ATSDR not use the "cancer risk" approach for these compounds in the PHA.

<u>ATSDR Response</u>:

When a health guideline is exceeded, ATSDR conducts a more thorough toxicological evaluation to determine if harmful health effects might occur. The first step is often to compare the estimated chemical dose to effect and no effect levels. In this comparison, ATSDR started with the Lowest Observed Adverse Effect Level (LOAEL) used to derive the RfD. One method is to divide the LOAEL by the estimated exposure dose. In general, the larger the resulting value, the less likely are harmful health effects. A small value means that harmful health effects are more likely, though not certain. Interpretation is somewhat subjective and dependent on a host to toxicological factors. Further evaluation consists of a careful comparison of the site-specific exposure doses to the known epidemiologic and experimental data on the chemical.

Another method, as suggested by the commenter, is to divide the estimated dose by the health guideline, to derive a hazard quotient (HQ). When the HQ is below 1, then the estimated dose is below the LOAEL and non-cancerous health effects are not expected. When the HQ exceeds 1, then a more thorough toxicological evaluation is needed.

Both methods are a ratio between an estimated dose and a known toxicological endpoint. ATSDR selected the current method to assist the reader in understanding the difference between an estimated dose, which is usually a low number, and the comparative result, which can also be a low number if using the HQ approach. Further, the ratio is a useful tool for deciding if further toxicological evaluation is needed; it is not the determining factor for deciding if health effects are likely.

ATSDR made major revisions to the discussion which hopefully clarify some of the issues identified by the commenter. Specifically, we 1) included a table of all the input data used to calculate the doses and cancer risk, 2) added language which describes our comparative process more thoroughly, 3) corrected the language to note the resulting values are lower than the LOAEL, 4) added text which instructs the reader that doses exceeding the MRL do not necessarily indicate a risk of adverse health effects.

As for the lack of consensus in EPA's slope factor value, ATSDR is not compelled to abandon the current cancer risk approach for PCDDs/PCDFs at this time. EPA's cancer dioxin reassessment, which has been underway for some time, should shed some more light on this issue. In the meantime, ATSDR will use the cancer slope factor developed by the California Environmental Protection Agency (CalEPA) and continue to use the Toxicological Profile for Chlorinated-p-Dioxins (1998) for scientific guidance. Once EPA's cancer reassessment is finalized, ATSDR will determine whether the findings of this document need to be updated to ensure our conclusions and recommendations reflect the current science and are protective of human health.

32. Comment:

Re: 4.0 Public Health Implications, A1. Ditch Sediment: Pre-Removal Health Implications, 2. Polycyclic Aromatic Hydrocarbons (PAHs)

Rick Bost (ERM 2001c) and B.C. Robinson (2003) of ERM, and Monson (2001) performed separate critiques of Dahlgren's original (April 2001) and revised (July 2001) report "Health Effects of Nearby Residents of a Wood Treatment Plant" to evaluate the validity of the methods utilized and the reliability of their conclusions. Deficiencies were identified with data collection and analysis methods, and many conclusions were found to be invalid or unreliable. The following general deficiencies were identified. The Dahlgren study did not account for the large number of variables and the possibility that the measure of significance should be adjusted to the number of variables. The report did not provide details to demonstrate that test administrators and medical doctors did not offer a source of bias in report results. The data lacked appropriate QA/QC. Due to errors identified in the Dahlgren database, results of statistical analysis are questionable and cannot be relied upon. Conclusions presented in the Dahlgren report do not meet the scientific criteria for cause and effect evaluation between environmental chemical exposure and health effects.

Specifically with regard to the self-reported survey results on "mucous and skin irritant" symptoms in Dahlgren's study, the authors did not control for confounding effects on the variables. The responses were not verified by a medical doctor, medical history, or examination of the respondents. The conclusion of significant difference in the exposed and control groups is questionable, and cannot be relied upon without acknowledgement of serious limitations and deficiencies. Tronox recommends that ATSDR reconsider including its presentation of the Dahlgren conclusions as valid linkage for other creosote wood

treating plant conditions to the KMCC site, considering the critical information provided in the submitted documents.

ATSDR Response:

ATSDR makes no claims regarding the validity of the linkage between conditions at other creosote wood treating plants and the Kerr-McGee site. The Dahlgren study was cited to add to existing information regarding creosote exposure and dermatological effects. Other sources have also reported a potential association between skin rash symptoms, photosensitivity and creosote exposure. References to those studies remain part of the text. Because of the potential conflict, ATSDR has removed the reference to the Dahlgren study in the discussion of PAHs and dermatological effects.

33. Comment:

Re: 4.0 Public Health Implications, A1. Ditch Sediment: Pre-Removal Health Implications, 2. Polycyclic Aromatic Hydrocarbons (PAHs)

With regard to the cancer risk associated with maximum PAH levels in sediment, the risk level does not match any of the risk levels in Tables 9 or 10. ATSDR should clarify the receptor for whom this risk was calculated, reference the table where the risk is presented, and also provide the maximum concentration of PAH used in the risk calculation so that it can be verified.

ATSDR Response:

The cancer risk evaluation has been revised to reflect the new ingestion rate and bioavailability factor applied for children and adults. All input variables to calculate the cancer risk have been included in appropriate tables.

34. Comment:

Re: 4.0 Public Health Implications, A1. Ditch Sediment: Pre-Removal Health Implications, 4. Pentachlorophenol (PCP)

Based on ATSDR's statement indicating that levels of PCP in sediment are not expected to cause health effects, the above paragraphs in Subsection 4. Pentachlorophenol (PCP), except for the first and last paragraphs, should be removed. This would be consistent with the level of detail provided in subsections with similar conclusions from Subsection 3. Arsenic. It could also be noted that a toxicological profile is included in Appendix F for the ATSDR report.

ATSDR Response:

The detail of the PCP health effects discussion has been revised to reflect the level of detail consistent with a contaminant for which no harmful health effects are expected.

<u>35. Comment</u>:

Re: 4.0 Public Health Implications, A2. Ditch Sediment: Post-Removal Health Implications

Tronox is pleased that the ATSDR is discussing potential health implications for both pre- and post-remediation conditions.

> <u>ATSDR Response</u>:
>
> As suggested by the commenter, ATSDR agrees that separate discussions for pre- and post-remediation conditions are appropriate.

<u>36. Comment</u>:

Re: 4.0 Public Health Implications, A2. Ditch Sediment: Post-Removal Health Implications

Tronox supports the conclusion that there are no current or future cancer or non-cancer health effects from residual PAHs in the ditches.

The calculations in this section were also difficult to follow and were not reproducible. Although Tronox agrees with the findings, it would be helpful to have reproducibility. The cancer risk seems to have a typographical error ($3 \times 3 \times 10^{-5}$).

> <u>ATSDR Response</u>:
>
> The cancer and non-cancer risk evaluation has been revised to reflect the new ingestion rate and bioavailability factor applied for children and adults. All input variables to calculate the cancer and non-cancer risk have been included in the tables. The typographical error has been corrected.
>
> ATSDR wants to reiterate that the conclusions regarding no current or future health risks from residual PAHs were made before the recent erosion and flood events at the site. These conclusions may not apply to current conditions if contaminants have migrated due to the erosion and flooding at the site since the document was released. ATSDR will determine whether revisions are needed once new sampling data are received.

<u>37. Comment</u>:

Re: Public Health Implications, A2. Ditch Sediment: Post-Removal Health Implications

It is noted that the input concentration data (average and maximum) for dioxin TEQs were not provided in the tables, and therefore the dose calculations cannot be reproduced/confirmed.

There were errors in the calculations indicating the relative exceedances compared to the LOAEL. It appears that the LOAEL was divided by the dose, instead of the dose divided by the LOAEL (which is how it should be calculated). Therefore, the values provided (i.e., 14 times greater than the LOAEL for the child, and 57 times greater than the LOAEL for the adult) are actually inverse of the true ratio. In fact, all of the doses for child and adult are below the LOAEL, and therefore suggest that no current or future public health hazard exists for children or adults relative to dioxin in the ditch sediment.

ATSDR Response:

When a health guideline is exceeded, ATSDR conducts a more thorough toxicological evaluation to determine if harmful health effects might occur. The first step is often to compare the estimated chemical dose to effect and no effect levels. In this comparison, ATSDR started with the Lowest Observed Adverse Effect Level (LOAEL) used to derive the RfD. One method is to divide the LOAEL by the estimated exposure dose. In general, the larger the resulting value, the less likely are harmful health effects. A small value means that harmful health effects are more likely, though not certain. Interpretation is somewhat subjective and dependent on a host to toxicological factors. Further evaluation consists of a careful comparison of the site-specific exposure doses to the known epidemiologic and experimental data on the chemical.

Another method, as suggested by the commenter, is to divide the estimated dose by the health guideline, to derive a hazard quotient (HQ). When the HQ is below 1, then the estimated dose is below the LOAEL and non-cancerous health effects are not expected. When the HQ exceeds 1, then a more thorough toxicological evaluation is needed.

Both methods are a ratio between an estimated dose and a known toxicological endpoint. ATSDR selected the current method to assist the reader in understanding the difference between an estimated dose, which is usually a low number, and the comparative result, which can also be a low number if using the HQ approach. Further, the ratio is a useful tool for deciding if further toxicological evaluation is needed; it is not the determining factor for deciding if health effects are likely.

ATSDR made major revisions to the discussion which hopefully clarify some of the issues identified by the commenter. Specifically, we 1) included a table of all the input data used to calculate the doses and cancer risk, 2) added language which describes our comparative process more thoroughly, 3) corrected the language to note the resulting values are lower than the LOAEL, 4) added text which instructs the reader that doses exceeding the RfD do not necessarily indicate a risk of adverse health effects.

38. Comment:

Re: 4.0 Public Health Implications, C. Residential Surface Soil

Tronox supports the conclusion that there should be no adverse health effects from exposures to PAHs and arsenic detected in residential surface soil. In addition, the highest

arsenic concentration was within the normal background range 1 to 40 ppm (ATSDR 2000). Additionally, there is no known evidence that the facility used arsenic within the production process as a raw material. Tronox believes any further evaluation of the arsenic concentration pursued by ATSDR should be considered unrelated to KMCC and should be removed from this PHA.

Based on the information presented in both this response and the ATSDR PHA, Tronox does not agree that additional residential soil sampling is warranted.

> ATSDR Response:
>
> Although we agree that arsenic can be naturally occurring and has multiple potential sources, it is ATSDR's policy to evaluate each chemical of potential health concern, regardless of the source.

39. Comment:

Re: 4.0 Public Health Implications D. Residential Dust (Indoors)

Tronox acknowledges and agrees that there are numerous sources of PAHs and dioxins in the vicinity of the site. The PAH data presented by ATSDR indicate that the dust samples generally report concentrations within normal ranges of established soil standards and the dioxin dust results were below background levels found in urban and rural soils. It is recommended that the background levels found in urban and rural air, dust, and urban soils should also be shown in the Appendix B table(s), as they are in the text.

> ATSDR Response:
>
> The tables in Appendix B contain applicable comparison values for the dust samples, which is consistent with the approach used in the other contaminant tables. To include other values might be confusing to readers. Additionally, the background concentrations contained in the text are not PAH or dioxin-congener specific. Therefore, the value to the reader without proper context would be compromised.

40. Comment:

Re: Public Health Implications, D. Residential Dust (Indoors)

Tronox supports the conclusion that residential dust does not pose an increased risk to health, and believes that this pathway should be eliminated in Section 3.4 of the PHA.

> ATSDR Response:
>
> ATSDR believes there is evidence to support the conclusion that residential dust is a viable potential exposure pathway. It will remain a potential exposure pathway until adequate data are presented to exclude it.

<u>41. Comment</u>:

Re: 5.0 Community Health Concerns

At numerous places in the PHA where PAHs are discussed it should be mentioned that other compounds are sources of many of the same PAHs and other chemicals found in creosote. The ATSDR-supplied chemical information in Appendix F, itself, indicates that there are other sources for PAHs.

<u>ATSDR Response</u>:

ATSDR added a section that gives key background information about the chemicals of concern.

<u>42. Comment</u>:

Re: 5.0 Community Health Concerns

Tronox agrees that the site is not currently emitting chemicals to the air and that there are no long-term respiratory health effects due to historical emissions. However, these findings appear to contradict the statements in the "Air Exposures to Wood Treatment, Kerr-McGee Chemical Corporation" PHA that indicate naphthalene is being emitted to the air during rain events, which is refuted in Tronox's response to the air pathway PHA. A combined report would likely have avoided this contradiction.

<u>ATSDR Response</u>:

ATSDR addressed the air pathway separately from other pathways in the interest of addressing the community's concerns quickly and accurately. Furthermore, this separate assessment allowed a more comprehensive and detailed analysis of the air pathway. The public comment period provides an opportunity to address any statements that may appear to be contradictory or any other issues arising from the assessment.

The commenter's claim that the two documents contradict is not supported. ATSDR correctly responds that long-term respiratory health effects from past releases are not expected. However, as reported in the air evaluation, harmful respiratory effects could have occurred in the past during certain processes while the facility was operational. The relevant conclusions of the air PHA are as follows:

- *Naphthalene released into the air during the creosote treatment process posed a risk for respiratory irritation. While levels were several hundred times lower than those known to cause health effects, we cannot rule out the low risk due to the lack of studies conducted at lower levels and the absence of genotoxic studies. Furthermore, African American children appear to be uniquely susceptible to acute exposure effects.*

- *Small amounts of naphthalene are released when it rains because rainwater fills the pore spaces in the soil and pushes the vapors out. These levels are much lower than most instruments can detect and do not pose a health risk. However, the unpleasant odors themselves are known to be linked with a sense of low quality of life and contribute to lowered immune response*.

To clarify this issue and assist the reader, ATSDR added text which better distinguishes between past and current exposures.

43. Comment:

Re: 5.0 Community Health Concerns

As stated previously, due to the capping and "backwater" effects ditch sediments are not transported onto the adjacent land. Therefore, conclusion in the ATSDR report based on the assumption that exposures have occurred due to flooding should be withdrawn.

ATSDR Response:

As explained above, ATSDR strongly believes that residential yards could be impacted by ditch flooding. The recent erosion and flooding events make this potential exposure pathway even more important to our assessment of human exposure.

44. Comment:

Re: 6.0 Health Outcome Evaluation

Tronox supports the conclusion that a health statistics review is unwarranted and impracticable. However, Tronox disagrees that historical exposure exists in the community. It is appropriate to acknowledge this potential existed, but there is no evidence to support such an assumption. Therefore, the text should be revised.

ATSDR Response:

ATSDR believes all necessary components to form completed exposure pathways exist or existed at this site. The completed exposure pathways are discussed in the document.

45. Comment:

Re: 7.0 Child Health Considerations

Tronox suggests that this section should also explain that the potentially greater exposure of children is taken into account in the development of toxicity values, health-based standards, and in the quantitation of dose/risk. Based on the ERM 2001a Main Ditch Risk Assessment Report, the risk to children playing in the ditch was below regulatory target

risk limits. This conclusion is in the public record and it seems appropriate to identify this in the PHA.

ATSDR Response:

ATSDR added the following statement to the Child Health Considerations section:

It is important to remember that sensitive populations, such as children, are considered when MRLs and other health-based comparison values are developed. ATSDR's comparison values are developed to specifically account for children's exposures.

As for the ERM risk assessment report, we believe a reference to the conclusions of this report to be inappropriate and potentially confusing. ATSDR's health assessment is a separate evaluation and does not rely upon the conclusions of the ERM report or any other report. Our conclusions and recommendations are based solely on the outcome of our public health assessment process, which is different from the risk assessment process in the ERM report.

46. Comment:

Re: 8.0 Uncertainties and Limitations

Tronox believes that the frequency of contact with ditch sediments by children is lower than the ATSDR estimates. ERM noted in their Main Ditch Risk Assessment Report, 2001a, that no children were observed in the ditch, the ditch sediments were often covered in water, and that the ditch appeared uninviting to those that might have considered entering the ditch. A conservative exposure frequency of 45 days per year was used in the site-specific risk assessment by ERM. While this value is also conservative, it is more realistic than ATSDR's assumption of 182 days.

ATSDR Response:

ATSDR's health assessment is a separate evaluation and does not rely upon the conclusions of the ERM report or any other report. Our conclusions and recommendations are based solely on the outcome of our public health assessment process, which is different from the risk assessment process in the ERM report.

In the absence of site-specific information, ATSDR used professional judgment and anecdotal evidence provided by community members to derive possible exposure scenarios. The fact that no children were observed during a limited time period does not mean that children do not access the ditches. We believe the conservative exposure scenarios selected by ATSDR to be protective of human health.

47. Comment:

Re: 8.0 Uncertainties and Limitations

Tronox agrees that 200 milligrams per day (mg/day) is likely an overestimation of sediment ingested by children during play activities. As stated previously, the ditches are unfavorable (e.g., full of trash, etc) for play activity. Furthermore, the sediments in the ditch are often covered in water and, therefore, less available for ingestion. Based on these site-specific conditions, Tronox suggests that ATSDR apply a more reasonable and yet conservative ingestion rate. The Child-Specific Exposure Factors Handbook (EPA 2008) recommends a mean soil ingestion rate of 50 mg/day for children.

ATSDR Response:

ATSDR has revised the ingestion rate in some instances, where appropriate, from 200 mg/day to 100 mg/day. This revision is based on the assumption that very small children, who are most likely to swallow 200 mg of soil per day, are unlikely to access the ditches. All exposure doses were recalculated to reflect this change. ATSDR believes the other site conditions to be reasonably defined.

48. Comment:

Re: 8.0 Uncertainties and Limitations

It is doubtful that merely knowing the dioxin and furan congeners underlying the TEQ calculations would enable source determination due to the multiple sources and ubiquity of many congeners, especially the higher chlorinated ones. As commented previously, other sources are mentioned in this PHA; however, the impact of their existence on data interpretation is not adequately discussed. Therefore, the existence of multiple sources should be indicated early in the PHA and repeated as necessary, and conclusions based on the assumption that KMCC was the only or a major source of dioxins should be revised or removed.

ATSDR Response:

Again, our focus at ATSDR is not to identify sources of contamination. That responsibility is more appropriately assigned to the regulatory agencies. Our goal is to evaluate the potential health risks associated with each identified contaminant, regardless of the source.

49. Comment:

Re: 8.0 Uncertainties and Limitations, Public Health Implications

As noted in several previous comments, the inadequate documentation of the dioxin-TEQs reported by contractors for plaintiffs in a lawsuit greatly comprise their interpretability. If ATSDR chooses to use questionable data for quantitative analysis of risk, the details of their derivation, including a description of TEFs and their uncertainties, should be

provided earlier in the PHA. A prominent characteristic of TEFs that must be accounted for is the fact that they were developed for the consumption of food products, and not abiotic matrices such as soils, sediment, etc. Thus, the TEF expert panel (van den Berg et al. 2006) cautioned:

> ***The expert panel emphasized that correct application of the present TEF scheme…and TEQ methodology in human risk assessment is only intended for estimating exposure to dioxin-like chemicals from consumption of food products, breast milk, etc. In fact, experimental toxicological studies using abiotic matrices with dioxin-like compounds that would allow for the determination of environmental matrice-based REPs (e.g., soil or sediment) are almost nonexistent. Furthermore, the issue of matrix-specific bioavailability of these chemicals from abiotic environmental samples leads to a high degree of uncertainty for risk assessment as this is largely dependent upon the organic carbon content and age of the particles. For example, direct application of these WHO TEFs for assessment of OCDD or OCDF present in soil, sediment, or fly ash would lead to inaccurate assessment of the potential toxic potency of the matrix. …[I[t is recommended that when a human risk assessment is to be done from abiotic matrices, factors such as fate, transport, and bioavailability from each matrix be specifically considered before a final estimate of the toxicological relevant TEQ is made. If a human risk assessment is done for abiotic matrices, the expert panel recognized that it would be preferable to use congener-specific equations throughout the whole model rather than base it on total TEQ in an abiotic matrix.***

While the use of TEFs on abiotic environmental matrices is common, these additional uncertainties of their use should be incorporated into the uncertainty discussion.

> ATSDR Response:
>
> ATSDR acknowledges the limitations and uncertainty associated with using the third party data. However, it is commonplace for EPA to evaluate dioxin in abiotic matrices at CERCLA and RCRA sites. The methods used by ATSDR have been derived in accordance with current guidance specified by EPA and ATSDR.

50. Comment:

Re: Conclusions

The levels of PAHs and dioxins in the ditches referred to are based on pre-corrective action (pre-removal) samples from areas that were subsequently excavated in 2004, 2006, and 2007 as part of an EPA-approved, voluntary remedial action. However, even including these pre-remediation samples in the health evaluation, PAH risk falls within the EPA target risk range for average concentrations. This context should be added to the discussion. Further, dioxin concentrations were reported to be less than carcinogenic or non-carcinogenic effects levels and 10 times less than developmental or reproductive levels. Therefore, the second statement is inconsistent with prior conclusions and should be modified. It is again noted that the site-specific risk evaluation on the main ditch sediment

in 2001 concluded no significant risk associated with PAHs and dioxins for the child exposure scenario.

Based on the ATSDR evaluation of available residential soil data, constituent concentrations in residential soils, including benzo(a) pyrene, are not a public health hazard. The average benzo(a) pyrene concentration is less than the Cancer Risk Evaluation Guide (CREG) and the maximum concentration exceeded the CREG by less than 10, conservatively assuming 100% bioavailability. Even the maximum concentration results in a risk estimate well within EPA target risk range.

Tronox has discussed the ponding effect of runoff previously and the low potential for flooding to serve as a transport mechanism to residential properties. Tronox does not agree that further sampling is required because of the ubiquitous nature of PAHs in the urban environment from multiple sources, no soil data suggesting public health concerns, and no demonstrated transport mechanism.

ATSDR Response:

The conclusions to which the commenter refers are based on pre-removal conditions. The conclusions accurately define past conditions. ATSDR did not make a determination about current site conditions (indeterminate) because key data needed to make such a determination was not available. As previously stated, ATSDR strongly believes that migration of contaminants to residential properties remains a possibility. Further sampling is recommended to fill this key data gap.

We have revised the public health implication discussions to reflect revisions to the ingestion rate and bioavailability factors. All exposure doses were recalculated, and the conclusions and recommendations were updated, to reflect these changes.

51. Comment:

Re: 9.0 : Conclusions

As stated above, the likelihood of contaminants being transported onto the residential yards is very low due to the capping effect. This position is further supported by the low velocity "backwater effect," meaning that ditchwater does not actually flow out of the ditch but runoff water ponds because it cannot flow into the ditch, causing a backwater effect as Luxapalila Creek backs up into the ditch. Under these conditions, ditch sediments are not transported onto the adjacent land. Therefore, conclusions in the ATSDR report based on the assumption that exposures have occurred due to flooding should be withdrawn.

ATSDR Response:

ATSDR strongly believes that drainage ditches remain a potential source of contamination to adjacent properties. We have seen such transport at similar sites, and are unaware of any containment or control procedures that would prevent a similar scenario from occurring here.

The limited data we evaluated, including off-site surface soil data, did not rule out the possibility of overland transport from the site or outfalls/drainage ditches to adjacent properties. In fact, recent erosion along 14th Avenue may have resulted in additional transport of on-site/drainage ditch contaminants to off-site locations.

If, as the commenter suggests, materials that would have left the site during operation of the facility have been capped by sedimentation and buried, then the ditches remain a potential source of on-going contamination as erosion and other high velocity events that turn the sediment occur. Further, the commenter's theory is based on the premise that on-site sources that contribute to off-site migration have been properly contained. We believe this to be in error because recent erosion events along 14th Avenue show that on-site containment/stability has not been achieved.

The commenter also suggests that the low velocity backwater effect causes ditch sediments to remain capped in place and not get transported onto nearby land. The low velocity backwater effect is where current velocities decrease such that flows are no longer capable of supporting sediment transport; entrained sediment becomes redeposited. We believe that overbank sediment transport from creek/ditch channels into adjoining yards is still a possibility at this site.

According to the Federal Emergency Management Agency (FEMA) flood maps, the area in and around the Luxapalila Creek and its tributaries is a designated flood hazard area. According to long-time residents and the local newspapers, the Luxapalila Creek overflows during heavy rains. The ditches near the facility also have been known to overflow. If the ditch overflows its banks due to either high precipitation, backwater effects from tides or downstream flooding, etc., then sediment transport is likely to occur. If the sediment in the ditches is disturbed at all under such conditions, it will go everywhere the flooding goes. Keep in mind that current velocities will be highest in channels (ditches/creeks). Finally, even if under "backwater" flooding conditions the ditch sediments are not disturbed, there are likely to be other types of flooding conditions that would disturb them (high precipitation in the ditch's drainage area, for example).

The commenter's suggestion that backwater flooding cannot, due to "low velocity backwater flooding", transport sediment out of the ditch and that sediment transport can only go downstream under such quiescent flooding conditions is very tenous. Farmers have depended on sediment deposition in "low-velocity" flooding conditions for centuries. Therefore, we believe that sediment transport from ditches onto nearby properties is still a possibility.

52. Comment:

Re: 10.0 Recommendations

The measures recommended by ATSDR have already been completed by KMCC. The former KMCC facility has been closed since late 2003. Prior to and post-closure, the facility has taken measures to reduce the potential for on-and offsite exposures. These measures

include fencing of the facility, encapsulating potentially contaminated soils below gravel, and continuing to monitor offsite storm water outfalls.

The natural capping process discussed above and the removal of off-site areas of ditch contamination has reduced the potential for persons to come into contact with buried sediments and possible creosote-containing materials. Furthermore, this PHA indicates in Section 3.4, Subsection b., that buried sediments are an eliminated exposure pathway.

ATSDR Response:

The following recommendation is referenced by the commenter:

> *ATSDR recommends that proper measures be taken to reduce or eliminate human exposures to contaminants in sediments and soils around the facility. Continue to remove on-site sources that contribute to off-site migration of contaminants, and off-site buried sediments/creosote-contaminated materials that people might contact through digging or other excavation activities.*

In light of the recent erosion and flooding events in the area, ATSDR strongly believes that off-site migration of contamination is still possible.

In the discussion on buried sediments, ATSDR noted that buried sediments are only a potential exposure pathway so long as the sediments remain buried (e.g., preventing human contact). Once the sediments are uncovered or brought to the surface through natural or man-made activities, then the sediments are no longer buried and are now available for human contact.

53. Comment:

Re: 10.0 Recommendations

Tronox has provided comment earlier in this report and in its response to the IRPHA that it does not agree with this recommendation and has provided supporting arguments. Tronox recommends that this ATSDR recommendation be reconsidered and deleted.

ATSDR Response:

The recommendation referred to by the commenter, and recommended by ATSDR, is for samples to be taken of surface soils in residential yards. As stated above, ATSDR strongly believes that migration of contaminants to residential properties remains a possibility, especially considering recent on-site erosion and flood events in the area. Further sampling is recommended to fill this key data gap.

54. Comment:

Re: 10.0 Recommendations

As stated in Tronox's response to the IRPHA, this recommendation does not appear to be associated with any specific findings of the report, and is vague regarding sampling locations and their proximity to media (e.g., ditch sediment) suspected to be historically impacted by KMCC operations. Tronox recommends that this ATSDR recommendation be reconsidered and deleted.

ATSDR Response:

The recommendation referred to by the commenter, and recommended by ATSDR, is for additional off-site sampling to further define the nature and extent of contamination. As stated above, ATSDR strongly believes that migration of contaminants to residential properties remains a possibility, especially considering recent on-site erosion and flood events in the area. Further sampling is recommended to fill this key data gap.

55. Comment:

Re: 11.0 Public Health Action Plan

Tronox again requests that the above statement regarding remediation be removed from this section of the ATSDR report. The remedial activities discussed above and in the Interim Measures Report (ERM 2005) were conducted by Tronox on a voluntary basis with EPA and MDEQ approvals. Because the remedial activities were not a part of a public health action plan, this statement does not belong in this section but the activity could be identified clearly elsewhere in the PHA.

To date, the assessments and remediation conducted by Tronox have been on a voluntary basis. Therefore it does not seem appropriate that ATSDR request that sampling should be required by EPA. However, Tronox will comply with additional sampling to confirm that there is not a current risk to the community, if such sampling is required.

As stated earlier in this document, Tronox would like to have the two PHAs combined into one report for the final release.

ATSDR Response:

The following statement was removed from the Public Health Action Plan section, as suggested by the commenter:

> *In 2004, Kerr-McGee completed a partial clean-up of the ditches bordering the site. Approximately 1780 linear feet of sediments were removed from the ditch, including some of the areas with the highest levels of contamination.*

ATSDR believes the justification for removal is reasonable in light of the stated purpose of the PHAP.

56. Comment:

Re: 11.0 Public Health Action Plan, Public Health Actions Planned

Health education materials developed for the Columbus community should focus on actual health risks in the community rather than the trivial hypothetical risks that lay readers of the PHA in its current form could mistakenly attribute solely to the KMCC site. To the very limited extent that the low levels of environmental chemicals measured in Columbus could impact human health, it is well known (and acknowledged in the PHA) that they are not exclusively linked to KMCC, but in fact arise from numerous sources in all communities.

ATSDR Response:

The health education provided at the Kerr-McGee site will conform to approved ATSDR guidance and procedures. The goal of health education is to work with communities to understand, prevent, and/or mitigate adverse health effects associated with hazardous substances present in their communities. ATSDR's role is not to establish or convey to the community the source of contamination.

57. Comment:

Re: Appendix E, Part B

As stated by EPA in the guidance used to calculate most existing toxicological criteria, including those for the chemicals of concern in the PHA (EPA 1986):

> ***It should be emphasized that the linearized multistage procedure leads to a plausible upper limit to the risk that is consistent with some proposed mechanisms of carcinogenicity. Such an estimate, however, does not necessarily give a realistic prediction of the risk. The true value of the risk is unknown, and may be as low as zero. The range of risks, defined by the upper limit given by the chosen model and the lower limit which may be as low as zero, should be explicitly stated.***

Formerly used as a default, the "no threshold" approach has been replaced in the most recent (and superseding) EPA guidance by an emphasis on carcinogenic mode of action.

ATSDR Response:

Until the cancer document is finalized, ATSDR will continue to use our Toxicological Profile and CalEPA's CSF for scientific guidance, which indicates that carcinogenic effects are not believed to have a threshold. Once the cancer reassessment is finalized, ATSDR will determine whether the findings of this document need to be updated to ensure our conclusions and recommendations are protective of human health.