# Health Consultation

SIGMON'S SEPTIC TANK SERVICE

STATESVILLE, IREDELL COUNTY, NORTH CAROLINA

EPA FACILITY ID: NCD062555792

APRIL 24, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

**Health Consultation: A Note of Explanation**

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

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

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# HEALTH CONSULTATION

## SIGMON'S SEPTIC TANK SERVICE

## STATESVILLE, IREDELL COUNTY, NORTH CAROLINA

## EPA FACILITY ID: NCD062555792

Prepared by:

U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

# STATEMENT OF ISSUES AND BACKGROUND

## Statement of Issues

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this health consultation to evaluate, based on the information currently available, any known or potential adverse human health hazards related to exposures to contaminants in surface soils at the Sigmon's Septic Tank Site.

## Background

The Sigmon's Septic Tank site is located at 1268 Eufola Road, approximately 5 miles southwest of Statesville, Iredell County, North Carolina. The property comprises approximately 15 acres. Sigmon's Septic Tank Service, a wholly owned subsidiary of AAA Enterprises, purchased the property in 1970. The business installed and repaired septic tanks. In addition, Sigmon's Septic Tank Service pumped septic tank wastes and heavy sludges from residential, commercial, and industrial customers. From 1978 to 1992, the property owners deposited waste in several unlined lagoons which had been dug on the property.

Previously, ATSDR has issued five health consultations for the Sigmon's Septic Tank Site (1,2,3,4,5). The health consultations include a review of sampling plans for the site as well as evaluations of the available groundwater and surface water data. The most recent health consultation, released on April 3, 2006, evaluates groundwater data collected in 2002 and 2004 (5). This health consultation is intended to address exposures to on-site and off-site surface soil. Currently, the U.S. Environmental Protection Agency (EPA) continues to investigate the soil and groundwater conditions at the site. Future health consultations may be prepared, as necessary, to evaluate the newly collected data.

## Demographics

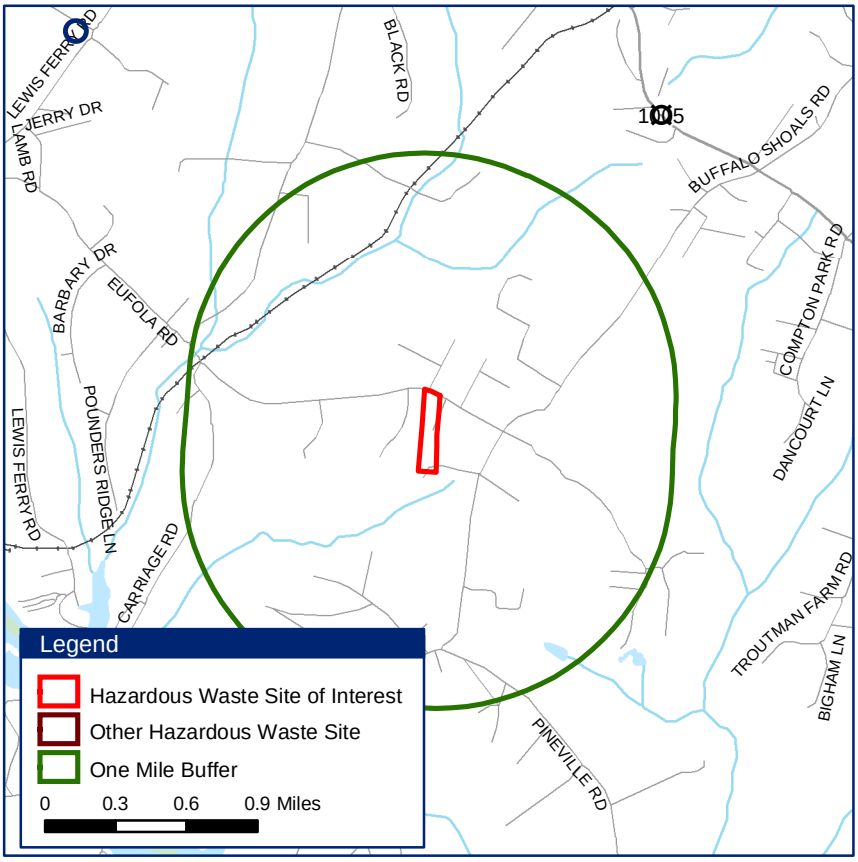
According to U.S. 2000 Census data, 802 persons live within a one-mile radius of the site. Approximately 95% of this population, or 760, are white. Also, 81 are children age 6 and under, and 83 are adults over age 65. A total of 323 housing units are in the site area. Additional demographic information for the community in the vicinity of the site is presented in the following figure.

# Sigmon's Septic Tank Service

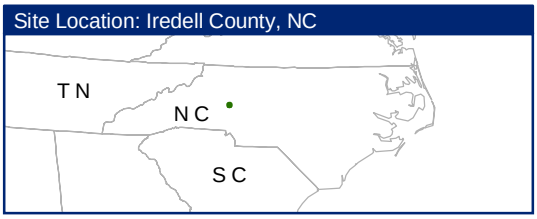
Statesville, NC

EPA Facility ID: NCD062555792

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY



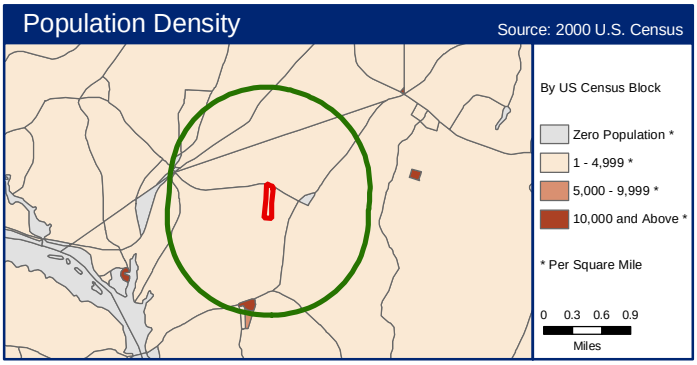

Base Map Source: Geographic Data Technology, May 2005.
Site Boundary Data Source: ATSDR Public Health GIS Program, May 2005.
Coordinate System (All Panels): NAD 1983 StatePlane North Carolina FIPS 3200 Feet

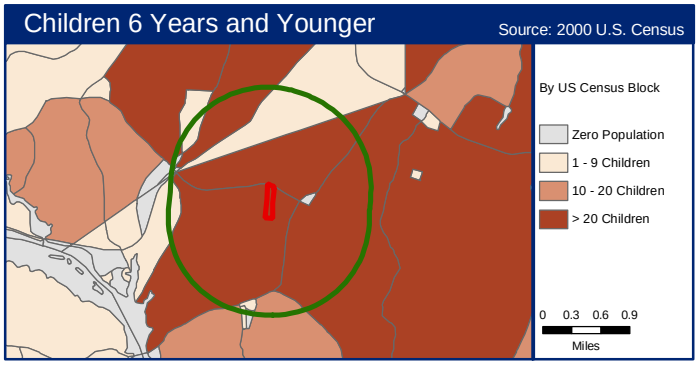


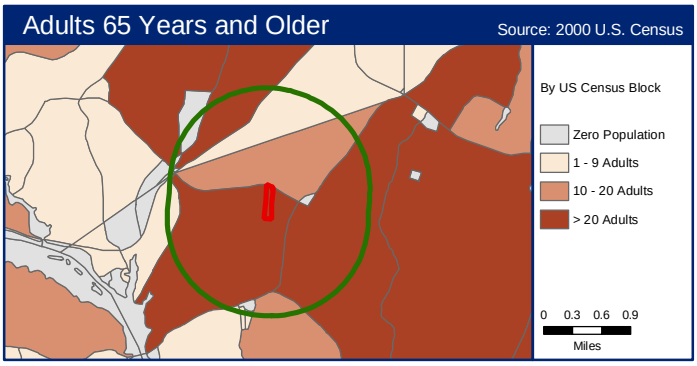

## Demographic Statistics
Within One Mile of Site*

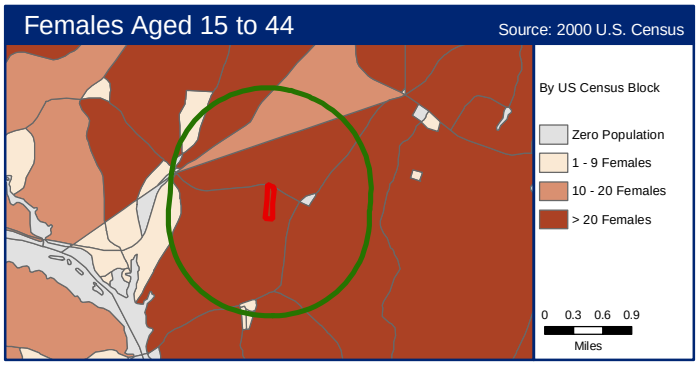
| | |
|---|---|
| Total Population | 802 |
| White Alone | 760 |
| Black Alone | 33 |
| Am. Indian & Alaska Native Alone | 0 |
| Asian Alone | 0 |
| Native Hawaiian & Other Pacific Islander Alone | 0 |
| Some Other Race Alone | 5 |
| Two or More Races | 4 |
| Hispanic or Latino** | 9 |
| Children Aged 6 and Younger | 81 |
| Adults Aged 65 and Older | 83 |
| Females Aged 15 to 44 | 176 |
| Total Housing Units | 323 |

Demographics Statistics Source: 2000 U.S. Census
* Calculated using an area-proportion spatial analysis technique
** People who identify their origin as Hispanic or Latino may be of any race.

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## ENVIRONMENTAL DATA

As part of this health consultation, ATSDR evaluates surface soil samples collected by EPA in 2002, 2004, and 2005. Forty-nine surface soil samples were located within the site boundary. An additional fifty-four samples were collected from areas outside the site boundary and on adjacent residential properties. Samples were collected at depths of 0-12 inches or 0-6 inches (6). Available data has undergone EPA's quality assurance/quality control process and has been determined to be useable. All surface soil samples were analyzed for metals. Approximately 25% of the samples have been analyzed for dioxins/furans, extractable organic compounds, pesticides/polychlorinated biphenyls (PCBs) and volatile organic compounds.

## PATHWAY ANALYSIS

ATSDR's pathways analysis determines whether people have come into contact with chemicals from a site and whether those contacts were substantial enough to cause harm. To make this determination, ATSDR identifies exposure pathways or ways in which a chemical could enter a person's body.

As outlined in ATSDR's Public Health Assessment Guidance Manual, an exposure pathway contains five major elements:

1. a source of contamination,
2. transport through an environmental medium,
3. a point of exposure,
4. a route of exposure, and
5. a receptor or a population which could be exposed.

If an exposure pathway contains all five elements and exists now or did exist in the past, the pathway is considered complete. Completed exposure pathways are evaluated to determine whether health effects could occur. If one or more of the five elements is not clearly defined but could be present, the exposure pathway is classified as potential (7). ATSDR has identified the surface soil pathway as a completed exposure pathway. Other completed or potential pathways may exist for the Sigmon's Septic Tank Site and may be evaluated in separate health consultations. More detailed information on the surface soil exposure pathway is presented in Table 1.

Table 1. Surface Soil Exposure Pathway Elements

| Source | Environmental Media | Point of Exposure | Route of Exposure | Exposed Population | Timeframe |
|---|---|---|---|---|---|
| Past disposal activities | Surface Soil | On-site | Ingestion<br>Inhalation<br>Direct Contact | Trespassers | Past<br>Present<br>Future |
| Past disposal activities | Surface Soil | Off-site | Ingestion<br>Inhalation<br>Direct Contact | Adult and children residents | Past<br>Present<br>Future |

## DISCUSSION

The first step in ATSDR's evaluation process is to select the chemicals of concern, also described as the chemicals that require further evaluation. ATSDR selects chemicals of concern on the basis of whether the maximum detected concentrations of the chemical are found to exceed applicable, health-based comparison values. A chemical found to exceed a comparison value indicates that a more detailed analysis is necessary for that chemical. Levels of chemicals greater than comparison values do not necessarily mean that adverse health effects will occur. The amount of the chemical, the duration of exposure, the route of exposure (i.e., ingestion, inhalation, and direct skin contact), and the health status of exposed individuals are also important factors in determining the potential for adverse health effects. Chemicals detected in surface soil for which no comparison value exists have been considered further as part of this health consultation. A complete discussion of ATSDR's evaluation process is presented in the appendix of this health consultation.

The chemicals of concern in on-site soils at this site are arsenic, vanadium, and polyaromatic hydrocarbons (PAHs). The PAHs found in on-site surface soil include: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and phenanthrene. More information about the chemicals detected is presented in Table 2.

Table 2. On-Site Soil Data – Detected chemicals that exceed comparison values or for which no comparison values are available

| CONTAMINANT | Milligrams/kilogram (mg/kg) or parts per million (ppm) | | | | SOURCE | FREQUENCY DETECTED |
|---|---|---|---|---|---|---|
| | Minimum | Maximum | Mean | Comparison Value | | |
| Arsenic | 1 | 4.2 | 2.05 | 0.5 | CREG | 21/27 |
| Vanadium | 11 | 210 | 50.36 | 200 | Int. Child EMEG | 49/49 |
| Benzo(a)anthracene | 0.060 | 0.060 | - | NA | NA | 1/18 |
| Benzo(a)pyrene | 0.19 | 0.19 | - | 0.1 | CREG | 1/18 |
| Benzo(b)fluoranthene | 0.041 | 0.210 | 0.083 | NA | NA | 5/18 |
| Benzo(g,h,i)perylene | 0.057 | 0.40 | 0.23 | NA | NA | 2/18 |
| Benzo(k)fluoranthene | 0.044 | 0.13 | 0.087 | NA | NA | 2/18 |
| Chrysene | 0.050 | 0.16 | 0.11 | NA | NA | 2/18 |
| Indeno(1,2,3cd)pyrene | 0.047 | 0.36 | 0.20 | NA | NA | 2/18 |
| Phenanthrene | 0.067 | 0.067 | - | NA | NA | 1/18 |

Notes:

CREG=Cancer Risk Evaluation Guide

Int. Child EMEG=Intermediate Child Environmental Media Evaluation Guide

NA=Not available

A comparison of the chemicals detected in off-site surface soil samples with CVs indicates that the only chemical of concern is arsenic. More information about the arsenic detected is presented in Table 3.

Table 3. Off-Site Soil Data – Detected chemicals that exceed comparison values or for which no comparison values are available

| CONTAMINANT | Milligrams/kilogram (mg/kg) or parts per million (ppm) | | | | SOURCE | FREQUENCY DETECTED |
|---|---|---|---|---|---|---|
| | Minimum | Maximum | Mean | Comparison Value | | |
| Arsenic | 1.2 | 3.1 | 1.91 | 0.5 | CREG | 30/39 |

Notes:

CREG=Cancer Risk Evaluation Guide

# PUBLIC HEALTH IMPLICATIONS

For chemical concentrations found to exceed comparison values, ATSDR performed calculations referred to as exposure doses and cancer risk estimates. These calculations estimate the amount of the chemicals of concern that individuals may have been exposed to and the likelihood of cancer and non-cancer health impacts. They are based on the types of site-specific activities that individuals may be involved with that result in contact with chemicals in the surface soil. In the event that calculated exposure doses exceed established health guidelines (e.g., ATSDR Minimal Risk Levels or EPA Reference Doses), an in-depth toxicological evaluation is the next step necessary to determine the likelihood of health effects.

On the basis of site-specific information, ATSDR has evaluated the trespassers (on-site surface soil) and adults and children residents (off-site surface soil) as part of this health consultation. Incidental ingestion, inhalation of dust, and direct skin contact has been evaluated. Information necessary to estimate past exposure to workers is not available. The average surface soil concentrations were used in the calculations. Additional information on the exposure scenarios, assumptions and calculations used to estimate exposures are discussed in the appendix of this health consultation.

Exposure to multiple chemicals was also considered in this health consultation. ATSDR used the toxicity equivalency factor methodology developed by the EPA to evaluate on-site surface soil. This methodology is useful when assessing a mixture of chemicals (with similar chemical structures) for which health guidelines are not available for all of the detected chemicals. Each of the detected PAHs were adjusted based on their toxicity compared with benzo(a)pyrene. Benzo(a)pyrene is considered to be the most toxic of the PAH compounds and has been the focus of much scientific study. The adjusted PAH mixture is referred to as benzo(a)pyrene equivalents in the remainder of this health consultation.

## Non-Cancer Health Effects Evaluation

As previously stated, calculated exposure doses were compared with the available health guidelines to determine whether the potential exists for adverse non-cancer health effects. None of the chemicals detected in on-site soil (arsenic, vanadium, and benzo(a)pyrene equivalents), were found at levels that exceed the established health guidelines. ***Therefore, ATSDR concludes that exposure to chemicals in on-site surface soil by trespassers is not expected to result in adverse non-cancer health effects.***

Arsenic was the only chemical found in off-site surface soil. Exposures to arsenic at the concentrations found in the vicinity of the site do not exceed health guidelines and are not expected to be harmful. ***Therefore, ATSDR concludes that exposure to arsenic in areas adjacent to the site and on nearby residential properties (off-site) are not expected to result in adverse non-cancer health effects.***

A complete list of the calculated doses and available health guidelines is presented in the appendix of this health consultation (Table A).

### Cancer Evaluation

The increased risk of individuals developing cancer from exposure to chemicals in surface soil was also considered. Cancer risk was calculated for the adult resident (includes exposure as an adult only) and a combined scenario. The combined approach considers the potential for chemical exposures occurring as a child, adolescent trespasser, and as an adult, for conservatism. The combined risk to the adult, adolescent and child is considered based on site-specific information provided by the community. ATSDR notes that this approach is very conservative and may overestimate the actual risks of these individuals.

***On the basis of the risk calculations, ATSDR has determined that there is no increased risk of cancer to adult residents exposed to surface soil. No increased cancer risk was indicated for the combination of surface soil exposures occurring during childhood, adolescence, and adulthood.***

A complete list of the calculated cancer risks for surface soil is presented in the appendix of this health consultation (Table B).

## Community Health Concerns

ATSDR held a public availability session on Monday, December 5, 2005 to gather health concerns from the community surrounding the Sigmon's Septic Tank Site. The public availability session was held at the Celeste Henkel Elementary School from 6:00 PM to 8:00 PM. A media availability session was held at the same location from 5:30 PM to 6:00 PM. Representatives from ATSDR and EPA attended the sessions. Flyers were sent out to residences in the vicinity of the Sigmon's Septic Tank Site to announce the meeting. Five community members attended the session. Most of the individuals had questions about EPA's environmental investigation and cleanup planned for the site. One soil-related health concern was received. The question and ATSDR's response are summarized as follows.

***Health Concern:*** *We live near the site and it smelled very badly while the septic business was in operation. We would like to know if there is anything in the soil that might be to blame for recent lung and breathing difficulties.*

**Response**: It is unlikely. The site is not active at this time and there are no processes taking place that would result in the chemicals becoming airborne. In the past, unpleasant odors associated with septic waste may have occurred at the site. These odors, while unpleasant, are not likely to have been harmful.

## Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

On the basis of the evaluation conducted in this health consultation, ATSDR has determined that children are not at risk for health effects from exposure to chemicals in off-site surface soils. The calculated doses were below the established health guidelines. Therefore, no harmful effects are expected among children living around the Sigmon's Septic Tank Site who are exposed to surface soil adjacent to the site and on neighboring residential properties.

## CONCLUSIONS

1. ATSDR has evaluated exposure to chemicals in on-site surface soil. On the basis of the available data, ATSDR has determined that exposure to chemicals in on-site surface soil by individuals trespassing on the site poses **no apparent public health hazard**.
2. ATSDR has also evaluated exposure to chemicals in off-site surface soil. ATSDR has determined exposure to adults and children residents who come in contact with surface soil adjacent to the site and on neighboring residential properties poses **no apparent public health hazard**.

## RECOMMENDATIONS

1. The site is located on private property and is currently under investigation by EPA. Residents should avoid accessing the property.

# PUBLIC HEALTH ACTION PLAN

A Public Health Action Plan describes the actions designed to mitigate or prevent adverse human health effects that might result from exposure to hazardous substances associated with site contamination. A summary of the public health actions that have been taken and those to be completed for the Sigmon's Septic Tank Site are provided below.

## Public Health Actions Taken

Previously, ATSDR has issued five health consultations for the Sigmon's Septic Tank Site (1,2,3,4,5). The health consultations include a review of sampling plans for the site as well as evaluations of the available groundwater and surface water data. The most recent health consultation, released on April 3, 2006, evaluates groundwater data collected in 2002 and 2004 (5).

ATSDR participated in a site tour conducted by EPA and its contractor on Monday, December 5, 2005. ATSDR examined the conditions of the site and toured the surrounding community at this time.

ATSDR conducted a public availability session on Monday, December 5, 2005 to gather health concerns from the community. The public availability session was held at the Celeste Henkel Elementary School from 6:00 PM to 8:00 PM. Representatives informed residents about ATSDR's work at the site and gathered community health concerns.

ATSDR also prepared a fact sheet that was mailed to the community in the vicinity of the site in spring 2006. The fact sheet provides information on ATSDR's work at the site, the findings of the health consultation, and contacts for additional information.

## Public Health Actions to be Completed

ATSDR will continue to collaborate with the appropriate federal, state, and local agencies. ATSDR will review new environmental data associated with the Sigmon's Septic Tank Site and will include results in future health consultations, as necessary.

## REFERENCES


1. Agency for Toxic Substances and Disease Registry. Health Consultation for Sigmon's Septic Tank Service. 2001 August 24.
2. Agency for Toxic Substances and Disease Registry. Health Consultation for Sigmon's Septic Tank Service – Review of Groundwater Data. 2002 March 29.
3. Agency for Toxic Substances and Disease Registry. Health Consultation for Sigmon's Septic Tank Service – Review of Surface Water Data. 2002 July 09.
4. Agency for Toxic Substances and Disease Registry. Health Consultation for Sigmon's Septic Tank Service – Review of Sampling Plan. 2005 July 05.
5. Agency for Toxic Substances and Disease Registry. Health Consultation for Sigmon's Septic Tank Service. 2006 April 03.
6. US Environmental Protection Agency. Remedial Investigation Report, Operable Unit 1 for Sigmon's Septic Tank Service. 2005 August.
7. Agency for Toxic Substances and Disease Registry. Public health assessment guidance manual. Atlanta: US Department of Health and Human Services; 2005.

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# Appendix - ATSDR's Evaluation Process

Step 1 – 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 chemical concentrations found in a specific media (for example: air, soil, or water) and are used to select chemicals for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of soil that someone may inhale or ingest each day. CVs are generated to be conservative and non-site specific. 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) oral cancer slope factor (CSF) or inhalation risk unit. CVs based on cancerous effects account for a lifetime exposure (70 years) with a theoretical 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 lower of these values is used in the comparison for conservatism. The chemical and media-specific CVs utilized during the preparation of this HC are listed below:

An **Environmental Media Evaluation Guide (EMEG)** is an estimated comparison concentration for which exposure is unlikely to cause adverse health effects, as determined by ATSDR from its toxicological profiles for a specific chemical.

A **Cancer Risk Evaluation Guide (CREG)** is a comparison concentration that is based on an excess cancer rate of one in a million persons and is calculated using EPA's cancer slope factor (CSF).

Step 2 – 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. Therefore, calculations are performed to estimate the possibility of cancer and non-cancer health problems. The calculations consider the activities of people living in the community. The assumptions used in the calculations are discussed in the following sections.

Adult Residents

Adult residents were assumed to be exposed to chemicals in off-site surface soil while gardening (3 days per week for 5 months of the year) and doing yard work (2 days per week for 7 months of the year). Incidental ingestion, inhalation of chemicals in dust

generated during activities, and direct skin contact with chemicals in off-site surface soil has been considered.

It was assumed that these individuals ingest 100 mg of soil per day (mg/day) and weighed 70 kilograms (kg) (153 pounds). The surface area available for direct skin contact is 3,325 cubic centimeters per day ($cm^2$/day) which represents exposure of the face, hands, and arms. An adherence factor of 0.07 milligrams per cubic centimeter ($mg/cm^3$) and, when available, a chemical-specific absorption factor was used. Individuals were assumed to be exposed for 30 years. For inhalation of dust, individuals were assumed to have an inhalation rate of 0.80 cubic meters per hour ($m^3$/hour) and be exposed for 4 hours per event. A default particulate emissions factor of $1.32 \times 10^{+9}$ cubic meter per kilogram ($m^3$/kg) was also used in the calculations.

Children Residents

Children residents were assumed to be exposed to chemicals while playing in contaminated soil in their yards or other off-site areas in the summer, fall, and spring (4 days of the week for 9 months of the year) as well as the winter (2 days per week for 3 months of the year). Incidental ingestion, inhalation of chemicals in dust generated during activities, and direct skin contact with chemicals in off-site surface soil while playing has been considered.

It was assumed that children residents ingest 200 mg/day and weighed 16 kg (35 pounds). The surface area available for direct skin contact is 4,785 $cm^2$/day in the summer, fall, and spring months which represents exposure of the face, hands, arms, legs, and feet. The surface area considered for winter months was 1,880 $cm^2$/day which accounts for exposure of the face, hands, and arms. An adherence factor of 0.2 $mg/cm^2$ and, when available, a chemical-specific absorption factor was used. Individuals were assumed to be exposed for 6 years. For inhalation of dust, individuals were assumed to have an inhalation rate of 0.42 $m^3$/hour and be exposed for 8 hours per event. A default particulate emissions factor of $1.32 \times 10^{+9}$ $m^3$/kg was also used in the calculations.

On-Site Adolescent Trespassers

Adolescent trespassers were assumed to be exposed to chemicals in soil while trespassing on the site 2 days per week. Incidental ingestion, inhalation of chemicals in dust generated during activities, and direct skin contact with chemicals in on-site soil has been considered. It was assumed that these individuals ingested 100 mg/day and weighed 50 kg (110 pounds). The surface area available for direct skin contact is 7,730 $cm^2$/day in the summer, fall, and spring months which represents exposure of the face, hands, arms, and legs. The surface area considered for winter months was 2,950 $cm^2$/day which accounts for exposure of the face, hands, and arms. An adherence factor of 0.2 $mg/cm^2$ and, when available, a chemical-specific absorption factor was used. Individuals were assumed to be exposed for 5 years. For inhalation of dust, individuals were assumed to have an inhalation rate of 0.42 $m^3$/hour and be exposed for 4 hours per event. A default particulate emissions factor $1.32 \times 10^{+9}$ $m^3$/kg was also used in the calculations.

**The Calculations**

In order to evaluate the potential for human exposure to chemicals present at the site and potential health effects from site-specific activities, ATSDR estimates human exposure to the site chemicals from different environmental media by calculating exposure doses and cancer risk estimates. A brief discussion of the calculations is presented below. Separate calculations have been performed for exposures to adults, adolescents, and children. The same equations have been used for the non-cancer and cancer calculations with the indicated modifications. The equations and the assumptions are based on the EPA Risk Assessment Guidance for Superfund, Part A[1] and the EPA Exposure Factors Handbook[2], unless otherwise specified. A discussion of the cancer and non-cancer evaluation of exposure is presented following the equations for each pathway.

Incidental Ingestion of Contaminants Present in Soil

(Exposure to adults during gardening; Children during playing)

Adult residents may be exposed to contaminants in soil gardening and yard work via unintentional ingestion. Children residents may also be exposed to chemicals in soil in residential yards. The exposure dose for incidental ingestion of soil is

$$Dose(mg/kg/day) = \frac{C \times IR \times EF \times ED \times CF}{BW \times AT}$$

where

C = chemical concentration (mg/kg)

IR = ingestion rate (mg/day)

EF = exposure frequency (days/years)

ED = exposure duration (years)

CF = conversion factor ($1 \times 10^{-6}$ kg/mg)

BW = body weight (kg)

AT = averaging time (days)

Direct Skin (Dermal) Contact with Contaminants Present in Soil

Dermal absorption depends on numerous factors, including the area of exposed skin, anatomical location of the exposed skin, length of contact, concentration of the chemical in contact with the skin, and other factors. Because chemicals differ greatly in their potential to be absorbed through the skin, each chemical needs to be evaluated separately.

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[1] U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund. December 1989.

[2] U.S. Environmental Protection Agency. Exposure Factors Handbook. August 1997.

The exposure dose for direct contact with chemicals in soil is

$$Dose\,(mg/kg/day) = \frac{C \times SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT}$$

where

C = chemical concentration (mg/kg)

SA = surface area exposed (square centimeters/day or $cm^2$/day)

AF = adherence factor (milligrams per square centimeters or $mg/cm^2$)

ABS = Absorption factor (unitless)

ET = exposure time (hours/day)

EF = exposure frequency (days/year)

ED = exposure duration (years)

CF = conversion factor ($1 \times 10^{-6}$ kg/mg)

BW = body weight (kg)

AT = averaging time (days)

Inhalation of Contaminants in Fugitive Dust Generated from Soil

Individuals may generate dust that can be inhaled during gardening, playing, and other activities with soil and sediment. The dose to evaluate this potential exposure is

$$Dose\,(mg/kg/day) = \frac{C \times IR \times ET \times EF \times ED}{PEF \times BW \times AT}$$

where

C = chemical concentration (mg/kg)

IR = inhalation rate ($m^3$/hour)

ET = exposure time (hours/day)

EF = exposure frequency (days/year)

ED = exposure duration (years)

PEF = particulate emissions factor ($m^3$/kg)

BW = body weight (kg)

AT = averaging time (days)

## Non-Cancer Health Effects

The doses calculated for exposure to each individual chemical are then compared to an established health guideline, such as a MRL or RfD, in order to assess whether adverse non-cancer health impacts from exposure 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 following 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 potentially cancer-causing chemicals detected in samples at this site. A more detailed discussion of the evaluation of cancer risks is presented in the following section.

### *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 that ingestion and inhalation 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 health consultation. 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.

## Cancer Risks

Exposure to a cancer-causing compound, even at low concentrations, is assumed to be associated with some increased risk for evaluation purposes. The estimated excess risk of developing cancer from exposure to chemicals associated with the site was calculated by multiplying the site-specific adult exposure doses, with a slight modification, by EPA's chemical-specific Cancer Slope Factors (CSFs or cancer potency estimates), which are available at http://www.epa.gov/iris. Calculated dermal doses were compared with the oral CSFs.

An increased excess lifetime cancer risk is not a specific estimate of expected cancers. Rather, it is an estimate of the increase in the probability that a person may develop cancer sometime during his or her lifetime following exposure to a particular chemical. Therefore, the cancer risk calculation incorporates the equations and parameters (including the exposure duration and frequency) used to calculate the dose estimates, but the estimated value is divided by 25,550 days (or the averaging time), which is equal to a lifetime of exposure (70 years) for 365 days/year.

There are varying suggestions among the scientific community regarding an acceptable excess lifetime cancer risk, due to the uncertainties regarding the mechanism of cancer. The recommendations of many scientists and EPA have been in the risk range of 1 in 1 million to 1 in 10,000 (as referred to as $1 \times 10^{-6}$ to $1 \times 10^{-4}$) excess cancer cases. An increased lifetime cancer risk of one in one million or less is generally considered an insignificant increase in cancer risk. Cancer risk less than 1 in 10,000 (or $1 \times 10^{-4}$) is not typically considered a health concern. An important consideration when determining cancer risk estimates is that the risk calculations incorporate several very conservative assumptions that are expected to overestimate actual exposure scenarios. For example, the method used to calculate EPA's CSFs assumes that high-dose animal data can be used to estimate the risk for low dose exposures in humans. As previously stated, the method also assumes that there is no safe level for exposure. Lastly, the method computes the

95% upper bound for the risk, rather than the average risk, suggesting that the cancer risk is actually lower, perhaps by several orders of magnitude.

Because of the uncertainties involved with estimating carcinogenic risk, ATSDR employs a weight-of-evidence approach in evaluating all relevant data. The numerical risk estimate must be considered in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions. The actual parameters of environmental exposures have been given careful and thorough consideration in evaluating the assumptions and variables relating to both toxicity and exposure. A complete review of the toxicological data regarding the doses associated with the production of cancer and the site-specific doses is an important element in determining the likelihood of exposed individuals being at a greater risk for cancer.

**Appendix, Table A - Summary of Calculated Exposure Doses**
**Sigmon's Septic Tank Site**

| | Ingestion & Direct Contact Dose (mg/kg/day) | Oral Health Guideline (mg/kg/day) | Exceeds Health Guideline? | Health Guideline Source | Inhalation Dose (mg/kg/day)[(a)] | Inhalation Health Guideline (mg/kg/day)[(b)] | Exceeds Health Guideline? |
|---|---|---|---|---|---|---|---|
| Adult Resident - Off-Site Soil Pathway | | | | | | | |
| Arsenic | 9.44E-07 | 3.00E-04 | No | (c) | NA | NA | NA |
| Child Resident - Off-Site Soil Pathway | | | | | | | |
| Arsenic | 1.20E-05 | 3.00E-04 | No | (c) | NA | NA | NA |
| Adolescent Trespasser - Soil Pathway | | | | | | | |
| Arsenic | 1.19E-06 | 3.00E-04 | No | (c) | NA | NA | NA |
| Vanadium | 7.75E-05 | 3.00E-03 | No | (d) | NA | NA | NA |
| Benzo(a)pyrene Equivalents | 5.74E-07 | NA | NA | NA | NA | NA | NA |

NOTES:
(a) Inhalation doses were calculated only for contaminants with an available inhalation health guideline.
(b) EPA's Inhalation Reference Dose
(c) ATSDR's Chronic Oral Minimal Risk Level and EPA's Oral Reference Dose
(d) ATSDR's Intermediate Oral Minimal Risk Level
NA = Not available

**Appendix, Table B - Summary of Theoretical Cancer Risk**
**Sigmon's Septic Tank Site**

**Calculated Theoretical Lifetime Cancer Risk**

| | Ingestion | Direct Contact | Inhalation of Dust | Total Cancer Risk | Cancer Risk Conclusion |
|---|---|---|---|---|---|
| **Adult Resident[1] - Soil Pathway** | | | | | |
| Arsenic | 6.06E-07 | 3.15E-08 | 1.48E-10 | 6.38E-07 | **No Increased Cancer Risk** |
| Total Risk for Contaminants | | | | **6.38E-07** | |
| **Combined[2] - Soil Pathway** | | | | | |
| Arsenic | 2.26E-06 | 2.53E-07 | 3.60E-10 | 2.51E-06 | **No Increased Cancer Risk** |
| Vanadium | NA | NA | NA | NA | |
| Benzo(a)pyrene | 7.03E-08 | 9.21E-08 | 3.81E-13 | 1.62E-07 | |
| Total Risk for Contaminants | | | | **2.68E-06** | |

NOTES:

[1] Adult Resident Soil Pathway includes the risk from exposure occuring only as an adult.

[2] Combined Soil Pathway includes the risk from exposure occurring as a child resident, adolescent trespasser, and adult resident. The combination of these pathways was considered based on site-specific information gathered from the community. It is considered a conservative approach that may result in an overestimation of risk.