

Health Consultation

Evaluation of Soil Exposures at the Fifth District Park

**GENERAL DYNAMICS FACILITY
WOODBIDGE TOWNSHIP, MIDDLESEX COUNTY, NEW JERSEY**

EPA FACILITY ID: NJD002173052

**Prepared by the
New Jersey Department of Health and Senior Services**

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

Health Consultation: A Note of Explanation

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

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

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Prepared By:

New Jersey Department of Health and Senior Services
Division of Epidemiology, Environmental and Occupational Health
Consumer, Environmental and Occupational Health Services
Environmental and Occupational Health Surveillance Program
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Summary

Introduction

In July 2007, the New Jersey Department of Environmental Protection (NJDEP) requested assistance from the New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) in determining whether soil contaminants in the Fifth District Park located adjacent to the former General Dynamics Facility, Woodbridge, Middlesex County posed a health threat.

Through a Cooperative Agreement with the ATSDR, the NJDHSS prepared this Health Consultation (HC) for the Fifth District Park site summarizing initial responses and blood lead evaluation for the impacted community.

Agency for Toxic Substances and Disease Registry (ATSDR) and New Jersey Department of Health and Senior Services's (NJDHSS) top priority is to ensure that the community around the site has the best information possible to safeguard its health.

Conclusions

The NJDHSS and ATSDR have reached the following four conclusions in this health consultation on the Fifth District Park site:

Conclusion 1

NJDHSS and ATSDR conclude that likely past lead exposures to area children associated with the soil of Fifth District Park may have harmed their health.

Basis for Conclusion

Children live in the vicinity of the Fifth District Park. Past exposures to lead were evaluated using an U.S. Environmental Protection Agency lead model. Results showed that if young children (aged 6 - 84 months) had visited the park five days a week for a period of nine months, between five to 28 percent of them may have blood lead levels above the action level of 10 µg/dL. Although the model results show the possibility of elevated blood lead levels in children who played in the park in the past, blood lead levels measured in children from Avenel were similar to statewide average blood lead levels (see Conclusion 4). The potential for adverse health effects to adults associated with lead exposures from the park are not expected.

Next Steps None at present

Conclusion 2 *NJDHSS and ATSDR conclude that past incidental ingestion of trichloroethylene, PAHs, chlordane, dieldrin, PCBs, antimony, arsenic, cadmium and zinc in surface soil is not expected to harm people's health.*

Basis for Conclusion Adverse non-cancer health effects from these contaminants are very unlikely because the calculated exposure doses from the site are less than the comparison values, which are protective of human health. The calculated cancer risks are considered to be a very low increase in risk when compared to the background risk for all or specific cancers.

Next Steps None at present.

Conclusion 3 *NJDHSS and ATSDR conclude that current and future exposures to soil contaminants at the Fifth District Park will not occur.*

Basis for Conclusion Exposures in the past are unlikely to occur in the present time since clean up has occurred and the contact with contaminated soil at the park has been eliminated.

Next Steps None at present.

Conclusion 4 *The blood lead levels measured in Avenel area children are similar to statewide average levels.*

Basis for Conclusion Childhood blood lead level data from the NJDHSS Childhood Lead Poisoning Surveillance System indicate that blood lead levels measured in children from Avenel were similar to statewide average levels.

Next Steps

A review of other health outcome data is not recommended due to the relatively small size of the impacted population.

**For More
Information**

Copies of this report were made available to concerned residents in the vicinity of the site via the township library and the internet.

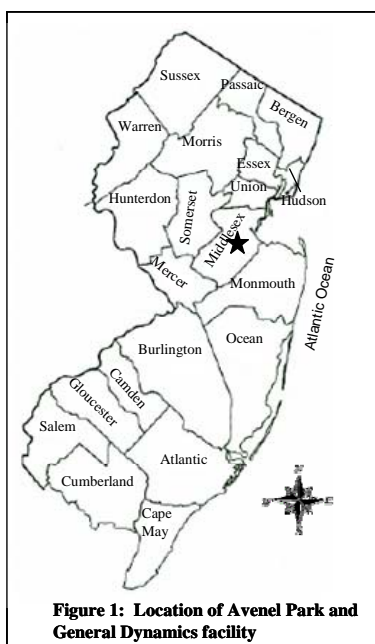
Questions about this health consultation should be directed to the NJDHSS at (609) 584-5367.

Statement of Issues

In July 2007, the New Jersey Department of Environmental Protection (NJDEP) requested assistance from the New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) in determining whether soil contaminants in the Fifth District Park located adjacent to the former General Dynamics Facility, Woodbridge, Middlesex County posed a health threat. Immediate guidance was provided to the NJDEP which supported the local elected officials' decision to close the park. In this document, NJDHSS and ATSDR provide a detailed blood lead analysis for the community and evaluate additional environmental sampling conducted following park closure.

Through a cooperative agreement with the ATSDR, the NJDHSS prepared this health consultation for the Fifth District Park site which documents all site activities that occurred upon receiving the request.

Background



The Fifth District Park (also known as Avenel Park), owned by Woodbridge Township, is bordered by the former General Dynamics site to the west, Avenel Street to the south, Cornell Street to the east and Lehigh Avenue to the north (see Figures 1 and 2). The former General Dynamics site is a 27-acre facility that includes several buildings, paved parking areas, concrete storage pads, courtyards located between sections of the main plant building, and an undeveloped wooded area. The site was developed in 1917 by Security Steel Equipment Corp., a manufacturer of metal office furniture. Raw materials were brought in by railway to produce office furniture products. Manufactured products were degreased, painted, dried and shipped (Enviro-Sciences 2007). General Dynamics assumed ownership of the property in 1963, and used the existing main plant building for the manufacture and assembly of various mechanical components for military and industry until 2000 when they ceased operations at the site.

In 2006, new owners of the site indicated an interest in further cleaning up the property prior to any potential development. As part of the extended environmental testing, the perimeter areas along the fence line of the Fifth District Park were sampled for environmental contamination (Birdsall Engineering, Inc. 2007). Nine of the 10 tests along the fence line produced results that indicated the presence of contamination. Additional testing was also performed in and around the playground area

Based on the recommendations of the Woodbridge Township Department of Health and Human Services, the Mayor of Woodbridge ordered the closure of the Fifth District Park on June 11th, 2007 as a precautionary measure while ongoing environmental testing in and around the

former General Dynamics site was being conducted (Township of Woodbridge 2007). The indefinite closure of the park was ordered after environmental test results indicated elevated levels of contaminants in soil samples taken from the perimeter of the park. All playground equipment from Fifth District Park was removed so that nobody, particularly children, would have any reason to access the park. In June 2008, new equipment was installed in the park and following site-wide clean-up, the park was re-opened to the public (D. Green, Health Officer, Woodbridge Township, personal communication, 2008).

Site Visit

On September 27, 2007, staff visited the Fifth District Park located near former General Dynamics site. Present were Sharon Kubiak, and Somia Aluwalia of the NJDHSS; Leah Graziano of the ATSDR; Mary Glenshaw of the Center for Disease Control and Prevention; and representatives from the Woodbridge Township Health Department.

The park was fenced on all four sides and the entrance was locked and held in place by plastic ratchet straps (see photograph 1). There were warning signs posted on the fences notifying the public not to access the park (see photograph 2). The ground cover on the park surface was thick with overgrown grass (see photograph 3). All playground equipment was removed in June 2007. There was a basketball court which was the only area of the park not covered with grass. Houses were present to the north and east of the park; the former General Dynamics Facility borders the park on the western side, and Avenel Street was to the south of the park.

Community Concerns

At the request of the mayor of Woodbridge, staff held an Availability Session (AV) and attended a public meeting on November 28, 2007 regarding the Fifth District Park in Avenel. In preparation for this meeting, staff met with local officials and their consultants on November 21, 2007. At the AV session, a resident's concerns included ingestion of contaminated groundwater and its potential relationship to cancer, and risk to adults, children and grandchildren.

Following the AV session, a public meeting was held later in the evening on the same day. Staff described why state and federal health agencies were involved with the park, gave an overview of the health consultation process in general, and discussed what could be stated with confidence about the park in particular (that is, soil was contaminated with lead and other chemicals and that the preliminary results support the municipality's closure of the park in June 2007). Exposure concerns included chlordane detections in soil at the property lines between the park and residences. Upon conclusion of the meeting, many residents spoke with NJDHSS staff about cancer among residents who live adjacent or near the park or General Dynamics. These cancers included bladder, stomach, lung, intestine, and leukemia (especially leukemia in children).

Environmental Contamination

An evaluation of site-related environmental contamination consists of a two-tiered approach. First, maximum concentrations of detected substances are compared to media-specific comparison values (known as environmental guideline comparison values ((CVs). If concentrations exceed the comparison values, these contaminants are selected for further evaluation. The second evaluation consists of the derivation of an Exposure Point Concentration (explained in detail in the following section) for each contaminant whose maximum value is elevated above the CVs. The Exposure Point Concentrations for contaminants are subsequently compared to the CVs; if they are elevated above the CVs, the contaminants are classified as Contaminants of Concern (COC). Contaminant levels above environmental guideline CVs do not mean that adverse health effects are likely, but that a health guideline comparison is necessary to evaluate site-specific exposures. Once exposure doses are estimated, they are compared with health guideline CVs to determine the likelihood of adverse health effects.

Environmental Guideline Comparison

The ATSDR chronic Environmental Media Evaluation Guide (EMEG) and Cancer Risk Evaluation Guide (CREG) were selected as the CVs. EMEGs are estimated contaminant concentrations that are not expected to result in adverse non-carcinogenic health effects. CREGs are media-specific comparison values that are used to identify concentrations of cancer-causing substances that are likely to result in an increase of cancer rates in an exposed population. In the absence of an ATSDR CV, other comparison values may be used to evaluate contaminant levels in environmental media. These include the USEPA Screening Levels (SL) and NJDEP Residential and Non-Residential Direct Contact Soil Cleanup Criteria (RDCSCC, NRDCSCC). Based primarily on human health impacts, these criteria also take into account natural background concentrations, analytical detection limits, and ecological effects.

A compilation of soil sample results (collected from 0 – 0.5 feet depth) for the Fifth District Park site is provided in the Table 1. As previously mentioned, the maximum concentrations of contaminants were compared to the environmental guideline CVs. If the concentrations were elevated over the CVs, the contaminant was categorized as a contaminant of potential concern and retained for further analysis (see Table 1).

Environmental Sampling

Table 1 indicates that trichloroethylene, polyaromatic hydrocarbons (PAHs) such as benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-c,d]pyrene were detected at levels exceeding the environmental guideline CVs. Chlordane and dieldrin (not known to be related to General Dynamics operations) were also elevated above the CVs. Metals such as arsenic, copper, lead and zinc were detected in all samples. These and other metals such as antimony, cadmium, chromium, nickel were also elevated above their environmental guideline CVs. Acenaphthylene, benzo[g,h,i]perylene, dibenzofuran and phenanthrene do not have environmental guideline CVs; these contaminants were categorized as contaminants of potential concern.

The contaminants of potential concern generated from the above analyses were retained for further analysis as described in the following section.

Exposure Point Concentration Calculation

Although the maximum concentration of contaminants is usually used to identify COC, it would be inappropriate to calculate site health risks based on the single highest concentration. This is because a single measurement is unlikely to represent the contamination at the entire site. Alternatively, a ‘conservative estimate’ of the average chemical concentration, known as the exposure point concentration (EPC) can be used to effectively represent a concentration at a site. An exposure point is an area location within which an exposed population’s contact with an environmental medium (e.g., air, soil) is assumed to be equally likely.

An EPC is an estimate of the true arithmetic mean concentration of a chemical in a medium at an exposure point. However, because the true arithmetic mean concentration cannot be calculated with certainty from a limited number of measurements, the USEPA recommends that the 95th percentile upper confidence limit (UCL) of the arithmetic mean be used when calculating exposure and risk at that location. To this end, USEPA has recently developed software (ProUCL[®]) that computes the UCL for a given data set by a variety of alternative statistical approaches and then recommends specific UCL values as being the most appropriate for that particular data set (USEPA 2007).

For this site, the ProUCL[®] 4.0 was used to estimate the EPCs for those contaminants that were elevated above the CVs, (see Table 2). If the EPC was found to be elevated above the comparison values, it was considered to be a contaminant of concern.

Listed below are the COC for the Fifth District Park site following the ProUCL[®] analyses:

Volatile Organic Compounds	Semi-Volatile Organic Compounds	Metals
Trichloroethylene	Acenaphthylene; Benzo[a]anthracene; Benzo[a]pyrene; Benzo[b]fluoranthene; Benzo(g,h,i)perylene; Dibenz(a,h)anthracene; Dibenzofuran; Indeno(1,2,3-cd)pyrene; Phenanthrene; Chlordane; Dieldrin; PCBs (Aroclor-1260)	Arsenic Cadmium Lead Zinc

Discussion

The method for assessing whether a health hazard exists to a community is to determine whether there is a completed exposure pathway from a contaminant source to a receptor population and whether exposures to contamination are high enough to be of health concern. Site-specific exposure doses can be calculated and compared with health guideline CVs.

Assessment Methodology

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. source of contamination;
2. environmental media and transport mechanisms;
3. point of exposure;
4. route of exposure; and
5. receptor population.

Generally, the ATSDR considers three exposure pathway categories: 1) completed exposure pathways, that is, all five elements of a pathway are present; 2) potential exposure pathways, that is, one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element; and 3) eliminated exposure pathways, that is, one or more of the elements is absent. Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future.

Based on results and knowledge of accessibility of the media to the population, exposure pathways for individuals who live (or lived) in the area are identified as follows:

Completed Pathway

Ingestion of contaminated soil (past). A number of PAHs, metals and pesticides such as dieldrin and chlordane were detected in the surface soil above screening levels in the Fifth District Park. Nearby residents, including children, may have been exposed to contaminants engaging in outdoor recreational activities at the site.

Eliminated Pathway

Ingestion of contaminated soil (present, future). Following remediation and site-wide clean up in June 2008, this pathway of exposure has been eliminated for current and future exposures.

Public Health Implications

When determining the public health implications of exposure to hazardous contaminants, NJDHSS considers how much of the contaminant people might come into contact with and compares these contaminant exposure doses with health protective comparison values. When contaminant exposure dose levels are below health-based comparison values, health impacts from exposure to those levels are unlikely. Contaminant levels exceeding comparison values do not indicate that health impacts are likely but instead warrant further evaluation.

Non-Cancer Health Effects

To assess non-cancer health effects, ATSDR has developed Minimal Risk Levels (MRLs) for contaminants that are commonly found at hazardous waste sites. An MRL is an estimate of the daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of adverse, non-cancer health effects. MRLs are developed for a route of exposure, i.e., ingestion or inhalation, over a specified time period, e.g., acute (less than 14 days); intermediate (15 - 364 days); and chronic (365 days or more). MRLs are based largely on toxicological studies in animals and on reports of human occupational (workplace) exposures. MRLs are usually extrapolated doses from observed effect levels in animal toxicological studies or occupational studies, and are adjusted by a series of uncertainty (or safety) factors or through the use of statistical models. In toxicological literature, observed effect levels include:

- no-observed-adverse-effect level (NOAEL); and
- lowest-observed-adverse-effect level (LOAEL).

NOAEL is the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals. LOAEL is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals. In order to provide additional perspective on these health effects, the calculated exposure doses were then compared to observed effect levels (e.g., NOAEL, LOAEL). As the exposure dose increases beyond the MRL to the level of the NOAEL and/or LOAEL, the likelihood of adverse health effects increases.

To ensure that MRLs are sufficiently protective, the extrapolated values can be several hundred times lower than the observed effect levels in experimental studies. When MRLs for specific contaminants are unavailable, other health based comparison values such as USEPA Reference Dose (RfD). The RfD is an estimate of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Exposures are based on ingestion of contaminated soil; non-cancer exposure doses were calculated using the following formula:

$$\text{Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF}{BW}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in soil (mg/kg);
IR = soil ingestion rate (kg/day);
EF = exposure factor representing the site-specific exposure scenario; and,
BW = body weight (kg)

NJDHSS evaluated non-cancer health risks based on likely recreational exposure scenarios for children and adults who may come in contact with soils at the site. The recreational exposure scenario assumes an exposure duration of nine months when it is thought that children

will be playing in the playground. Based on the USEPA Exposure Factors (USEPA 1997) and site-specific conditions, the following assumptions were used to calculate exposure doses for children and adults:

Receptor	Soil Ingestion Rate (mg)	Body Weight (kg)	Exposure Frequency
Child	100	17	5 days per week for 9 months
Adult	200	70	

Tables 3 presents calculated doses, expressed in scientific notation, which is simply a method for expressing either very large or very small numbers. For example, 1,000,000 can be expressed in scientific notation as 1×10^6 ; and 0.001 can be expressed as 1×10^{-3} , respectively.

Results are presented and compared to MRLs in Table 3 for all contaminants of concern except lead. Based on the EPC of trichloroethylene, chlordane, dieldrin, PCBs, arsenic, cadmium, and zinc detected in surface soil, chronic exposure doses calculated for children and adults were lower than the corresponding health guideline CVs (see Table 3). As such, exposures to these COC are unlikely to cause non-cancer adverse health effects.

Since PAHs and lead do not have health guideline CVs, the health implications are discussed below.

PAHs: PAHs are a class of over 100 different compounds that are found in and formed during incomplete combustion of coal, oil, wood, or other organic substances (ATSDR 1995). More commonly they are found in petroleum based products such as coal tar, asphalt, creosote, and roofing tar. In the environment, PAHs are found as complex mixtures of compounds, and many have similar toxicological effects and environmental fate. Because they are produced by combustion processes, PAHs are widespread in the environment. PAHs have been found to exhibit antiandrogenic¹ properties in human cell cultures and are implicated in the loss of fertility in males (Kizu 2003). Non-cancer adverse health effects associated with PAH exposures has been observed in animals but generally not in humans (ATSDR 1995).

Based on the 95% UCL of mean concentrations of PAHs detected in the surface soil in the Fifth District Park area, the chronic exposure doses for children and adults were calculated (see Table 3); no health guideline CVs are available for these PAHs identified as COCs. However, the NOAEL, RfD and associated critical health effects for a number of PAHs (i.e., acenaphthene, anthracene, fluoranthene, fluorene, naphthalene and pyrene) are available and is shown below:

¹An antiandrogen is any of a group of hormone receptor antagonist compounds that are capable of preventing or inhibiting the biologic effects of androgens (i.e., male sex hormones) on normally responsive tissues in the body

Reference Dose for Chronic Oral Exposure			
PAH	NOAEL (mg/kg/day)	RfD (mg/kg/day)	Health Effect
Acenaphthene	175	0.06	Hepatotoxicity
Anthracene	1,000	0.3	No observed effect
Fluoranthene	125	0.04	Nephropathy, increased liver weights, hematological alterations, and clinical effects
Fluorene	125	0.04	Decreased red blood count, packed cell volume and hemoglobin
Naphthalene	71	0.02	Decreased mean terminal body weight in males
Pyrene	75	0.03	Kidney effects (renal tubular pathology, decreased kidney weights)

Source: EPA 2006

The RfD's of these PAHs are based on the NOAEL for less serious health effects and are much higher than those calculated for the PAHs detected in the soil (see Table 3). Based on the 95% UCL of arithmetic mean concentration of phenanthrene detected in surface soil (2.65 mg/kg, see Table 3), the calculated chronic child exposure dose (0.0000086 mg/kg/day) was about 2,300 times lower than the lowest reported RfD (i.e., 0.02 mg/kg/day for naphthalene). The exposure doses associated with the remaining PAHs (acenaphthylene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, dibenzo[a,h]anthracene, dibenzofuran and indeno[1,2,3-c,d]pyrene) were also several orders of magnitude lower than the lowest reported RfD. As such, non-cancer adverse health effects associated with on-site PAH exposures in the past are unlikely in children and adults.

Lead: Lead is considered separately using the USEPA Integrated Exposure Uptake Biokinetic (IEUBK) model for children and the Adult Lead Methodology (ALM) model for adults. These models predict total human exposure as measured by the amount of lead in blood, based on contaminant levels in the environment. In this health consultation, the IEUBK model was used to calculate the geometric mean of lead in blood in children, aged up to 84 months (USEPA 1994a). Each age group was modeled separately because the exposures at the site are intermittent in nature. The model also provides the probability estimate (expressed as P_{10}) that a typical child will have a blood lead level greater or equal to the level of concern established by the U.S. Centers for Disease Control and Prevention (10 $\mu\text{g/dL}$) (CDC 1991). This P_{10} estimate should be at or below a protection level of five percent, i.e., $P_{10} \leq 5$ percent, as recommended by the USEPA Office of Solid Waste and Emergency Response (USEPA 1994b). The Adult Lead Model describes a methodology for assessing risks associated with non-residential exposures to lead in soil. It provides similar outputs as the IEUBK lead model (USEPA 2003a).

Lead exposures associated with the recreational (i.e., intermittent) use of the park by children aged up to 84 months was evaluated using the following assumptions (USEPA 2003b):

1. Children were exposed to soil and surface water containing lead each time the area was visited. The visit frequency was assumed to be five days per week over nine months of the year. This scenario does not consider a lead “wash-out²” period in between the annual cycles of nine-month exposure periods over the course of a child life from 6-84 months.
2. The lead concentration of residential soil was assumed to be 50 mg/kg (ATSDR 2002). The daily site soil was added to the IEUBK model alternate source parameter.
3. The daily lead intake for use in the model was calculated using the 95% UCL exposure level of 1,469 mg/kg for soil lead concentration. The IEUBK model assumes lead bioavailability of 30% for soil lead. The calculation of daily lead intake shown below:

$$1,469 \text{ mg/kg} * 45^3 \text{ mg/day} * (1/1000) * (5 \text{ days}/7 \text{ days}) * (30\%) = 14.2 \text{ } \mu\text{g/day}$$
4. IEUBK model default values were used for all other variables (USEPA 2002).
5. It is important to note that the IEUBK model should not be used for exposure periods of less than three months, or in which a higher exposure occurs less than once per week or varies irregularly

The predicted geometric mean blood lead levels and the probability of blood lead levels exceeding 10 $\mu\text{g/dL}$ (P_{10}) for children are shown in the following table. The exposure estimate characterizes children who visit the playground for a period of nine months each year, and whose added blood lead burden are assumed to be not eliminated during the intervening months between successive annual exposures.

² For exposures that are restricted to some fraction of a year (e.g., summer months), some of the lead burden accumulated during the exposure season will be eliminated during the intervening months between exposure periods. However, the IEUBK model cannot simulate this loss of lead; model predictions correspond to a full year of exposure to a contact exposure level regardless of the actual exposure period.

³ Daily soil-dust ingestion rate is an age-specific range in the IEUBK model (85-135 mg/day). The USEPA default child ingestion rate of 100 mg/day represents a reasonable central value for the age-specific range. The soil-dust ingestion rate is a composite of soil ingestion (45%) and dust ingestion (55%); hence 45 mg/day is a reasonable ingestion rate for assessing exposure to outdoor soil sources.

Exposure Scenario		
Age (months)	Five Site Visits Per Week	
	Blood Lead Level ¹ (µg/dL)	P ₁₀ (%) ²
6 - 12	7.6	28
12 - 24	6.8	21
24 - 36	6.0	14
36 - 48	5.7	12
48 - 60	5.4	9.4
60 - 72	5.0	7.3
72 - 84	4.7	5.3

¹Geometric mean lead levels in blood; ²probability of blood lead level > 10 µg/dL

The above table presents a range of blood lead levels for a child who visits the playground for a period of nine months each year from the age of six months through 84 months. The blood lead levels for all the age groups are below the action level of 10 µg/dL. The P₁₀ values for the individual age-years (from 6 months to 84 months) ranged from five to 28 percent. Therefore, it can be concluded that if children aged 6 – 84 months were to visit the park five days a week for a period of nine months, five to 28 percent of them may have blood lead levels above 10 µg/dL. Accumulation of lead in the body can cause damage to the nervous or gastrointestinal system, kidneys, or red blood cells (ATSDR 2006). Children, infants, and fetuses are the most sensitive populations. Lead may cause learning difficulties and stunted growth, or may endanger fetal development. Health effects associated with lead exposure, particularly changes in children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold (i.e., no NOAEL or LOAEL is available).

An adult blood lead model estimated a geometric mean blood lead level of 3.5 µg/dL for adult workers. Approximately five percent of fetal blood will have lead levels exceeding 10 µg/dL. As such, the potential for adverse health effects to adults associated with lead exposures from the site are not expected.

Cancer Health Effects

The site-specific lifetime excess cancer risk (LECR) indicates the cancer potential of contaminants. LECR estimates are usually expressed in terms of excess cancer cases in an exposed population in addition to the background rate of cancer. For perspective, the lifetime risk of being diagnosed with cancer in the United States is 46 per 100 individuals for males, and 38 per 100 for females; the lifetime risk of being diagnosed with any of several common types of cancer ranges approximately between 1 in 100 and 10 in 100 (SEER 2005). Typically, health guideline CVs developed for carcinogens are based on a lifetime risk of one excess cancer case per 1,000,000 individuals. ATSDR considers estimated cancer risks of less than one additional cancer case among one million persons exposed as insignificant or no increased risk (expressed exponentially as 10⁻⁶).

According to the USEPA, the cancer class of contaminants detected at a site is as follows (USEPA 2009):

- **Group A.** Human Carcinogen: sufficient evidence from epidemiologic studies to support a causal association between exposure to the agents and cancer.
- **Group B.** Probable Human Carcinogen: The group is divided into two subgroups.
 - Group B1: limited evidence of carcinogenicity from epidemiologic studies.
 - Group B2: "sufficient" evidence from animal studies and for which there is inadequate evidence or "inadequate evidence" or "no data" from epidemiologic studies
- **Group C.** Possible Human Carcinogen: limited evidence of carcinogenicity in animals in the absence of human data.
- **Group D.** Not Classifiable as to Human Carcinogenicity: inadequate human and animal evidence of carcinogenicity or for which no data are available.
- **Group E.** Evidence of Non-Carcinogenicity for Humans: no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.

The USEPA cancer classification of the COC detected in the soil is presented in Table 4. Acenaphthylene, benzo[g,h,i]perylene, dibenzofuran, phenanthrene, and zinc are not classified as carcinogens.

Exposure doses were calculated using the following formula:

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

where C = concentration of contaminant in soil (mg/kg);
IR = soil ingestion rate (kg/day);
EF = exposure factor representing the site-specific exposure scenario;
ED = exposure duration (year);
BW = body weight (kg); and,
AT = averaging time (year).

where the exposure factor:

$$EF = \frac{\text{number of days of exposure per year} \times \text{the number of years of exposure}}{\text{days per year} \times 70 \text{ years}}$$

Based on the USEPA Exposure Factors (USEPA 1997) and site-specific conditions, the following assumptions were used to calculate the exposure doses and the corresponding LECRs:

Media	Target Population	Ingestion Rate (mg/day)	No. of Days of Exposure Per Year	Years Exposed	Body Weight (kg)
Soil	Adult	100	5 days per week, 9 months per year	30	70

LECRs based on contaminant concentrations detected in soil for trichloroethylene, PAHs, chlordane, dieldrin, PCBs, arsenic and cadmium are presented in Table 4 and are derived as follows:

The USEPA has developed a relative potency estimate approach for PAHs (USEPA 1993). Using this approach, the cancer potency of carcinogenic PAHs can be estimated based on their relative potency with reference to benzo[a]pyrene. For each of the carcinogenic PAHs, the benzo[a]pyrene equivalence was calculated by multiplying the maximum concentration detected with the cancer potency factor. The total benzo[a]pyrene equivalence was then obtained by summing each of the individual benzo[a]pyrene equivalences (see Tables 4).

Based on previously described exposure assumptions, LECRs were calculated by multiplying the exposure dose by the cancer slope factor. The cancer slope factor is defined as the slope of the dose-response curve obtained from animal and/or human cancer studies and is expressed as the inverse of the daily exposure dose, i.e., $(\text{mg/kg/day})^{-1}$. Based on 95% UCL of the mean and using conservative exposure parameters, the calculated LECRs for contaminants ranged from 3.0E-05 to 4.0E-07 (see Table 4). For exposures to trichloroethylene, chlordane and dieldrin, there would be less than two additional cancer cases among one million persons exposed. This is considered an insignificant risk. For exposures to PAHs, PCBs and arsenic, there would be one to three additional cancer cases among one hundred thousand persons exposed. This may be considered a very low increase in cancer risk. The cumulative cancer risk from all carcinogenic contaminants at the site was calculated to five additional cancer cases among one hundred thousand persons exposed, representing a very low increase in lifetime cancer risk when compared to United States background cancer risk.

Although lead has not been classified as a carcinogen by the USDHHS⁴, the carcinogenicity of inorganic lead and lead compounds have been evaluated by the USEPA (USEPA 1986, 1989). The USEPA has determined that data from human studies are inadequate for evaluating the carcinogenicity of lead, but there is sufficient data from animal studies which demonstrate that lead induces renal tumors in experimental animals. In addition, there are some animal studies which have shown evidence of tumor induction at other sites (i.e., cerebral gliomas; testicular, adrenal, prostate, pituitary, and thyroid tumors). A cancer slope factor has not been derived for inorganic lead or lead compounds, so an estimation of LECR can not be made for lead exposure.

⁴Lead and Lead Compounds are listed in the Eleventh Edition of the Report on Carcinogens as “reasonably anticipated to be human carcinogens” (NTP 2006)

Community Concerns

The NJDHSS and ATSDR strive to identify the community's concerns about a site during the development of a health assessment or consultation in order to ensure that those concerns are addressed. For the Fifth District Park site, we have met with community members, individually and in groups, at two meetings held in Woodbridge. These included a NJDHSS and ATSDR Availability Session and a Public Meeting in November 2007. The community had raised following health concerns:

- **contaminated groundwater** and its potential relationship to cancer, and risk to adults, children and grandchildren. Residents are on public water supply and current groundwater contamination related to the General Dynamics Facility is not expected to impact the residents through ingestion of drinking water.
- **chlordanne detections** in soil at the property lines between the park and residences. Based on the EPC of chlordanne detected in surface soil, chronic exposure doses calculated for children and adults were lower than the corresponding health guideline CVs (see Table 3). As such, exposure to chlordanne is unlikely to cause non-cancer adverse health effects. When evaluating cancer risks from exposures to chlordanne, there would be less than two additional cancer cases among one million persons exposed. This is considered an insignificant risk.
- **cancer** (such as bladder, stomach, lung, intestine, and leukemia) among residents who live adjacent or near the park or General Dynamics. The cumulative cancer risk from all carcinogenic contaminants at the park was calculated to five additional cancer cases among one hundred thousand persons exposed, representing a very low increase in lifetime cancer risk when compared to United States background cancer risk. As such it is unlikely that the specific cancers mentioned by the community are associated with ingestion exposures related to the park.

Health Outcome Data

Based on a review of data available, a completed exposure pathway existed for the site by area residents accessing the contaminated soil present in the park. A review of health outcome data (e.g., adverse pregnancy outcomes, cancers, deaths) may be conducted to assess the public health significance of these completed exposure pathways. However, due to the small number of individuals exposed, an evaluation of these health data is unlikely to produce interpretable results.

Because of the potential for exposure to lead in contaminated park soil, data on blood lead tests were evaluated for children living in the Avenel area of Woodbridge Township, with particular interest in those children living close to the Fifth District Park next to General Dynamics. Information on blood lead levels comes from the NJDHSS' Childhood Lead Poisoning Surveillance System.

Blood lead is an excellent indicator of exposure to lead. Current state regulations, in accordance with federal CDC guidelines, require health care providers to do a blood lead test on

all one and two year old children. This is the age at which lead poisoning is most damaging to the developing nervous system. State regulation requires all clinical laboratories to report the results of all blood lead tests to the NJDHSS. Prior to July 1999, only blood lead tests above 20 micrograms per deciliter ($\mu\text{g}/\text{dL}$) were reportable. While the current CDC blood lead guideline is 10 $\mu\text{g}/\text{dL}$, all blood-lead test data are reportable to the NJDHSS' Childhood Lead Poisoning Prevention Surveillance System.

Data from the Childhood Lead Poisoning Prevention Surveillance System was reviewed for the period January 1999 through November 2007 for Avenel. A total of 1,975 Avenel children were tested during this period. The age range for children tested was from less than 1 month to 16.8 years. The range of blood lead levels in Avenel children was less than 0.1 to 57 $\mu\text{g}/\text{dL}$. Nineteen children (1.0%) were found to have a blood lead level exceeding the CDC guideline during this time period. The geometric blood lead average was 2.4 $\mu\text{g}/\text{dL}$ with a 95% confidence interval (CI) of 2.3 to 2.5 $\mu\text{g}/\text{dL}$.

Childhood blood lead data was further evaluated for the each of the five Census Block Groups in the Census Tract that the park is located in. Census Tracts and their corresponding Block Groups are designated by the U.S. Census Bureau for the purpose of delineating population characteristics. A total of 390 children from the five Census Blocks were tested during this period. The age range for children tested was 11 months to 16.3 years. The range of blood lead levels for children in the Census Tract was less than 0.1 to 15 $\mu\text{g}/\text{dL}$. Four of these children (1.0%) were found to have a blood lead level exceeding the CDC guideline during this time period. The geometric blood lead average was 2.4 $\mu\text{g}/\text{dL}$ with a 95% CI of 2.2 to 2.6 $\mu\text{g}/\text{dL}$.

The number of children tested from Avenel Census Tract by the each of the five Block Groups (1 through 5) was 44, 72, 107, 94, and 73, respectively. The geometric blood lead averages for each of the Block Groups (BG) were found as follows:

BG 1	2.4 $\mu\text{g}/\text{dL}$ (95% CI: 2.0 to 2.9 $\mu\text{g}/\text{dL}$)
BG 2	2.6 $\mu\text{g}/\text{dL}$ (95% CI: 2.2 to 3.1 $\mu\text{g}/\text{dL}$)
BG 3	2.1 $\mu\text{g}/\text{dL}$ (95% CI: 1.8 to 2.5 $\mu\text{g}/\text{dL}$)
BG 4	2.3 $\mu\text{g}/\text{dL}$ (95% CI: 1.9 to 2.8 $\mu\text{g}/\text{dL}$)
BG 5	2.5 $\mu\text{g}/\text{dL}$ (95% CI: 2.0 to 3.2 $\mu\text{g}/\text{dL}$)

Three of the four children with a blood lead level exceeding the CDC guideline resided in BG 5 (4.1%) while the other child resided in BG 2 (1.4%).

In general, these results indicate that blood lead levels measured in children from Avenel Census Tract and each of the five BGs were not statistically significant different from one another, and were similar to statewide average levels. A higher proportion of blood lead tests from children in BG 5 exceeded the CDC guideline.

Child Health Considerations

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than adults from certain kinds of exposures to hazardous substances because they eat and breathe more than adults (on a pound for pound basis). They also play outdoors and often bring food into contaminated areas. They are shorter than an adult, which means they breathe dust, soil, and heavy vapors closer to the ground. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most important, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

The NJDHSS and ATSDR evaluated the potential risk for children residing in the area who were exposed to site contaminants. The exposure doses calculated for children based on the exposure point concentrations of trichloroethylene, PAHs, chlordane, dieldrin, PCBs, antimony, arsenic, cadmium and zinc in surface soil indicate that adverse non-cancer health effects in children are not expected.

The potential cancer health effects associated with exposure to site-related contaminants were evaluated with respect to past ingestion of contaminated soil. Based on the 95% UCL of the mean concentration of contaminants detected, the total calculated LECR was estimated to be five excess cancer cases per 100,000 individuals (including exposure to children). The calculated LECR is primarily driven by the presence of PAHs, PCBs and arsenic in soil. This estimate, as mentioned earlier, represents a very low increase in lifetime cancer risk when compared to United States background cancer risk.

The 95% UCL exposure level of 1,469 mg/kg for lead detected in surface soil considerably exceeded the New Jersey RDCSCC (400 mg/kg). Blood lead levels for a child who visited the playground for a period of nine months each year from the age of six months through 84 months was calculated using the IEUBK lead model. The blood lead levels for all the age groups were calculated to be below the action level of 10 µg/dL. It was concluded that if children aged 6 – 84 months visited the park five days a week for a period of nine months prior to remediation, between five to 28 percent of them may have blood lead levels above 10 µg/dL. Health effects associated with lead exposure, particularly changes in children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold.

Because of the potential for exposure to lead in contaminated park soil, data on blood lead tests were evaluated for children, particularly those living close to Fifth District Park. Blood lead levels obtained from the NJDHSS' Childhood Lead Poisoning Surveillance System indicated that blood lead levels measured in children from Avenel Census Tract were similar to statewide average levels.

Conclusions

The Fifth District park site is contaminated due to past site operations and waste disposal practices at the adjacent General Dynamics facility. Nearby residents, including children may have been exposed to contaminants engaging in outdoor recreational activities at the site. Contaminants of concern identified for the site were trichloroethylene, PAHs, chlordane, dieldrin, PCBs, antimony, arsenic, cadmium, lead and zinc. There are completed exposure pathways via the incidental ingestion of contaminated surface soil.

NJDHSS and ATSDR reached these important conclusions about the Fifth District park site.

NJDHSS and ATSDR conclude that likely past lead exposures to area children associated with the soil of Fifth District Park may have harmed their health. Children live in the vicinity of the lead-contaminated off-site area. Results from the U.S. Environmental Protection Agency Integrated Exposure Uptake Biokinetic Model for Lead in Children indicated that if young children (aged 6 - 84 months) had visited the park five days a week for a period of nine months, between five to 28 percent of them may have blood lead levels above 10 µg/dL. When blood lead level data from the NJDHSS Childhood Lead Poisoning Surveillance System were evaluated, results indicated that blood lead levels measured in children from Avenel were similar to statewide average levels (see Conclusion 4). The potential for adverse health effects to adults associated with lead exposures from the site are not expected.

NJDHSS and ATSDR conclude that past incidental ingestion of trichloroethylene, PAHs, chlordane, dieldrin, PCBs, antimony, arsenic, cadmium and zinc in surface soil is not expected to harm people's health. Adverse non-cancer health effects from these contaminants are very unlikely because the calculated exposure doses from the site are less than the MRLs. The calculated LECRs are considered to be a very low increase in cancer risk when compared to the background risk for all or specific cancers.

NJDHSS and ATSDR conclude that current and future exposures to soil contaminants at the Fifth District Park will not occur. Exposures in the past are unlikely to occur in the present time since actions have been taken to eliminate exposures.

The blood lead levels measured in Avenel area children are similar to statewide average levels. Childhood blood lead level data from the NJDHSS Childhood Lead Poisoning Surveillance System for the years 1999 through 2007 were evaluated. Because of the potential for exposure to lead in contaminated park soil, data on blood lead tests were evaluated for children living in the Avenel area of Woodbridge Township, with particular emphasis in those children living close to the park next to General Dynamics. In general, these results indicate that blood lead levels measured in children from Avenel Census Tract and each of the five Block Groups were not statistically significant different from one another, and were similar to statewide average levels.

Recommendations

The NJDHSS and ATSDR do not propose any follow-up and/or recommendations for the Fifth District Park site.

Public Health Action Plan

The Public Health Action Plan (PHAP) for the Fifth District Park site contains a description of the actions to be taken by the NJDHSS and/or ATSDR at or in the vicinity of the site subsequent to the completion of this Public Health Assessment. The purpose of the PHAP is to ensure that this health assessment not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of the NJDHSS and ATSDR to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by NJDHSS and ATSDR are as follows:

Public Health Actions Taken

1. Available environmental data and other relevant information associated with the Fifth District Park site have been reviewed and evaluated to determine human exposure pathways and public health issues.
2. In cooperation with the ATSDR, the NJDHSS held an availability session and attended a public meeting in November 2007 to provide health related information regarding the health concerns related to the site.
3. NJDHSS evaluated childhood blood lead levels among children living closest to the park, as well as children living in the Avenel section of Woodbridge Township, to learn if the park had an impact on children's blood lead levels.
4. NJDHSS provided ATSDR ToxFAQs on contaminants of concern to local elected and health officials, as well as to residents, describing health risks from exposures to site contaminants.

Public Health Actions Planned

Copies of this report will be made available to concerned area residents via the township library and the internet.

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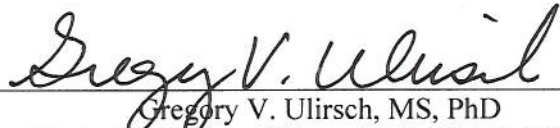
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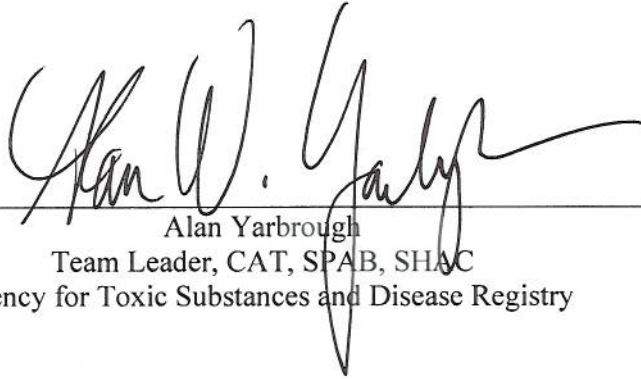
Certification

This health consultation was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This health consultation is in accordance with approved methodology and procedures existing at the time it was initiated.



Gregory V. Ulirsch, MS, PhD
Technical Project Officer, CAT, SPAB, SHAC
Agency for Toxic Substances and Disease Registry

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.



Alan Yarbrough
Team Leader, CAT, SPAB, SHAC
Agency for Toxic Substances and Disease Registry

Agency Information

Preparers of the Report

Somia Aluwalia, Ph.D.
Consumer, Environmental and Occupational Health Service
New Jersey Department of Health and Senior Services

ATSDR Regional Representative

Leah Escobar
Senior Regional Representative
Region 2, Regional Operations
Office of the Assistant Administrator

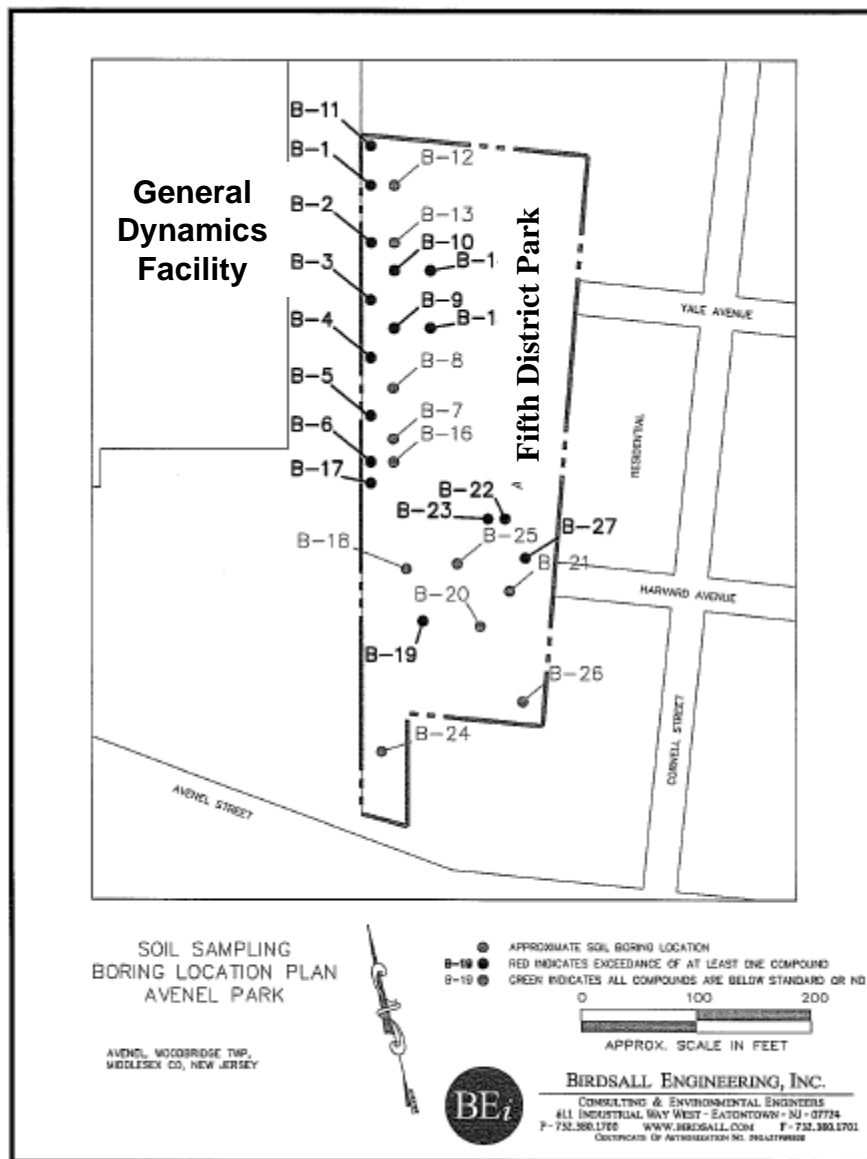
Lt. Racquel Stephenson, M.P.H.
Associate Regional Representative
Region 2, Regional Operations
Office of the Assistant Administrator

ATSDR Technical Project Officers

Gregory V. Ulirsch
Technical Project Officer
Division of Health Assessments and Consultations

Any questions concerning this document should be directed to

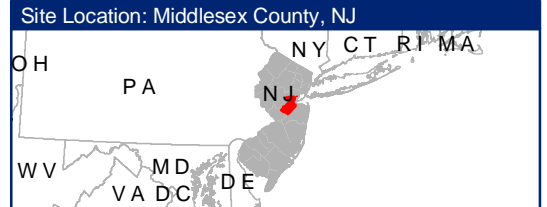
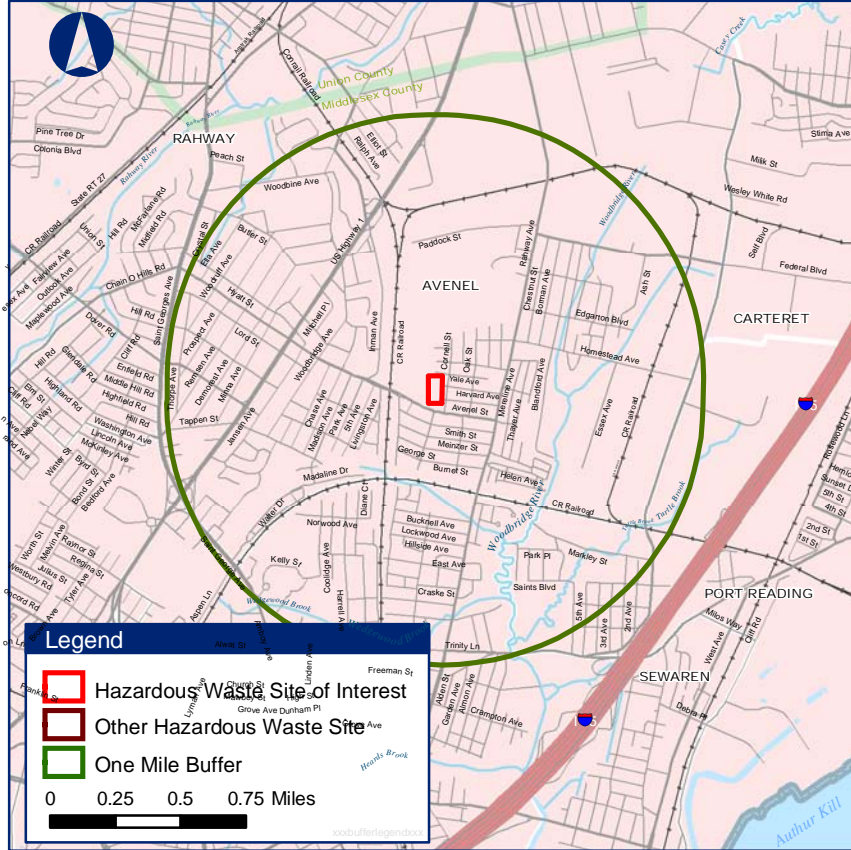
Environmental and Occupational Health Surveillance Program
New Jersey Department of Health and Senior Services
Consumer, Environmental and Occupational Health Service
P.O. Box 369
Trenton, New Jersey 08625-0369



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Figure 2: Site map of General Dynamics Facility

EPA Facility ID: UNAVAILABLE

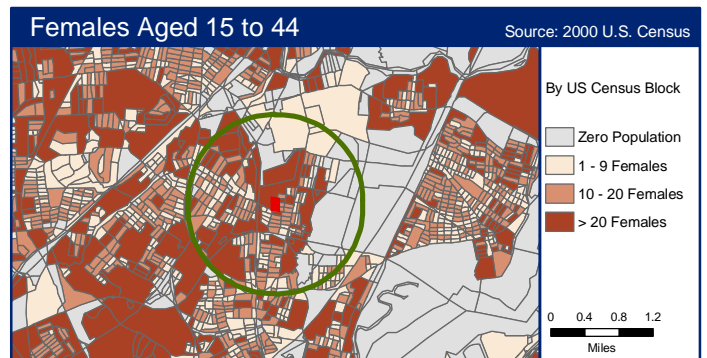
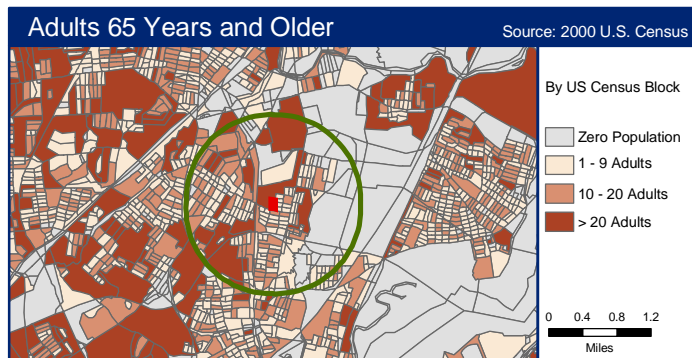
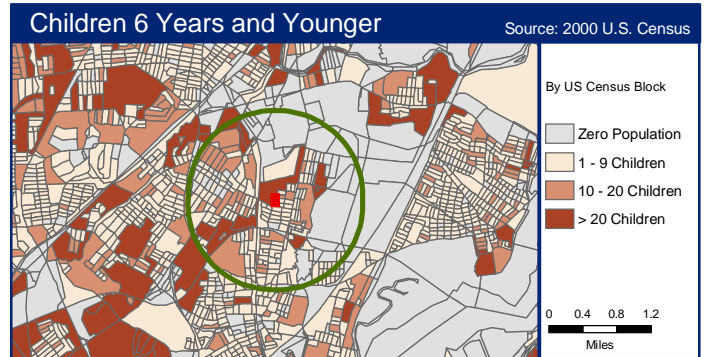
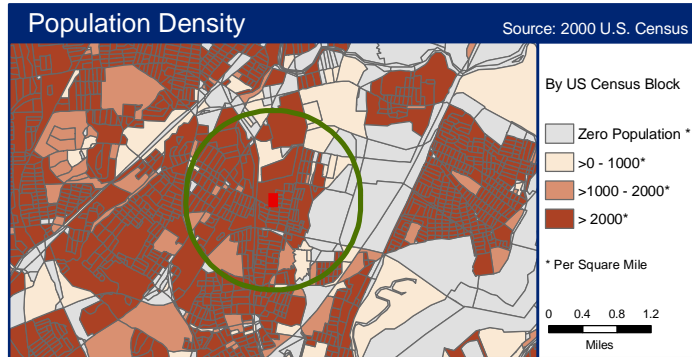


Demographic Statistics
Within One Mile of Site*

Total Population	18,713
White Alone	11,900
Black Alone	2,882
Am. Indian & Alaska Native Alone	56
Asian Alone	2,728
Native Hawaiian & Other Pacific Islander Alone	4
Some Other Race Alone	616
Two or More Races	526
Hispanic or Latino**	1,688
Children Aged 6 and Younger	1,612
Adults Aged 65 and Older	1,931
Females Aged 15 to 44	3,793
Total Housing Units	5,991

Base Map Source: Geographic Data Technology, May 2005.
Site Boundary Data Source: ATSDR Geospatial Research, Analysis, and Services Program, Current as of Generate Date (bottom left-hand corner).
Coordinate System (All Panels): NAD 1983 StatePlane New Jersey FIPS 2900 Feet

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.



<project=03538><userid=JXA0><go=Middlesex County, NJ><keywords=NJSAIDS3538, Avenel, Park>

Table 1: Contaminant Concentration in On-site Surface Soil (0-0.5 feet) samples site-wide (June to August 2007)

Contaminant	No. of Samples	No. of Detected Samples	Concentration Range (mg/kg)	Environmental Guideline Comparison Value (mg/kg)	COPC ^a
Volatile Organic Compounds					
Trichloroethylene	60	2	ND ^b - 9.13	2.8 (EPA SL ^c)	Yes
Semi-Volatile Organic Compounds					
2-Methylnaphthalene	60	3	ND - 0.32	200 (RMEG ^d)	No
Acenaphthene	60	8	ND - 1.10	3,000 (EMEG ^e)	No
Acenaphthylene	60	9	ND - 1.08	NA ^f	Yes
Anthracene	91	16	ND - 3.12	17,000 (EPA SL)	No
Benzo[a]anthracene	96	36	ND - 7.51	0.15 (EPA SL)	Yes
Benzo[a]pyrene	95	34	ND - 6.17	0.1 (CREG ^g)	Yes
Benzo[b]fluoranthene	95	41	ND - 7.72	0.15 (EPA SL)	Yes
Benzo[g,h,i]perylene	91	23	ND - 4.71	NA	Yes
Benzo[k]fluoranthene	95	36	ND - 3.11	1.5 (EPA SL)	Yes
Carbazole	60	6	ND - 2.52	32 (EPA SL)	No
Chrysene	96	42	ND - 7.95	15 (EPA SL)	No
Dibenz[a,h]anthracene	91	6	ND - 1.61	0.015 (EPA SL)	Yes
Dibenzofuran	60	3	ND - 0.72	NA	Yes
Fluoranthene	96	61	ND - 361	2,300 (EPA SL)	No
Fluorene	60	7	ND - 2.89	2,300 (EPA SL)	No
Indeno[1,2,3-cd]pyrene	91	24	ND - 3.94	0.15 (EPA SL)	Yes
Naphthalene	91	3	ND - 0.67	3.9 (EPA SL)	No
Phenanthrene	96	36	ND - 17.1	NA	Yes

Table 1: - cont. -

Contaminant	No. of Samples	No. of Detected Samples	Concentration Range (mg/kg)	Environmental Guideline Comparison Value (mg/kg)	COPC
Pyrene	96	57	ND - 18.8	1,700 (NJRDCSCC ^h)	No
bis(2-Ethylhexyl)phthalate	95	50	ND - 233	49 (NJRDCSCC)	Yes
Butylbenzylphthalate	55	23	ND - 0.66	1,100 (NJRDCSCC)	No
Di-n-butylphthalate	91	19	ND - 1.20	5,000 (RMEG)	No
Chlordane	69	29	ND - 107	2 (CREG)	Yes
Dieldrin	32	2	ND - 0.13	0.042 (NJRDCSCC)	Yes
PCBs (Aroclor-1260)	62	1	ND - 0.72	0.4 (CREG)	Yes
Metals					
Antimony	91	56	ND - 61.4	14 (NJRDCSCC)	Yes
Arsenic	92	91	ND - 366	0.5 (CREG)	Yes
Beryllium	60	47	ND - 0.81	1 (NJRDCSCC)	No
Cadmium	60	42	ND - 10.4	1 (NJRDCSCC)	Yes
Chromium	60	60	3.49 - 903	200 (RMEG)	Yes
Copper	91	91	3.58 - 2,810	500 (EMEG)	Yes
Lead	91	91	8.64 - 12,400	400 (NJRDCSCC)	Yes
Mercury	60	56	ND - 4.16	14 (NJRDCSCC)	No
Nickel	62	62	0.93 - 1,100	250 (NJRDCSCC)	Yes
Selenium	60	14	ND - 16.4	63 (NJRDCSCC)	No
Silver	60	13	ND - 12.2	110 (NJRDCSCC)	No
Thallium	49	7	ND - 1.84	2 (NJRDCSCC)	No
Zinc	91	91	6.6 - 11,200	1,500 (NJRDCSCC)	Yes

^aContaminants of Potential Concern; ^bNot Detected; ^cUSEPA Screening Levels; ^dReference Media Evaluation Guide; ^eEnvironmental Media Evaluation Guide; ^fNot Available; ^gCancer Risk Evaluation Guideline; ^hNew Jersey Residential Direct Contact Soil Cleanup Criteria

Table 2: Recommended 95% Upper Confidence Limit (UCL) of Mean by ProUCL 4.0 for the COCs

Contaminants of Potential Concern	Exposure Point Concentration (mg/kg)	Method of Calculation	Environmental Guideline CV (mg/kg)	COC ^a
Trichloroethylene	9.13	Maximum ^b	2.8 (EPA SL ^c)	Yes
Acenaphthylene	0.44	UCL ^d	NA ^e	Yes
Benzo[a]anthracene	1.44	UCL	0.15 (EPA SL)	Yes
Benzo[a]pyrene	1.31	UCL	0.1 (CREG ^f)	Yes
Benzo[b]fluoranthene	1.46	UCL	0.15 (EPA SL)	Yes
Benzo[g,h,i]perylene	1.00	UCL	NA	Yes
Benzo[k]fluoranthene	0.63	UCL	1.5 (EPA SL)	No
bis(2-Ethylhexyl)phthalate	25.6	UCL	49 (NJRDCSCC ^g)	No
Dibenz[a,h]anthracene	0.79	UCL	0.015 (EPA SL)	Yes
Dibenzofuran	0.48	Arithmetic Mean ^b	NA	Yes
Indeno[1,2,3-cd]pyrene	0.85	UCL	0.15 (EPA SL)	Yes
Phenanthrene	2.65	UCL	NA	Yes
Chlordane	20.6	UCL	2 (CREG)	Yes
Dieldrin	0.13	Maximum ^b	0.042 (NJRDCSCC)	Yes
PCBs (Aroclor 1260)	0.72	Maximum ^b	0.4 (CREG)	Yes
Antimony	11.7	UCL	14 (NJRDCSCC)	No
Arsenic	59.2	UCL	0.5 (CREG)	Yes
Cadmium	2.94	UCL	1 (NJRDCSCC)	Yes
Chromium	177	UCL	200 (RMEG ^h)	No
Copper	402	UCL	500 (EMEG ⁱ)	No
Lead	1,469	UCL	400 (NJRDCSCC)	Yes
Nickel	140	UCL	250 (NJRDCSCC)	No
Zinc	1,636	UCL	1,500 (NJRDCSCC)	Yes

^aContaminant of Concern; ^bMaximum/mean was used due to low no. of detected samples; ^cUSEPA Screening Levels; ^d95% Upper Confidence Limit; ^eNot Available; ^fCancer Risk Evaluation Guide; ^gNew Jersey Residential Direct Contact Soil Cleanup Criteria; ^hReference Media Evaluation Guide; ⁱEnvironmental Media Evaluation Guide

Table 3: Comparison of Calculated Exposure Doses with Non-Cancer Health Guideline CV based on contaminant concentrations in soil at the Fifth District Park Site

Contaminants of Concern	Exposure Point Concentration (mg/kg)	Estimated Exposure Dose (mg/kg/day)		Health Guideline CVs ^c (mg/kg/day)	Potential for Non-cancer Health Effects
		Child ^a	Adult ^b		
Trichloroethylene	9.13	2.9E-05	1.4E-05	3.0E-04	No
Acenaphthylene	0.44	1.4E-06	6.7E-07	NA	No
Benzo[a]anthracene	1.44	4.5E-06	2.2E-06	NA	No
Benzo[a]pyrene	1.31	4.1E-06	2.0E-06	NA	No
Benzo[b]fluoranthene	1.46	4.6E-06	2.2E-06	NA	No
Benzo[g,h,i]perylene	1.00	3.2E-06	1.5E-06	NA	No
Dibenz[a,h]anthracene	0.79	2.5E-06	1.2E-06	NA	No
Dibenzofuran	0.48	1.5E-06	7.3E-07	NA	No
Indeno[1,2,3-cd]pyrene	0.85	2.7E-06	1.3E-06	NA	No
Phenanthrene	2.65	8.4E-06	4.1E-06	NA	No
Chlordane	20.6	6.5E-05	3.2E-05	6.0E-04	No
Dieldrin	0.13	4.1E-07	2.0E-07	5.0E-05	No
PCBs (Aroclor 1260)	0.72	2.3E-06	1.1E-06	2.0E-05	No
Arsenic	59.2	1.9E-04	9.1E-05	3.0E-04	No
Cadmium	2.94	9.3E-06	4.5E-06	2.0E-04	No
Lead	1,469	4.6E-03	2.2E-03	NA	Yes
Zinc	1,636	5.2E-03	2.5E-03	3.0E-01	No

^aChild exposure scenario: 5 days/week, 9 month/year, 200 mg/day ingestion rate and 21 kg body weight; ^bAdult exposure scenario: 5 days/week, 9 month/year, 100 mg/day ingestion rate and 70 kg body weight; ^cComparison Value; ^dNot Available

Table 4: Calculated LECR associated with the contaminants detected in the site surface soil at the Fifth District Park Site

Contaminants of Concern	Exposure Point Conc. (mg/kg)	USEPA ^a Cancer Class	Potency Factor ^b	BaP Equiv. (mg/kg)	Total BaP Equiv. (mg/kg)	Exposure Dose ^c (mg/kg/day)	Cancer Slope Factor (mg/kg/d) ⁻¹	LECR ^d
Trichloroethylene	9.13	B2	NA ^e	NA	NA	2.9E-06	0.4	1.0E-06
Acenaphthylene	0.44	D	0.001	0.00044	5.65	1.9E-06	7.3	1.0E-05
Benzo[a]anthracene	1.44	B2	0.1	0.144				
Benzo[a]pyrene	1.31	B2	1	1.31				
Benzo[b]fluoranthene	1.46	B2	0.1	0.146				
Benzo[g,h,i]perylene	1.00	D	0.1	0.01				
Dibenz[a,h]anthracene	0.79	B2	5	3.95				
Dibenzofuran	0.48	D	NA	NA				
Indeno[1,2,3-cd]pyrene	0.85	B2	0.1	0.085				
Phenanthrene	2.65	D	NA	0.0027				
Chlordane	20.6	B2	NA	NA				
Dieldrin	0.13	B2	NA	NA	NA	2.6E-08	16	4.0E-07
PCBs (Aroclor 1260)	0.72	B2	NA	NA	NA	1.9E-06	2	1.0E-05
Arsenic	59.2	A	NA	NA	NA	1.9E-05	1.5	3.0E-05
Cadmium	2.94	B1	NA	NA	NA	9.6E-07	NA ^f	NA
Lead	1,469	B2	NA	NA	NA	1.1E-04	NA ^g	NA
Zinc	1,636	D	NA	NA	NA	5.4E-04	NA ^e	NA
Sum=								5.0E-05

^aUSEPA Cancer classification; ^bCancer potency factor relative to benzo[a]pyrene; ^cAdult exposure scenario: 5 days/week, 9 months/year, 100 mg/day ingestion rate, 70 kg body weight and 30 year exposure duration; ^dLifetime Excess Cancer Risk; ^eNot Applicable; ^fLimited epidemiologic studies have indicated that exposure to cadmium in food or drinking water is not carcinogenic; ^gCancer Slope Factor not available for lead.