PUBLIC HEALTH ASSESSMENT MCB CAMP LEJEUNE NC

1/6/1995

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

U.S. MARINE CORPS CAMP LEJEUNE
CAMP LEJEUNE, ONSLOW COUNTY, NORTH CAROLINA
CERCLIS NO. NC6170022580
JANUARY 6, 1995

FEBRUARY 20, 1995

PUBLIC HEALTH ASSESSMENT

U.S. MARINE CORPS CAMP LEJEUNE

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Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Federal Facilities Assessment Branch
Atlanta, Georgia

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment-Public Comment Release was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations 42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate. This document represents the Agency's best efforts, based on currently available information, to fulfill the statutory criteria set out in CERCLA section 104 (i)(6) within a limited timeframe. To the extent possible, it presents an assessment of the potential risks to human health. Actions authorized by CERCLA section 104 (i)(11), or otherwise authorized by CERCLA, may be undertaken to prevent or mitigate human exposure or risks to human health. In addition, ATSDR will utilize this document to determine if follow-up health actions are appropriate at this time.

This document has been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. Where necessary, it has been revised in response to comments or additional relevant information provided by them to ATSDR. This revised document has now been released for a 30 day public comment period. Subsequent to the public comment period, ATSDR will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This will conclude the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

Please address comments regarding this report to:

Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Attn: Chief, Program Evaluation, Records, and Information Services Branch, E-56
1600 Clifton Road, N.E., Atlanta, Georgia 30333

FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, is an agency of the U.S. Public Health Service. It was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The U.S. Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. (The legal definition of a health assessment is included on the inside front cover.) If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists then evaluate whether or not there will be any harmful effects from these exposures. The report focuses on public health, or the health impact on the community as a whole, rather than on individual risks. Again, ATSDR generally makes use of existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further research studies are needed.

Conclusions: The report presents conclusions about the level of health threat, if any, posed by a site and recommends ways to stop or reduce exposure in its public health action plan. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Interactive Process: The health assessment is an interactive process. ATSDR solicits and evaluates information from numerous city, state and federal agencies, the companies responsible for cleaning up the site, and the community. It then shares its conclusions with them. Agencies are asked to respond to an early version of the report to make sure that the data they have provided is accurate and current. When informed of ATSDR's conclusions and recommendations, sometimes the agencies will begin to act on them before the final release of the report.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief
Program Evaluation, Records and Information Services Branch
Agency for Toxic Substances and Disease Registry
1600 Clifton Road (E-56)
Atlanta, Georgia 30333

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SUMMARY

As a result of environmental contamination, the U.S. Marine Corps Base (MCB) Camp Lejeune was listed on the U.S. Environmental Protection Agency's National Priorities List on October 4, 1989. Located in Onslow County, North Carolina near the city of Jacksonville, the base covers a large area, approximately 151,000 acres (about 233 square miles) with 14 miles of beach on the Atlantic Ocean. It is densely populated, with over 43,200 active duty military personnel and 51,656 dependents.

Prior to the current established environmental regulations, previously accepted hazardous material handling and disposal led to environmental contamination at several areas on base. In 1983, the Marine Corps conducted an initial assessment of the potentially contaminated areas. Seventy-six waste disposal sites were identified as potentially contaminated from records reviews and personnel interviews. MCB Camp Lejeune prioritized 22 of those sites for further investigation; some environmental data are available for each of those sites. Base wide environmental investigations have been on going since that time and continues under the Installation Restoration Program.

ATSDR evaluated the environmental information on the 22 sites and identified 8 sites where there was the potential for human exposure. Two exposure situations were evaluated at Site 28. In addition to the environmental data, ATSDR evaluated information on base plumbing as a possible source of lead contamination of drinking water, a common problem in older buildings. We also evaluated data on groundwater contamination where there was past exposure or there is potential for future exposure. Appendix B-2 describes our evaluation of all 22 sites.

HEALTH HAZARDS

We concluded that three situations posed public health hazards. In order of health priority: 1) recent exposure to lead in the tap water in on-base buildings containing lead plumbing; 2) recent and past exposure to pesticides in the soil at Site 2, a former day-care center; and 3) past exposure to volatile organic compounds (VOCs) in the three drinking water systems on base. MCB Camp Lejeune has taken action to stop or reduce exposure in all of these situations.

Lead levels in tap water on base were of immediate health concern. Sampling results, although variable, indicated a widespread problem with lead leaching from faucets or water pipes into drinking water. It is not possible to determine the exact number of people exposed to lead in drinking water or the exact amount of lead they were exposed to because lead levels in tap water are variable, dropping as the water pipes are flushed by running water. Blood lead samples taken from people who live or work in the two buildings containing the highest lead levels were considered within normal range. However, because of the extremely high levels found at some taps, ATSDR recommended exposure be reduced or in some cases stopped. As a result of ATSDR's recommendations, MCB Camp Lejeune took action to reduce lead exposure by educating base employees, residents, and visitors on the importance of flushing the water lines before using them, and stopped exposure by restricting the use of sinks in certain buildings.

Pesticide levels in surface soil at Building 712 at Site 2, a former day-care center, were of health concern. The pesticides of concern were chlordane, DDT, and its breakdown products, DDD and DDE, which have remained in the surface soil since the 1950s when the site was used for pesticide storage and handling. ATSDR recommended MCB Camp Lejeune prevent further pesticide exposure for approximately 20 current office and lawn-care workers. Consequently, MCB Camp Lejeune restricted access to the contaminated soil areas and in 1994 removed the contaminated soil from the parking lot and lawn areas. Each year, from 1966 to 1982, approximately 60 people, including adults and children, attended a day care center located in Building 712. They were also exposed to pesticide-laden soil. Workers and other adults who used the parking lot over time may have inhaled or swallowed enough contaminated soil to increase their risk of developing cancer over their lifetime. However, non-cancerous adverse health effects are unlikely in any of the people exposed.

Volatile Organic Compound (VOC) levels in three base drinking water systems (Tarawa Terrace, Hadnot Point, and Holcomb Boulevard) were of health concern until 1985 when use of contaminated wells stopped. Well contamination was caused from leaks in off-base and on-base underground tanks which were installed in the 1940s and 1950s. Approximately 50,000 base residents and workers were exposed to VOCs during the years that drinking water contamination was documented. VOC levels in drinking water may have been high enough to have caused adverse pregnancy outcomes among women exposed during their pregnancy. However, the adults and children exposed are not expected to experience cancerous or non-cancerous adverse health effects. A study of birth outcomes, in particular of low birth weight, pre-term births, and fetal deaths, should further understanding of the health effects of low-dose VOC exposure. This information will be valuable in determining safe VOC levels since the base's drinking water supply could be affected again by these compounds. We have recommended such a study be done by our agency.

POTENTIAL (INDETERMINATE) HEALTH HAZARDS: MORE DATA NEEDED

ATSDR concluded that three other situations were potential public health hazards. In these situations, more information is required to adequately define the magnitude of the health threat.

Groundwater contamination on base is considered a potential health hazard. Although 14 wells have been closed because of groundwater contamination with VOCs and fuels, 68 more wells are still in operation on-base and are susceptible to contamination. We estimate that future exposures could be, as they were in the past, at levels high enough to cause health concern. The contamination from the underground fuel tanks and other sources have not been completely defined and we strongly recommend that the full extent of contamination be charted by further sampling. Additionally, we recommend that MCB continue to monitor water from the distribution systems quarterly and supply wells no less than semi-annually to ensure the safety of the base drinking water supply.

Possible fish and shellfish contamination in the New River is a potential health hazard because surface water and sediments were found to be contaminated. Of greatest concern, was the detection of low levels of mercury in sediments near Site 48, Mercury Dump Site. Other sources of contamination may come from surface water runoff into creeks, streams, and tributaries on base, which then flow into the New River. Additionally, groundwater recharges the New River along the river's entire length. Contaminated groundwater may contribute to contamination found in the river. Because the New River is used as a popular fishing area, we recommend that adequate fish and shellfish analysis be conducted to determine if people consuming seafood from the New River are being exposed to hazardous chemicals at levels that pose a health hazard.

Physical hazards and possible soil contamination at Site 43 - Agan Street Dump present a potential health hazard because rusted tanks and various other metallic debris pose physical hazards to children from the nearby housing area who readily have access to the site. Additionally, the site contains possible soil contamination that may pose a health hazard to people who come in contact with the contaminated soil.

NO APPARENT HEALTH HAZARDS

ATSDR concluded that two other situations were no apparent public health hazards. In both situations, people are using these areas and contamination could be present from past disposal practices. However, in these situations, certain conditions exist (e.g., the area was covered with clean fill, contaminant concentrations would be diluted, etc.) that make it unlikely people would be exposed to contaminants at levels that would be of health concern.

Fish contamination in Wallace and Bear Head Creeks presents a no apparent health hazard because our preliminary review of the survey data indicates that contaminant levels in edible-size fish do not appear to be at levels of health concern. ATSDR recently received the Supplemental Aquatic Survey for Wallace and Bear Head Creeks. Even though survey data indicate that fish in Wallace and Bear Head Creeks contain low levels of polychlorinated biphenyls (PCBs), pesticides, and VOCs, the levels are much lower than levels which cause adverse health effects. However, we stress that this conclusion is based on a preliminary review of the data. The final release of this public health assessment will include results of our complete evaluation of this data. Sites 6, 9, and 82 are considered possible sources of contamination of the creeks.

Soil contamination at Site 69 - Rifle Range Chemical Dump is considered a no apparent health hazard because the hazardous substances deposited here were buried and all waste was covered with clean fill dirt; therefore, it is unlikely that contaminated soil could migrate from this site. Additionally, a fence surrounding the site prevents people from readily accessing the site.

NO HEALTH HAZARDS

ATSDR concluded that two other situations at the same site were not health hazards because no contamination was detected in the media.

Suspected soil contamination at Site 28 - Orde Recreational Area, previously known as Site 28 - Hadnot Point Burn Dump is considered a no apparent health hazard because ashes from the burn area were covered with a tremendous volume of clean fill dirt (between 185,000 and 379,000 cubic yards) when the site was closed in 1971. MCB Camp Lejeune's Remedial Investigation indicate that surface soil in the playground and picnic areas are not contaminated. ATSDR will review the recently received sampling results and include our complete evaluation in the final release of this public health assessment.

Suspected fish contamination at Site 28 - Orde Recreational Area presents no health hazard. In reviewing a past environmental sampling document, ATSDR had concerns about reported results from the 1984 fish sampling. In response to ATSDR concerns, MCB Camp Lejeune expedited its fish sampling by 5 months. Preliminary results from 1994 fish sampling in Orde Pond (part of Site 28) indicate that fish are not contaminated, so eating them does not pose a health hazard.

INTRODUCTION

This report is organized by exposure situations. These situations are discussed in the order of their public health importance. The exposure situations and the sites at which they occurred are listed below. The term *site* is used to describe a distinct area to which MCB Camp Lejeune has assigned a reference number. *Exposure situation* is used to describe conditions and circumstances by which people could come in contact with contaminants.

In preparing this public health assessment, ATSDR relied on the information provided in the referenced documents. Some references used to develop this public health assessment were MCB Camp Lejeune's preliminary documents that were undergoing Navy, EPA, and state review. ATSDR assumes that adequate quality assurance and quality control measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The validity of the analyses and conclusions drawn for this public health assessment are determined by the availability and reliability of the referenced information. Data about which ATSDR had concerns are noted in the discussion for that situation.

During the environmental investigations at MCB Camp Lejeune, base personnel identified 76 sites from old documents and interviews with past and current employees. Environmental sampling was conducted at 22 of those sites where there was strong evidence to suggest environmental contamination. No sampling data exists for the other sites. ATSDR reviewed the available data on these 22 sites. From this data and from the information gathered during our site visits and from our visual inspections, we identified 8 different sites which had the potential for human exposure (Sites 2, 48, 6, 9, 82, 43, 69, and 28). See Figure 1. Additionally, exposure was identified from the following situations which are not related to a specific site; lead in tap water and volatile organic compounds in tap water. Appendix B-2 describes our evaluation of all 22 sites. The body of the report discusses the 10 exposure situations we identified and evaluated.

CONCLUSION CATEGORY	SITUATIONS / SITES
Public Health Hazards	Lead Exposure (Tap Water) Pesticide Exposure (Soil at Site 2) Volatile Organic Compound Exposure (Tap Water)
Potential Health Hazards	Groundwater Contamination (Base wide) Potential Fish and Shellfish Contamination (New River - Site 48) Physical Hazards and Possible Soil Contamination (Site 43)
No Apparent Health Hazards	Fish Contamination (Sites 6,9, and 82) Soil Contamination (Site 69)
No Health Hazard	Suspected Soil Contamination (Site 28) Suspected Fish Contamination (Site 28)

BACKGROUND

SITE DESCRIPTION / HISTORY / DEMOGRAPHICS / LAND USE AND NATURAL RESOURCES USE

MCB Camp Lejeune covers a large area; approximately 233 square miles (151,000 acres) in Onslow County, North Carolina, bordering the Atlantic Ocean on the southeast. MCB Camp Lejeune consists of two major geographical regions divided by the New River: Mainside is east of the New River; Marine Corps Air Station New River (MCAS) is west of it.

Currently, there are six major Marine Corps commands and two Navy commands which include reconnaissance, intelligence, infantry, artillery, and amphibious units. Camp Lejeune also operates training schools for infantry, engineers, service support, and medical support. Additionally, Marine Corps Air Station New River consists of helicopter and Marine Aircraft groups. Although the MCAS is a separate command, the real estate it occupies is owned by the Marine Corps Base. Camp Lejeune also operates the Naval Hospital and Naval Dental Center which provide primary medical and dental care to 110,000 marines, sailors, and their families (1).

MCB Camp Lejeune is a densely populated base with over 43,200 active duty military personnel stationed there in January, 1990, with 51,656 dependents. The base has a relatively young population with 63% of the 30,764 military personnel and dependents living on the base between the ages of 15 and 24 while only 1% of the population is age 60 or over. Over 75% of the population is male (2). Base housing consists of barracks for unmarried service personnel (enlisted and officer), enlisted family housing, and officer family housing in many areas throughout Mainside and MCAS.

The city of Jacksonville, which is adjacent to the northern edge of the base, has a current population of approximately 31,000. This is an 80% increase from the 1990 population of just over 17,000 people. Jacksonville's 1990 population consisted of 80.1% whites, 16.4% blacks, and 2.8% were of Hispanic origin. Approximately 9% of the 1990 population were under age 5, with greater than 8% at age 60 and over. The percentage of families in Jacksonville with incomes below poverty level in 1979 was 14.8%, nearly the same as the state percentage of 14.5%.

Onslow County has a current population of approximately 131,000 people. The county population grew by 12.2% from 1980 to 1986, in spite of a net loss of 2,600 people through migration (i.e., more people moved away than moved in). There were approximately 19,400 births and only 3,000 deaths in the county during this period. This accounts for the entire population increase. These figures reflect the unusually high percentage of young couples in their childbearing years typically found residing at major military bases. Only about half of those who lived in the county in 1975 still lived there in 1980, a trend which is indicative of the transient nature of military populations. There were approximately 145 males for every 100 females in Onslow County in 1984. This high ratio is also typical of the areas around military bases.

Environmental contamination has occurred at many areas on base since MCB Camp Lejeune began operation in 1942 because of the use, handling, and disposal of hazardous chemicals. The potential for human contact with contamination is great because of the large number of people on base and the number of suspected contaminated areas scattered within the industrial, training, and near residential areas on base.

In 1983, the Marine Corps began an initial assessment of the potentially contaminated areas. Seventy-six waste disposal sites, as listed in Appendix B-1, were identified as potentially contaminated. MCB Camp Lejeune prioritized 22 of those sites and grouped them into operable units (shown in Appendix B-2) for further investigation; some environmental data are available for each of the 22 sites (3). Base wide environmental investigations have been ongoing since that time and continue under the Installation Restoration Program. As a result of environmental contamination, the base was listed on the U.S. Environmental Protection Agency's National Priorities List (NPL) in October 1989.

After entering into a Memorandum of Understanding with the Department of Defense (DoD) in 1991, ATSDR visited the 96 DoD installations then on the NPL and ranked them according to their potential public health hazard. ATSDR ranking took into account the extent of contamination, the potential for people to come in contact with site contaminants, and the number and plausibility of community health concerns. On those criteria, MCB Camp Lejeune received a high priority ranking for a public health assessment as compared with other NPL sites. To evaluate the public health impact that exposures to environmental contamination at MCB Camp Lejeune might have on people, ATSDR conducted four site visits to MCB Camp Lejeune. During those site visits, we reviewed sampling plans, met with base personnel, citizens in the community, and visually evaluated site conditions.

This report, as previously mentioned, focuses on the 10 identified exposure situations. It also includes our conclusions on all the 22 prioritized sites (Appendix B-2) from which environmental sampling data was collected.

MCB Camp Lejeune has completed investigations for sites 2, 21, 24, 78, 48, 6, 9, and 82. See Figure 1. Although exposure in the remaining sites is unlikely, we lack the environmental data to conclude definitely that health threats do not exist in these areas. The Marine Corps continues to monitor and characterize environmental contamination and to evaluate options for environmental clean-up in conjunction with federal, state, and local environmental and health agencies. For detailed information on the Marine Corps' continued environmental investigation and remediation plans, refer to MCB Camp Lejeune's documents at the public repositories: Onslow County Public Library and MCB Camp Lejeune Library.

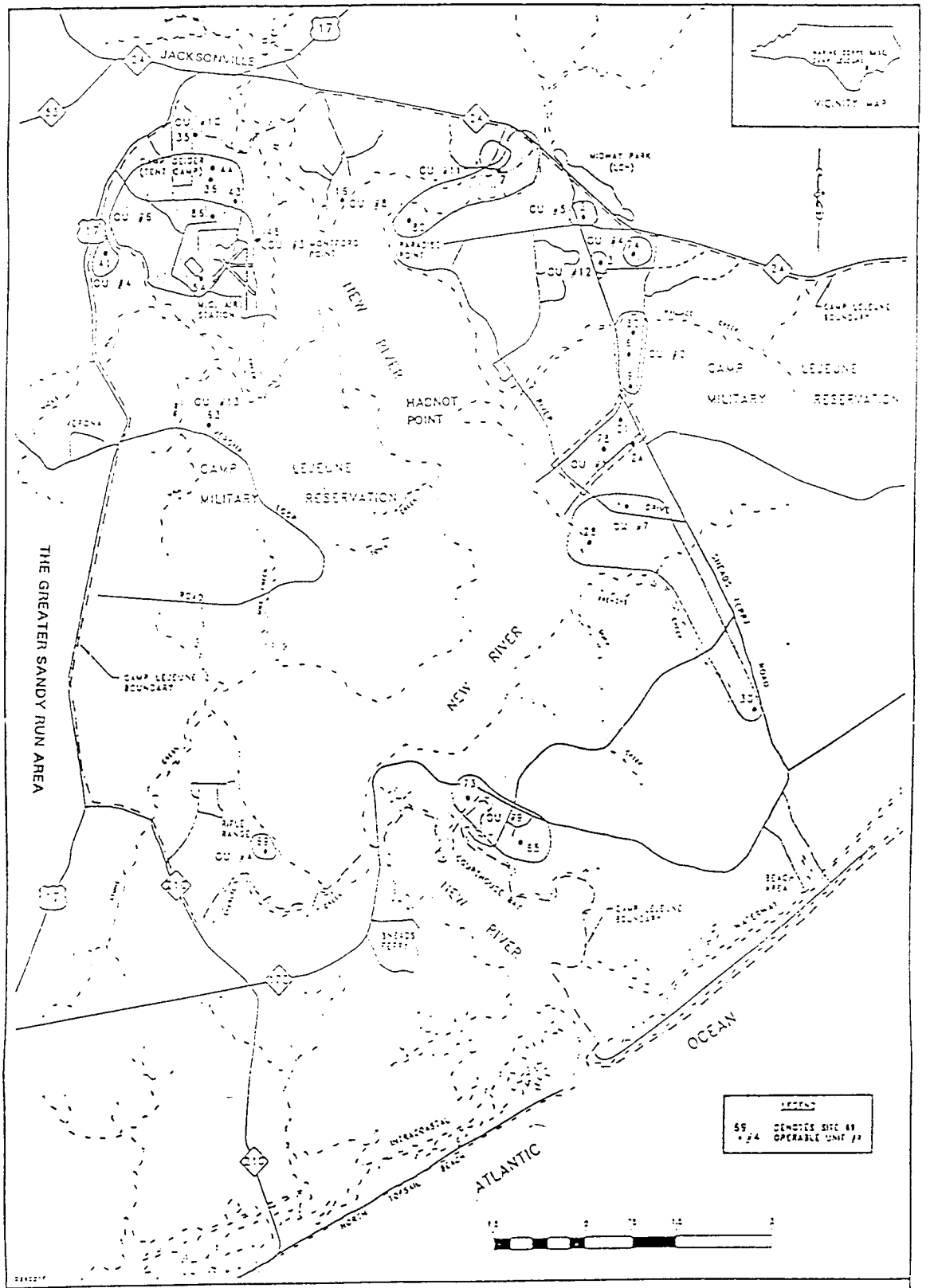

Figure 1
SITE LOCATION MAP
MARINE CORPS BASE, CAMP LEJEUNE

Source: MCB Camp Lejeune received July 1994

ENVIRONMENTAL CONTAMINATION / PATHWAYS ANALYSES / PUBLIC HEALTH IMPLICATIONS

INTRODUCTION

The emphasis in this section will be on the three known past exposure situations that posed public health hazards. Additionally, we describe the three situations we think pose potential public health hazards and include a list of information that we will need in order to make definite conclusions about them. We also briefly describe those four situations we have determined do not pose public health hazards.

ATSDR's public health assessments are exposure, or contact, driven. Chemical contaminants disposed or released into the environment at MCB Camp Lejeune have the potential to cause adverse health effects. However, a release does not always result in exposure. People can only be exposed to a chemical if they come in contact with the chemical. Exposure may occur by breathing, eating, or drinking a substance containing the contaminant or by skin (dermal) contact with a substance containing the contaminant.

The type and severity of health effects that occur in an individual from contact with a contaminant depend on the exposure concentration (how much), the frequency and/or duration of exposure (how long), the route or pathway of exposure (breathing, eating, drinking, or skin contact), and the multiplicity of exposure (combination of contaminants). Once exposure occurs, characteristics such as age, sex, nutritional status, genetics, life style, and health status of the exposed individual influence how the individual absorbs, distributes, metabolizes, and excretes the contaminant. Together these factors and characteristics determine the health effects that may occur as a result of exposure to a contaminant.

ATSDR conducts a review of existing health outcome data (e.g., birth and death certificates, birth defects registries, cancer registries, etc.), when available, if people have been exposed to site contaminants or if the community has concerns related to specific health outcomes.

I. HEALTH HAZARDS - PAST EXPOSURE SITUATIONS

People were exposed to contaminants on base in the following situations, in order of health priority: 1) recent acute exposure to lead in the tap water in on-base buildings containing plumbing with lead solder, 2) recent and past exposure to pesticides in the soil at Site 2 - Former Day Care Center, and 3) past exposure to volatile organic compounds (VOCs) in three drinking water systems on base. MCB Camp Lejeune has taken action to stop or reduce exposure in all of these situations; therefore, they are no longer a public health hazard. Table 1 outlines those cases. None of the exposed populations received combined exposures from any other identified situations.

Table 1 - Health Hazard Situations

PATHWAY NAME	CONTAMINANT	EXPOSURE PATHWAY ELEMENTS					TIME	COMMENTS
		SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION		
1. Lead in Tap Water	Lead	On-Base Lead Plumbing	Drinking Water	Tap Water	Ingestion	Base Workers and Base Residents (Adults)	Past 19??-1993	Tap water sampling survey, in accordance with Lead and Copper Rule, reported for medium-sized systems since December 1992 and for small-sized systems since December 1993. Data separate from Installation Restoration Program.
						Base Residents (Children and Pregnant Women)		
2. Pesticides in Soil at Site 2	Chlordane, DDT, DDE, and DDD	Former Pesticide Storage, Handling, and Dispensing Area	Surface Soil	Lawn	Ingestion, Inhalation, and Skin Absorption	Lawn Care Workers	Past Until 1993	Used for pesticide handling from 1945-1958. Used as day-care for military and civilian employee's dependents from 1966-1982. Currently used as a personnel office.
				Parking Lot		Adult Workers Using Parking Lot	Past Until 1993	
				Parking Lot		Children and Adults Using Parking Lot	Past 1966-1982	
				Surface Soil at Playground		Children Playing in Playground and Day Care Workers	Past 1966-1982	
3a. VOCs in Drinking Water at Hadnot Point	TCE, DCE, Methylene Chloride, and Vinyl Chloride	Leaking Underground Lines and Storage Tanks	Groundwater	Tap Water	Ingestion, Inhalation, and Skin Absorption	Base Workers and Base Residents (Adults)	Past 1982-1985	Leaks from tanks have been reported since operations began in 1940s. Tap water data was first collected in 1982 and contamination was present at that time. Actual exposures may have occurred earlier.
						Base Residents (Children and Pregnant Women)		
3b. VOCs in Drinking Water at Tarawa Terrace	PCE, TCE, and DCE	Leading Tank from Off-base Dry Cleaners	Groundwater	Tap Water	Ingestion, Inhalation, and Skin Absorption	Base Workers and Base Residents (Adults)	Past 1982-1985	Contamination discovered in 1982. Dry cleaner began operating in 1954. Estimated duration of exposure is 3 years when data is available. Actual exposures may have occurred earlier.
						Base Residents (Children and Pregnant Women)		
3c. VOCs in Drinking Water at Holcomb Boulevard	TCE and DCE	Back-up Water Piped in from Hadnot Point	Groundwater	Tap Water	Ingestion, Inhalation, and Skin Absorption	Base Workers and Base Residents (Adults)	Past Two Weeks in 1985	Holcomb Boulevard system was shut down and back up water was piped in from Hadnot Point which unknowingly was also contaminated. Data is only available for water piped from Hadnot Point; therefore, estimated duration of exposure is two weeks.
						Base Residents (Children and Pregnant Women)		

A. Lead Exposure (Tap Water)

Base employees and residents could have been exposed to extremely high levels of lead in tap water in some of the buildings on base. The source of the lead is the plumbing containing lead solder. Testing of 102 adults did not show blood lead levels of health concern, but it is not known if these individuals drank water containing high levels of lead. If people consume water contaminated with lead at levels detected in many of the taps on base, they could absorb enough lead to experience long-term health consequences. Therefore, we recommend that people highly sensitive to the effects of lead, such as children, pregnant women, and women considering pregnancy not drink water from taps where lead is ever detected at 15 parts per billion (ppb) or higher. We also recommend that other adults should not drink water containing lead above 50 ppb. Furthermore, everyone on base should try to reduce their exposure to lead by flushing water lines before using them. MCB Camp Lejeune has taken action on all three of these recommendations. (See Summary and Follow-up of this section.)

What is lead?
Lead is a naturally occurring, bluish-gray metal found in small amounts of the earth's surface. It is often used in batteries, pipes, brass, solder, and paints. The amount and wide-range use of lead has decreased over the last several years because of the harmful neurotoxic effects of lead in people. Lead can get into drinking water several different ways, including corrosion of lead piping, lead-based solder, and brass water faucets.

Lead Sampling

During 1992, in accordance with EPA's Lead and Copper Rule, MCB Camp Lejeune began regularly testing the tap water on base for lead and copper (4). The findings we discuss here are based on three sampling rounds for the major drinking water systems (serving 10,001 - 50,000 people) on base, Holcomb Boulevard, Hadnot Point and MCAS-New River, beginning in July 1992. Sampling for the minor drinking water systems (serving 501 - 3,300 people), Courthouse Bay, Rifle Range, and Onslow Beach, began in December 1993. Our findings are based on one sampling round for those systems. From 1992 to 1993, we have received sampling data from 260 different faucets or 560 samples.

The base is carrying out all the procedures required by the Lead and Copper Rule, i.e., regularly sampling tap water (every six months) and developing a water treatment plan to reduce lead and bring the base systems into compliance with EPA's established action levels of 15 ppb for lead and 1300 ppb for copper (5).

How Can I Reduce My Exposure To Lead In Tap Water?
Since you cannot see, taste, or smell lead in your drinking water, it is important to perform these precautionary steps.

1) Let the water run from the tap for 30 seconds to 2 minutes before using it for drinking or cooking. Water that has sat in the pipes more than 4 hours should be flushed for 3-5 minutes, and

2) Use cold water even for cooking or making infant formula because water from the hot water tap dissolves lead more quickly.

For additional information see Appendix C-6

The sampling priority scheme established by EPA concentrates on buildings which had copper pipes and lead-containing solder installed between 1983 and 1987 because the solder used during that time was more apt to leach lead into the tap water (5). MCB Camp Lejeune conducted a materials evaluation of records kept for each building on base. They found no buildings with lead piping, but for all the drinking water systems, they did find buildings with copper piping and lead-containing solder. The base's sampling plan, in accordance with EPA regulations, concentrated on those buildings and focused on single family homes, where the population at greatest health risk lives (4). Lead was detected in tap water samples from buildings on each of the water systems. Appendix C shows a summary of the lead levels detected at specific taps within each distribution system. No lead or copper were detected in any of the water plants, which indicated that the source of the contamination in each system was the plumbing (4). We reviewed the tap water sampling data for potential health hazards. Copper levels did not pose a health concern.

Lead levels were consistently low in nearly all the single family homes tested. The tap water in two houses tested above the EPA action level of 15 ppb (levels were 52, and 60 ppb). One elevated level was detected in the second testing round and the other in the third round. Lead levels were not elevated in the first sampling round. All schools and day care centers were sampled for lead and copper. None were found to be above EPA action levels (6).

The lead levels from the other buildings sampled on base fluctuated tremendously with each sampling and ranged from less than 2 ppb (lower limit of detection) to 10,100 ppb. The highest level, 10,100 ppb was much higher than the next highest concentration of 2720 ppb and possibly could be a piece of lead solder that broke away from the pipe and was collected in the sampling bottle. Even though the 10,100 ppb may be a rare case, many faucets (11.5%) contained lead at extremely high levels, above 200 ppb.

Although water from a high percentage of "deep sink" faucets tested showed elevated lead levels, extremely high lead levels detected in one sampling round were often not detected in a subsequent sample from the same tap. The reasons for the inconsistency are not clear. However, the levels detected in many samples throughout the base, which ranged from 16 ppb to 10,100 ppb, were of immediate health concern.

Human Exposure Routes and Public Health Implications

ATSDR has identified these specific areas where people were being exposed: 1) residents of two single-family homes (approximately 12 individuals including adults and children), 2) residents of multifamily buildings and bachelor enlisted quarters, (approximately 10,000 individuals), and 3) workers exposed to lead at various office buildings on base (approximately 15,000 individuals).

In response to ATSDR's concern, the base tested the blood lead levels of 102 adults from two buildings, a barracks and an office building, where the highest lead levels were detected in tap water. Appendix C-6 lists the specific blood lead level sampling results. Ninety-nine out of 102 blood lead levels were within the expected national average range for adults (7,8). Three individuals had only slightly elevated blood lead levels at 10, 11, 12 ug/dL respectively (9). No adverse health effects associated with these blood lead levels are expected to occur in these three adults. However, there is no information on whether or not individuals who had their blood lead tested drank water from those taps containing high lead levels. Therefore, the blood sampling results are inconclusive because they do not provide a correlation between people drinking lead contaminated water and blood lead levels. For this reason, we must interpret the blood lead data cautiously and have recommended that individuals not drink water from taps containing high lead levels. Our recommendations are based on the known health risks posed by lead, particularly at the very high levels detected intermittently in some of the taps at MCB Camp Lejeune.

Because lead levels at MCB Camp Lejeune fluctuated above and below the action level of 15 ppb (less than 2 ppb to 10,100 ppb) and some of these lead levels were extremely high, two aspects of lead exposure are of concern. One is exposure, even once, to extremely high levels of lead. The second is intermittent exposure to even moderate levels of lead over an extended period of time, e.g., more than a year. Under both of these exposure conditions, people can absorb enough lead to raise their body burden of lead to levels that could pose health problems. People swallowing lead contaminated water at the highest concentrations detected (1000 to 10,100 ppb) can experience acute effects, such as nausea and vomiting, but they can also absorb enough lead to cause serious long-term adverse health effects (20).

In order to evaluate the likelihood of adverse health effects in people at MCB Camp Lejeune who drink lead contaminated water, we reviewed the available scientific information. Studies of lead's health effects on people are based on blood lead levels, a measure of the amount of lead absorbed by the body, not the amount of lead detected in water or some other medium. Blood lead is measured in micrograms per deciliter (μg/dL). Several studies have analyzed the correlation between lead levels in drinking water and resulting blood lead levels in infants, older children, and adults (10-18).

ATSDR used these mathematical factors for estimating the likelihood of adverse health effects in people at MCB Camp Lejeune who drink lead contaminated water. Based on these calculations, people drinking water containing lead at levels above 50 ppb, could absorb enough lead to experience long-term health consequences. Moreover, people highly sensitive to the effects of lead, particularly children, infants, and fetuses, could experience irreversible adverse health effects such as decreased IQ (intelligent quotient) and compromised mental development (19).

The health effects of lead are not immediately apparent. Once in the blood, lead is distributed to soft tissue (kidneys, bone marrow, liver, and brain) and mineralizing tissue (bones and teeth). Bones and teeth contain about 95% of the total body burden of lead in adults (20).

It is the total body burden of lead that is related to the risk of adverse health effects. Because the body accumulates lead over a lifetime and releases it slowly, even small doses of lead over time can cause lead poisoning. Further, relatively low blood lead levels can cause adverse health effects, some of which, like decreased IQ or mild behavioral disorders, may not produce noticeable signs or symptoms.

Exposure to high levels of lead can damage the brain, red blood cells, and kidneys of adults at blood lead levels ranging from 40 - 100 μg/dL and children at blood lead levels of 35 - 50 μg/dL. Acute effects of exposure to high lead levels are nausea, vomiting, and headache. Lead exposure in adults may increase blood pressure. High levels of blood lead (40 μg/dL) may affect sperm or damage other parts of the male reproductive system, making it difficult for a couple to have children (20).

Fetuses and children are especially sensitive to the effects of lead. Additionally, when women are pregnant, lead stored in their bone can enter their blood stream increasing the amount of lead reaching the fetus, resulting in premature birth, low birth weight, and decreased mental ability. In infants and young children, lead exposure has been shown to decrease intelligence, slow growth, and cause hearing problems at blood lead levels at or below 10 μg/dL, a level previously thought to be safe. These effects can persist as children get older and interfere with successful performance in school (19).

Summary and Follow-up

Lead was detected throughout the drinking water systems of MCB Camp Lejeune but the data were inconsistent, with lead levels fluctuating above and below the EPA action level. Given the very wide range of lead levels detected in the tap water and the inconclusiveness of the blood lead sampling, ATSDR made the following recommendations to protect the health of base personnel, residents, and visitors: 1) stop exposure of personnel, residents and visitors at taps that showed elevated lead results; 2) educate all MCB Camp Lejeune employees, residents, and visitors about how to reduce their lead exposure (i.e., by flushing taps). As a result of ATSDR's recommendations, MCB Camp Lejeune: posted "DO NOT DRINK" signs at deep sink faucets base wide to stop people from drinking water from those faucets because they seem to release more lead than other faucets, posted signs at faucets where water samples show lead levels above 50 ppb, and installed filters on water lines to stop residents of single family homes from drinking water from faucets that show lead levels above 15 ppb. In addition to the educational efforts carried out by MCB Camp Lejeune, ATSDR provided a pamphlet (included as Appendix C-7) for MCB to distribute to the base community (personnel, residents, and visitors). In general we recommend that pregnant women and children not drink water containing lead at levels

greater than 15 ppb, and adults not drink water containing lead at levels above 50 ppb (21). MCB Camp Lejeune has already implemented all of these recommendations and continues to educate new base employees, residents, and visitors. The base also continues to monitor lead levels in drinking water base wide (24). Additional follow-up health actions may be proposed at a later time.

Because lead levels at MCB Camp Lejeune fluctuated above and below the action level of 15 ppb (less than 2 ppb to 10,100 ppb) and some of these lead levels were extremely high, we could not evaluate the likelihood of adverse health effects in people who drank tap water. People who drank lead contaminated water at the highest concentrations detected (1000 to 10,100 ppb) would have experienced acute effects, such as nausea and vomiting. Because these people could absorb enough lead to cause serious long-term adverse health effects, they can contact their physician for a blood lead screening or follow-up evaluation.

The health outcome data collected to address this exposure were obtained from the Naval Hospital at MCB Camp Lejeune. Blood lead levels were collected from 102 individuals who may have been exposed to lead in drinking water from the two buildings that had the highest detected lead levels. Only three individuals had blood lead levels slightly above the national average for adults. However, there is no information on whether or not individuals drank water from taps with elevated lead levels. Therefore, ATSDR has recommended that exposure cease in all buildings showing lead levels above 50 ppb.

Additional health outcome data was collected regarding elevated blood lead levels in children of military personnel at MCB Camp Lejeune. All children of Camp Lejeune personnel are required to have their blood lead levels tested on their first birthday and again annually after that. Seven children who were tested in 1993 had blood lead levels above the Centers for Disease Control and Prevention's (CDC) maximum recommended level of 10 μg/dL for children. MCB Camp Lejeune conducted investigations to determine the possible source of the lead to which the children may have been exposed. Tap water from all base schools, day care centers, and single family residences was tested. Lead paint in the homes of these children was determined to be the source of the lead. Lead paint abatement programs have been initiated by the base. One child was treated for lead poisoning as a result of his exposure to lead paint.

Conclusion and Public Health Action Plan for Lead Exposure (Tap Water)

Conclusion:

Even though MCB Camp Lejeune was following all current EPA regulations for the Lead and Copper Rule, the concentrations of lead detected at drinking water taps collected in 1992-1993 in several buildings on base were of immediate health concern. People drinking lead-contaminated tap water may have absorbed enough lead to experience acute or long-term adverse health effects.

Completed Actions:

1. MCB Camp Lejeune placed notices in the base newspaper and posted educational material to notify people of possible lead in drinking water.

2. In response to ATSDR's concerns, MCB Camp Lejeune sampled blood lead levels in workers and residents of the two buildings on base that had the highest lead levels detected in the tap water. Although no elevated blood lead levels were found, no information is available on whether the individuals tested drank from the water taps containing high lead levels.

3. Based on ATSDR recommendations, MCB Camp Lejeune took further action to stop exposure by restricting the use of taps in certain buildings. Additionally, ATSDR developed a flyer addressing frequently asked questions and ways to reduce lead exposure. MCB Camp Lejeune distributed the flyer to all employees, residents, and visitors.

4. As a result of ATSDR's recommendation, MCB Camp Lejeune continues to provide educational material to all base employees, residents, and visitors on ways people can reduce their lead exposure from drinking water.

5. MCB Camp Lejeune continues to monitor lead levels in base drinking water. Additionally, they are proceeding with corrosion control demonstration studies and confirmation testing.

6. As a result of ATSDR's recommendation, MCB Camp Lejeune posted "DO NOT DRINK" signs at deep sink faucets base wide to stop people from drinking water from those faucets because they seem to release more lead than other faucets. To prevent people from drinking contaminated water, the base has also posted signs at faucets where water samples show lead levels above 50 ppb.

7. As a result of ATSDR's recommendation, MCB Camp Lejeune installed filters on water lines to stop residents of single family homes from drinking water from faucets that show lead levels above 15 ppb. Additionally, they replaced the water lines in several homes.

Planned Action:

ATSDR's Division of Health Education plans to review the educational efforts to date and talk with MCB Camp Lejeune officials to determine if additional education is needed. If a determination is made for additional education, ATSDR will work in cooperation with MCB Camp Lejeune to provide the needed education.*

Recommended Action:

If future water samples show lead levels that exceed 15 ppb, women and children should be promptly advised not to drink water from those faucets. Adults should be advised not to drink water from any faucet where lead exceeds 50 ppb.

* This is an ATSDR Health Activities Recommendation Panel statement for follow-up health action. This intra-agency panel reviews and approves recommendations for further actions.

B. Pesticide Exposure (Site 2)

The soil around Building 712 at Site 2 was contaminated with the pesticides chlordane and DDT and its breakdown products, DDD and DDE. At different times over the years, people working or playing on the surrounding grounds were exposed to different concentrations of these pesticides in surface soil from the parking lot, lawn, or playground. People exposed to contaminated soil include office workers, lawn care workers, children, and adults who used the parking lot. Those exposures were estimated to be high enough to increase the lifetime risk for cancer in office workers, but non-cancerous adverse health effects are not likely. Lawn care workers and other adults are not expected to have non-cancerous or cancerous effects as a result of their exposure to the pesticides at this site. However, because of the limited scientific information available on adverse effects in children exposed to pesticides, ATSDR was not able to adequately address the likelihood of either cancerous or non-cancerous adverse health effects in them. All exposures were stopped in 1993 when access to the contaminated areas were physically restricted. Additionally, contaminated soil was removed in October, 1994. ATSDR recommended that people most recently exposed to pesticide contaminated soils be informed of their exposure. Table 2 outlines the pesticide exposure situations.

What is DDT?

From 1946 to 1972, DDT (dichlorodiphenyltrichlorethane) was one of the most widely used man-made insecticides in the world. On January 1, 1973, all uses of DDT in the U.S. and Canada were banned. DDT is still used in Mexico and many tropical countries. DDT does not readily dissolve in water, but instead binds tightly to the soil. Breakdown of DDT is very slow resulting in its persistence in the environment. In the presence of oxygen, DDT breaks down to form DDE, and in the absence of oxygen, DDD is formed. The major health concern with DDT exposure is possible increased risk of developing cancer.

Site 2 - History and Use

Building 712 is located in the northeastern portion of MCB Camp Lejeune just off Holcomb Boulevard (Figure 1). From 1945 through 1958, the building was used as a pesticide storehouse and as an office for the pesticide workers. Two outside concrete pads, level with ground surface, were used as platforms for mixing pesticides and washing pesticide containers. These pads and the surrounding soils contain the highest level of contamination. In 1958, pesticide handling was relocated to a different area on base and building 712 remained unused until 1966 (3). There is no record that building 712 was ever decontaminated. The surrounding grounds were not decontaminated until 1994 when the contaminated soil was removed from the parking lot and lawn areas (22,23).

What is chlordane?

Chlordane is a man-made pesticide used in the United States from 1948-1988 primarily to control termites. It was used in agriculture until 1978. Chlordane is a mixture of many chemicals; e.g., cis-chlordane, trans-chlordane, B-chlordane, heptachlor, and trans-nonachlor. Chlordane does not dissolve in water and readily binds to soil. Limited information is available on how chlordane degrades in soil, but the degradation process is slow, resulting in chlordane's persistence in the environment. The major health concern with chlordane exposure is possible increased risk of developing cancer.

Table 2 - Potential Health Effects for Pesticide Exposures at Site 2

Exposed Population	Exposure Timeframe	Exposure Activity	Surface Soil Contaminant		Maximum Estimated Exposure Dose (mg/kg/day)	Potential Health Effects	
			Chemical	Concentration Range (ppm)		Non-cancer Effects	Cancer Risk Increase†
1. Workers (Adults)	Recent Past 1989-1993	Swallowing contaminated dust stirred up when parking cars in the parking lot	Chlordane	ND - 0.310	0.000000	Not Likely	No
			DDD	5.7 - 1,200	0.001714	Not Likely	Yes
			DDE	0.93 - 30.0	0.000043	Not Likely	No
			DDT	2.10 - 930	0.001329	Not Likely	Yes
2. Lawn care workers (Adults)	Recent Past 1989-1993	Swallowing contaminated dust stirred up during lawn mowing	Chlordane	ND - 7.4	0.000001	Not Likely	No
			DDD	ND - 1,200	0.000154	Not Likely	No
			DDE	ND - 30.0	0.000004	Not Likely	No
			DDT	ND - 3,000	0.000386	Not Likely	No
3a. Children	Past 1966-1982	Swallowing contaminated dust stirred up by cars being parked in the parking lot	Chlordane	0.06 - 45.7	0.000286	Unknown	Unknown
			DDD	0.100 - 644	0.004025	Unknown	Unknown
			DDE	0.02 - 68.7	0.000429	Unknown	Unknown
			DDT	0.061 - 7,500	0.046875	Unknown	Unknown
3b. Workers (Adults)	Past 1966-1982	Swallowing contaminated dust stirred up when parking cars in the parking lot	Chlordane	0.06 - 45.7	0.000065	Not Likely	No
			DDD	0.100 - 644	0.000920	Not Likely	No
			DDE	0.02 - 68.7	0.000098	Not Likely	No
			DDT	0.061 - 7,500	0.010714	Not Likely	Yes
4a. Children (Pica)	Past 1966-1982	Swallowing and skin contact with contaminated surface soil while playing in the playground	Chlordane	< 0.10 - 0.390	0.000122	Unknown	Unknown
			DDT	0.030 - 6.7	0.002094	Unknown	Unknown
4b. Children (Non-pica)	Past 1966-1982	Swallowing and skin contact with contaminated surface soil while playing in the playground	Chlordane	< 0.10 - 0.390	0.000005	Not Likely	Unknown
			DDT	0.030 - 6.7	0.000084	Not Likely	Unknown

† - Increased cancer risk is based on $\geq 5.5 \times 10^{-5}$.
Values for children's cancer risk are reported here as unknown because generalizing cancer risk calculation for children is strongly questioned among the scientific community. Appendix D-1 contains the assumptions used in estimating dose and cancer risk.

In 1966, building 712 was opened as a day care facility for the children of MCB Camp Lejeune employees. The day care center had an enrollment of approximately 45 children ranging in age from 6 weeks to 12 years; the majority were about 5 years old (25). The children's playground area was fenced and approximately 100 feet from the old concrete wash pad. A gravel parking lot is located at the rear of the building. The old concrete mix pad was adjacent to the parking lot and cars could actually park on the concrete pad.

In 1982, during environmental contamination investigations at MCB Camp Lejeune, pesticides in surface soil were detected at several locations around the building, i.e., near the mix and wash pads, in the lawn area, in the parking lot, in the day care playground area, and in the drainage ditch (3). Figure 2 diagrams those locations at Site 2. The pesticides detected (DDT and chlordane) are not water soluble. They bind tightly to soil particles and are not easily washed away from the soil. Therefore, movement of pesticides from the immediate area where they were released is not expected. However, migration of the soil particles from erosion due to heavy rains or winds may explain the presence of pesticides in the adjacent drainage ditch.

In June 1982, after environmental contamination was detected, the Marine Corps relocated the day care center to another area on base (26). Presently, building 712 is used as a personnel office and has one part-time and fifteen full-time employees (27). The area previously used as a playground is now covered with grass. Exposures were stopped in December 1993 when MCB Camp Lejeune installed a fence and posted signs in the lawn and parking lot warning people not to enter the contaminated areas (28). In 1994, the concrete pads and contaminated soil from the parking lot and lawn areas were removed (22,23). The parking lot was backfilled with clean gravel. The lawn was backfilled with clean soil and seeded with grass.

Human Exposure Routes and Public Health Implications

Exposures to pesticide at Building 712 stopped in December 1993, so the discussion here is for estimates of past, not current, exposure. ATSDR identified four groups of people who were exposed to pesticide-laden soil. In the recent past, 1) office workers were exposed to parking lot dust and 2) lawn-care workers were exposed to soil stirred up by lawn mowers. During the time period from 1966-1982, 3) children were exposed to dust from the parking lot and soil in the playground and 4) adults were exposed to dust from the day care parking lot.

In 1982 and 1993, soil samples were collected from different locations surrounding Site 2. We discuss here the levels of exposure we estimate for each group beginning with the most recent exposure. These exposure levels are dependent on assumptions we make about the length of time people were exposed, their contaminant dose, and their own sensitivity based on age. We have evaluated the exposure dose for each group of people who would have been exposed to contaminated soil at each sampling location.

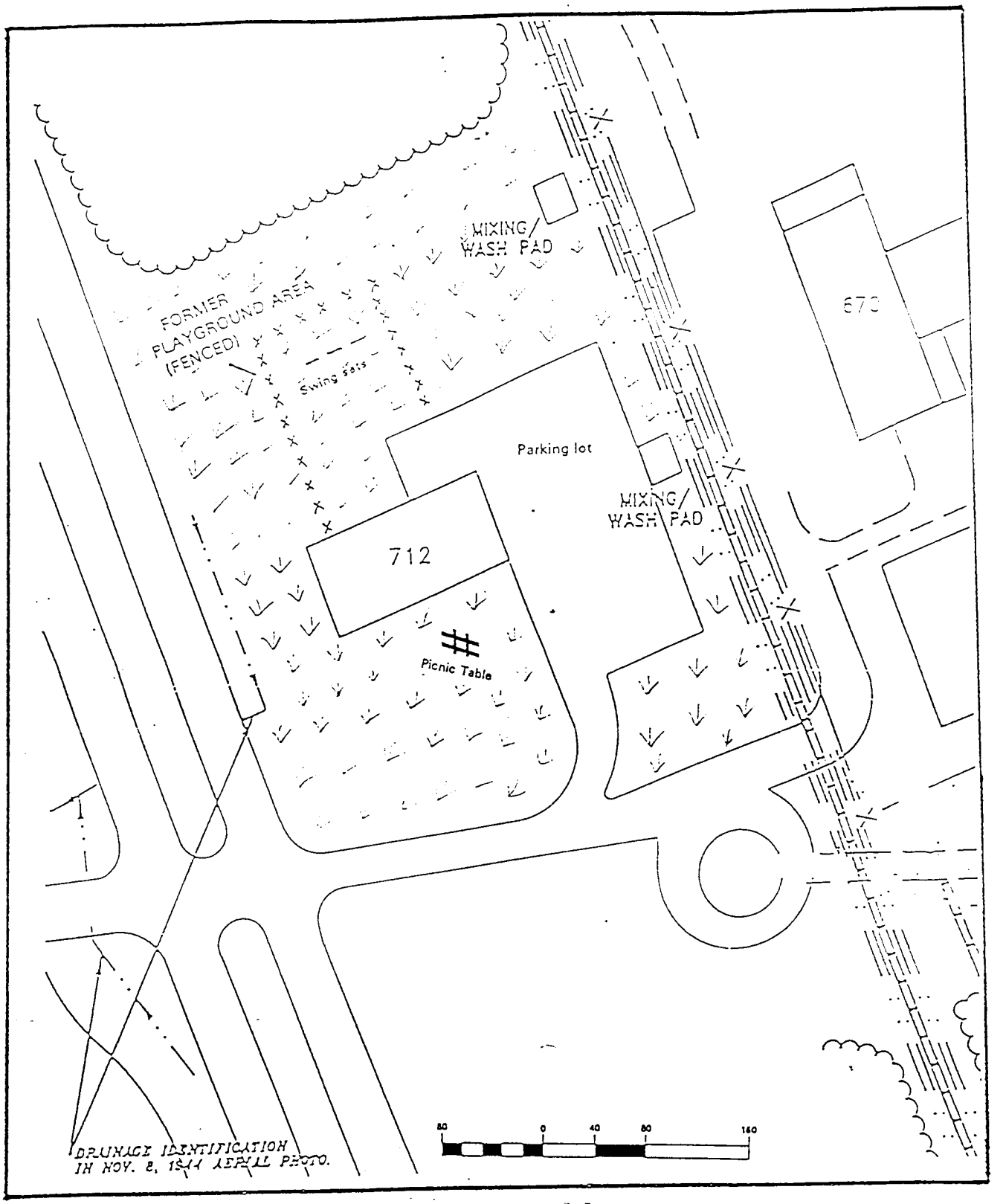

Figure 2
Site 2 Former Day Care Center
Marine Corps Base, Camp Lejeune

Source: Modified from Baker Draft Report 1993

ATSDR determines the likelihood that either cancerous and noncancerous adverse health effects will result from the exposure dose of the chemical contaminant. Because cancerous and noncancerous health effects occur through different biological mechanisms, they are evaluated separately using different health guidelines and scientific information. If either cancerous or noncancerous health outcomes are likely to result from exposure to contaminants, the exposure is considered a public health hazard.

ATSDR's approach is conservative. (In other words we include a wide margin of safety in our estimates of risk.) We use the maximum concentrations detected for estimating exposure dose. This estimate gives us a "worst case" estimate of the likelihood of adverse health effects. Thus, our public health recommendations are protective of the most sensitive members of the public.

1. Office Workers - Recent Past Exposure

Office workers were exposed to pesticide contaminated dust when they parked their cars in the parking lot. The contaminated dust would have been absorbed by breathing or swallowing it. We assume that exposure would have lasted longer than one year because the length of employment is commonly longer than one year. The personnel office employs 16 employees.

Surface soil samples collected in 1993 from the parking lot area adjacent to the old concrete mix pad (the area with the highest concentrations of pesticide) contained these maximum levels: DDD at 1,200 ppm, DDT at 930 ppm, DDE at 30 ppm, and chlordane at 0.31 ppm (29).

The estimated exposure doses for office workers are listed in Table 2. Non-cancerous adverse health effects resulting from those exposures are unlikely. However, when evaluated using the cancer risk values, we estimate that, as a result of their exposure, office workers may have an increased risk of developing cancer over their lifetime (Appendix D-1). Simultaneous exposures to those pesticides may increase this risk. Therefore, we concluded that exposure to pesticides at the levels detected in the parking lot area posed a public health hazard.

2. Lawn-Care Workers - Recent Exposure

Lawn-care workers were exposed to pesticides by breathing or swallowing dust stirred up by the lawn mowers. We estimate those exposures would have been seasonal, occurring for 4 months of the year, one day per week, and possibly could have lasted more than one year for an estimated five individual lawn care workers (22).

Surface soil samples collected in 1993 (Table 2) at the grass-covered areas contained maximum levels of DDT at 3,000 ppm, DDD at 1,200 ppm, DDE at 30 ppm, and chlordane at 7.4 ppm (29).

The estimated exposure doses for lawn care workers are listed in Table 2. Most likely, lawn care workers were exposed to lower doses of pesticides than people who apply pesticides.

However, pesticide applicators are aware that safety equipment such as respirators, gloves, and coveralls greatly reduce their chance of exposure, whereas lawn care workers would not usually wear such equipment when mowing the lawn.

Non-cancerous adverse health effects resulting from those exposures are unlikely. Additionally, we evaluated the likelihood of increased cancer risk to lawn care workers from exposure to the chemicals, (chlordane, DDT, DDE, and DDD). Based on the estimated duration of exposure, it is unlikely that lawn care workers have any increased risk of developing cancer as a result of their exposure. Therefore, the exposure to lawn care workers at Site 2 does not present a public health hazard. Appendix D-1 lists the exposure doses and cancer risk values estimated at Site 2.

3. Children at Day Care - Past Exposure: 1966-1982

Due to their hand-to-mouth activity, children ingest more soil than adults. As a result, children who attended the day care center were exposed to higher doses of pesticides than adults. Children at the day care center absorbed the pesticides by touching the soil in the playground and by breathing or swallowing the soil. We estimated that approximately 225 individual children would have been exposed during the time the day care center was in operation. We assumed that children would have attended the day care for longer than one year because the average tour of duty for military personnel at MCB Camp Lejeune at that time was 3 years. Therefore, we estimated exposure to be chronic.

When soil sampling was carried out in 1982, surface soil samples collected from the playground area contained DDT at 6.7 ppm and chlordane at 0.39 ppm. Since the breakdown of those compounds is slow, we assumed that the concentrations were within the same range throughout the 16 year period that the day care operated.

We calculated exposure doses for pica and non-pica children, based on the amount of soil to which the children would have been exposed. Children are classified as "pica" if they intentionally eat non-food items, in this case soil. Pica behavior occurs in about 16% of children age 6 months to two years old (30). The exposure dose for pica children usually is greater than for non-pica children and would represent a "worst case" exposure dose. The estimated exposure doses for pica children exposed to pesticide contaminated soil in the playground are in Table 2.

Children received additional pesticide exposure from the dust in the parking lot. We assumed that exposure would have lasted longer than one year. The additional exposure doses for children are also listed in Table 2.

One difficulty in estimating the health risk posed by these exposures is that the effects of pesticides in children have not been well-studied. The way pesticides are metabolized in the body has been studied for many years in adults, who have usually been exposed as a result of accidental or occupational exposure. However, no scientific studies were found that described how pesticides are metabolized in children. This is important when trying to estimate the

effects on very young children because children less than two years old may not yet have developed the enzymes that metabolize these pesticides (30).

We assume that the sensitivity of children older than two is similar to that of adults. Therefore, as in the adult populations, we do not think non-cancerous adverse health effects are likely in children as a result of this exposure.

Cancer mechanisms in children are not well understood, but could be similar to adults; therefore children exposed at Site 2 may have some increased lifetime risk of cancer. However, generalizing cancer risk calculation for children is strongly questioned among the scientific community because of a child's changing metabolism which can cause a child to be either more sensitive or less sensitive to the effects of a carcinogen based on their ability to repair cell damage and other factors. Therefore, we do not think a numerical estimate of increased risk would be applicable for children because we cannot generalize from adult studies to children.

4. Adults at Parking Lot - Past Exposure: 1966-1982

Adults who used the parking lot of Building 712 when it was a day care center, were exposed to pesticide contaminated dust. This group would have included day care center employees and parents taking their children to the day care center. The approximate number of exposed adults is difficult to estimate. However, we believe that more than 50 adults were exposed during the time the day care was in operation. The exposure would be through breathing or swallowing contaminated dust and may have lasted longer than one year.

Surface soil samples collected in 1982 from the parking lot area adjacent to the old concrete mix pad contained the highest concentrations of pesticides within the parking lot area: DDT at 7,500 ppm, DDD at 644 ppm, DDE at 69 ppm, and chlordane at 45 ppm. The estimated exposure doses for adults exposed to pesticide contaminated soil are in Table 2.

At these exposure doses, we do not think non-cancerous adverse health effects are likely. However, as with the other groups described here, we think that exposure was high enough to increase the lifetime risk of developing cancer. Simultaneous exposures to DDT, DDE, DDD, and chlordane may have further increased this risk. Based on this, we concluded that the exposure in the past posed a public health hazard.

Chemical Specific Considerations

DDT - p,p'-dichlorodiphenyltrichloroethane,
DDD - p,p'-dichlorodiphenyldichloroethane, and
DDE - p,p'-dichlorodiphenyldichloroethylene

Since it was first used in 1946, DDT has been studied extensively in humans and animals. We reviewed the available scientific literature and determined that DDT and its breakdown products, DDD and DDE at concentrations higher than those detected at MCB Camp Lejeune are only mildly harmful to humans.

We do not predict non-cancerous adverse health effects in people exposed to pesticides at Site 2. The scientific literature has reported cases where workers were accidentally poisoned after drinking concentrated DDT. In these cases, which had DDT concentrations much higher than those estimated for people at MCB Camp Lejeune, health effects were limited to headaches, confusion, vomiting, nausea, increased sensitivity of the mouth and lower part of the face, and tremor of the extremities. In general, symptoms occurred as soon as 30 minutes after a large dose or as late as 6 hours after a small dose (30, 31). Complete recovery from the acute symptoms occurred within several weeks.

Even today, DDT's effect as a human carcinogen is unknown (32). EPA has classified it as a possible human carcinogen based on evidence that it causes cancer in animals. Epidemiological studies of pesticide workers suggest there may be an association between long-term exposures to high doses of DDT and pancreatic cancer (33). In the interest of public health, ATSDR's approach is cautious, and we have accepted the "worst case" evaluation for these exposures. Although we have estimated the exposure doses to be representative of actual exposures, our cancer risk estimates are designed to be highly conservative. We have therefore estimated cancer risk as if DDT and its breakdown products DDD and DDE were human carcinogens (Appendix D-1). Combined chemical exposures may further increase this risk. Even though our cancer risk estimates are conservative, we consider these risks to be a public health hazard and have recommended that exposure be stopped.

Chlordane

The level of chlordane detected in the soil surrounding Site 2 during the 1982 and 1993 samplings are considered low. ATSDR estimated the exposure doses to chlordane in the area surrounding building 712. These estimated exposure doses were much lower (10 to 100 times lower) than any dose reported to be associated with non-cancerous adverse health effects (35). Further, the limited number of scientific studies of long-term human exposure to chlordane have shown no consistent detrimental effects in adults. There are only anecdotal reports suggesting a correlation between chlordane exposure and the subsequent development of aplastic anemia and leukemia (34).

When evaluated using the cancer risk values, the maximum concentration of chlordane detected is not expected to cause any increased risk of cancer in any of the exposed groups. Therefore, chlordane at the levels detected does not pose a public health hazard.

Summary and Follow-up

Workers in building 712 were exposed to levels of DDT and its breakdown products estimated to be high enough to increase the lifetime risk for cancer. In 1993 because recent surface soil sampling indicated that pesticides in the lawn and parking lot were of health concern, MCB Camp Lejeune installed a fence to prevent lawn-care and office workers from coming in contact with the contaminants and stopped mowing in that area. In 1994, MCB Camp Lejeune removed the concrete pad and contaminated soil. After the soil was removed, confirmation sampling was performed to ensure that the desired clean-up levels were achieved. Since exposures to pesticides at Site 2 have ceased, ATSDR recommends that people most recently exposed to pesticide contaminated soils be educated about their exposure.

ATSDR did not review the health outcome data of local cancer registries because such a review would provide inconclusive information for the following reason. Because pancreatic cancer (the cancer potentially associated with DDT exposure) only occurs in small numbers within the county's total population and because a very small number of workers were exposed, any evidence of excess cancer cases in this small group may be hidden within the rates of cancer for the entire county.

A local family had concerns that their child's current allergies might be caused from exposure to pesticides they got while attending that day care center. Because of these concerns, ATSDR contacted the Director of Human Services at MCB Camp Lejeune to determine if records had been kept on individuals who attended the day care center at Site 2. No records were kept on the children who attended the day care center. Therefore, we could not review specific health outcome data for those individuals.

Since no health outcome data were reviewed, ATSDR conducted a literature search to determine if an increase in allergy cases had been reported from a similar exposure. No link between pesticide exposure and general allergies were identified. However, in this case, exposure to the pesticides found at Site 2 (DDT and chlordane) could possibly cause an allergic response if exposures to DDT or chlordane reoccurred, but would not cause general allergies to other substances such as cats, dusts, or grasses. Further, if the child was no longer being exposed to DDT and chlordane, then that child would not be expected to currently have allergic responses. DDT and chlordane have not been used in the U.S. since the 1970s. Moreover, one would not likely see a sustained reaction over the twelve years since the time the day care center was closed.

Conclusion and Public Health Action Plan for Pesticide Exposure (Site 2)

Conclusion:

The soil around Building 712 - Site 2 was contaminated with the pesticides chlordane and DDT, and its breakdown products DDD and DDE. At different times, three groups of people have been exposed to different concentrations of these pesticides in soil from the unpaved parking lot or the lawn. The exposures to workers from the parking lot were estimated to be high enough to increase their lifetime risk for cancer. Non-cancerous health effects are not likely in any of the people exposed.

Completed Actions:

1. At Site 2, sampling data from 1993 indicated that pesticide levels in surface soils in the lawn and parking lot were of health concern. MCB Camp Lejeune installed a fence to prevent lawn-care and office workers from coming in contact with the contaminants and stopped mowing in that area.
2. MCB Camp Lejeune removed the concrete pads and contaminated soil. During this action, the Removal Action Contractor conducted air monitoring and implemented dust control procedures, as needed, to prevent office workers and visitors from being exposed to site contaminants.
3. After the soil was removed, confirmation sampling was performed to ensure that the desired clean-up levels were achieved.

Planned Action:

ATSDR's Division of Health Education plans to review the exposures at Site 2 and talk with MCB Camp Lejeune officials to determine if education is needed. If a determination is made for education, ATSDR will work in cooperation with MCB Camp Lejeune to provide the needed education.*

Recommended Actions:

1. Provide education to current lawn-care and office workers on their exposure to DDT, DDD, DDE, and chlordane contaminated soil at Site 2.
2. Provide ATSDR with results of air monitoring and sampling and the Proposed Remediation Action Plan for this site.
3. Provide ATSDR with the confirmatory sampling data to evaluate the current public health implications.

C. Volatile Organic Compound Exposure (Tap Water)

In the past, the Tarawa Terrace, Hadnot Point, and Holcomb Boulevard water distribution systems on base were contaminated with volatile organic compounds (VOCs) see Table 3. The sources of contamination were leaks from off-base and on-base underground tanks, some of which were installed in the 1940s. People who used this water were exposed to VOCs. Exposure was intermittent and stopped when the contaminated wells were closed in 1985. From the sampling data, we estimated probable exposure dose levels for adults and concluded that non-cancerous and cancerous health effects are unlikely to occur in those adults exposed. However, not enough scientific information is available to completely rule out the possibility of cancerous health effects from low dose exposure to VOCs such as these at MCB Camp Lejeune. A follow-up cancer evaluation is not being considered by ATSDR at this time because 1) any evidence of excess cancer cases in this small group may be hidden within the rates of cancer for the entire county; 2) the expected delay that occurs between the time of exposure to a carcinogen and the development of cancer is between 10 and 20 years for most cancers, so any individuals exposed to carcinogens in the 1982-1985 timeframe would just now begin to be diagnosed with cancer; and 3) most of the exposed individuals who develop cancer are likely to have moved before they are diagnosed and therefore, not included in the state registry. For children, we could not determine the likelihood of either non-cancerous or cancerous health effects because there is not enough scientific information on the adverse health effects these compounds might have on children. However, there is evidence that because of their developing systems, fetuses are potentially more sensitive to the effects of VOCs than either adults or children. Several epidemiological studies have suggested that there may be associations between exposure to VOCs and birth defects, low birthweight, and late fetal death. Therefore, we recommend that our agency carry out a study of birth outcomes for those women who were exposed to VOCs in drinking water at MCB Camp Lejeune during their pregnancy.

What are VOCs?
VOCs make up a group of chemicals having similar physical properties. VOCs readily evaporate or volatilize into gases when exposed to air. Chemicals in this group include trichloroethylene (TCE), dichloroethylene (DCE), benzene, tetrachloroethylene (PCE), methylene chloride, and vinyl chloride and in general may be used as dry cleaning solutions, additives in fuels, or as solvents to dissolve grease or other compounds. The major health concern of VOC exposure is adverse birth outcomes. ATSDR's proposed health study will address this issue.

VOC Sampling

In 1982, MCB Camp Lejeune performed base wide routine sampling of treated drinking water for trihalomethanes (THMs), a procedure to test for chlorine disinfection by-products. In May 1982, the laboratory noted difficulty in measuring THMs in two of the eight water systems in operation at that time because of interference by unidentified compounds. The analysis was then expanded to include trichloroethylene (TCE) and tetrachloroethylene (PCE) which were thought to be the interfering compounds (37). The findings for each distribution system are summarized below.

Hadnot Point Water Distribution System

At Hadnot Point, tap water samples contained TCE at 1,400 ppb and 1,2 DCE at 407 ppb in May 1982, but in July 1982, levels dropped to 20 ppb TCE and 1,2 DCE was not detected (see Table 3) (37). The drop in these levels can be explained by the use of different supply wells (a few containing contamination and others not) on different days. In the Hadnot Point system, any given well would have been in use about two-thirds of the time because water demand did not require using all wells at the same time (38). There were 39 operational wells in the system, but only 20 of those wells were used at any one time. The wells pump water to the distribution system where the water is blended and treated. This means that although the contamination is then spread from the one well to the entire distribution system, it is also diluted by being combined with water from uncontaminated wells. Chlorine, fluoride, and softeners are added to the water before it is pumped to water towers prior to distribution (38). The possible sources of contamination at the Hadnot Point distribution system are leaking underground storage tanks containing TCE and fuels, spills during vehicle maintenance operations, and disposal of drums at Sites 6, 9, and 82 and associated storage lots in Operable Unit 2 (39, 40).

In July 1984, as part of the Navy Assessment and Control of Installation Pollutants (NACIP) Program, MCB Camp Lejeune conducted water quality sampling in wells on base. They found that eight of the 39 wells in use at Hadnot Point and one of the seven wells in use at Tarawa Terrace were contaminated with various VOCs. All nine wells were abandoned and have not been used in the drinking water system since 1985 (38).

Table 3 - Maximum Contaminant Concentrations Detected in On-Base Drinking Water Tap Samples in 1982 - 1985

Chemical	Maximum Concentration (ppb)			Drinking Water Standard Established 1991* (ppb)
	Hadnot Point	Tarawa Terrace	Holcomb Blvd	
Trichloroethylene (TCE)	1,400	8	1,148	5
Dichloroethylene (DCE)	407	12	407	7
Tetrachloroethylene (PCE)	ND	215	ND	5
Methylene Chloride	54	ND	ND	5
Vinyl Chloride	3 J†	ND	ND	2

* - EPA's Drinking Water Standard referred to as the Maximum Contaminant Level (MCL) allowable
ND - None Detected
J - Estimated Value
† - Detection limit was 10 ppb.

Table 4 - Potential Health Effects for VOC Exposures

Water System	Exposed Population	Exposure Timeframe	Exposure Activity	Drinking Water Contaminant		Estimated Exposure Dose (mg/kg/day)	Potential Health Effects	
				Chemical	Maximum Concentration (ppb)		Non-cancer Effects	Cancer Risk Increase†
Hadnot Point	Base residents and workers (Adults, children, and fetuses)	Past known 1982-1985, unknown 1940's - 1982	People in the Hospital Point Housing Complex and other buildings supplied by the Hadnot Point Drinking Water System ingesting, inhaling, and dermal contact with contaminated drinking water	TCE	1,400	Adult 1.7E-03	Not Likely	No
						Child 3.7E-03	Not Likely	Unknown
				DCE	407	Adult 4.9E-04	Not Likely	No
						Child 1.1E-03	Not Likely	Unknown
				Methylene Chloride	54	Adult 6.6E-05	Not Likely	No
						Child 1.4E-04	Not Likely	Unknown
				Vinyl Chloride	3 J	Adult 3.6E-06	Not Likely	No
						Child 8.1E-06	Not Likely	Unknown
Tarawa Terrace	Base residents (Adults, children, and fetuses)	Past known 1982-1985, unknown 1954-1982	People in the Tarawa Terrace Housing Complexes ingesting, inhaling, and dermal contact with contaminated drinking water supplied by Tarawa Terrace Drinking Water System	TCE	8	Adult 9.8E-06	Not Likely	No
						Child 2.2E-05	Not Likely	Unknown
				DCE	12	Adult 1.5E-05	Not Likely	No
						Child 3.2E-05	Not Likely	Unknown
				PCE	215	Adult 2.6E-04	Not Likely	No
						Child 5.8E-04	Not Likely	Unknown
Holcomb Blvd	Base residents and workers (Adults, children, and fetuses)	Past known January 27 -February 7, 1985	People in the Paradise Point, Watkins Village, Berkeley Manor, Midway Park Housing Complexes and other buildings supplied by the Holcomb Boulevard Drinking Water System ingesting, inhaling, and dermal contact with contaminated drinking water	TCE	1,148	Adult 3.3E-05	Not Likely	No
						Child 7.2E-05	Not Likely	Unknown
				DCE	407	Adult 1.2E-05	Not Likely	No
						Child 2.5E-05	Not Likely	Unknown

† - Increase cancer risk is based on $\geq 5.5 \times 10^{-5}$.
NOTE: Dose calculations and cancer risk estimates are included in Appendix D-2.
The Probable Health Effects does NOT Include those for fetuses which would be unknown.

Tarawa Terrace Water Distribution System

Tap water sampling in the Tarawa Terrace water system in May 1982 detected PCE at 80 ppb which remained consistent during the July sampling. Sampling in February 1985, detected PCE at 215 ppb. In 1982, DCE was detected at 12 ppb. Trace amounts TCE were detected, but because of the laboratory instrument detection limit of 10 ppb, TCE was estimated to be at 8 ppb. At the time of the 1982 sampling, no source for the contamination at either Hadnot Point or Tarawa Terrace system had been identified (41). Additionally, there were no drinking water standards for these chemicals in 1982; TCE, PCE, and 1,2-DCE levels in drinking water were not regulated until the Safe Drinking Water Act was amended in 1991 (42). Table 3 shows the maximum detected concentrations of VOCs at the tap and the current drinking water standard referred to as the Maximum Contaminant Level (MCL) allowable.

Subsequently, it was determined that contamination at the Tarawa Terrace distribution system was caused by an off-base dry cleaning operation (ABC Cleaners) whose septic system released the cleaning fluid PCE into the ground (43). The septic system was installed in 1954 and used until 1985. In 1958, a well supplying the Tarawa Terrace system was drilled approximately 900 feet from the dry-cleaners. Because the well was so close to the septic field, the well was probably contaminated soon after it was built. That well could have contaminated the water distribution system with PCE for as long as 27 years. Over time, contaminants migrated into a second base well, located approximately 1,800 feet south of the septic system, but the PCE contamination was detected before this well was put into use. In 1985, both of these contaminated wells were shut down (41). Unable to meet the increasing water demand without those wells, the Tarawa Terrace distribution system was closed (38). This public health assessment evaluates exposures which occurred during the time for which sampling data is available. However, the recommended study of birth outcomes will review available birth records over the longer estimated exposure duration.

Holcomb Boulevard Water Distribution System

On January 27, 1985, a generator fuel line at the Holcomb Boulevard water distribution plant burst, leaking fuel into the system. This situation was identified after the base received complaints of a gasoline smell in on-base residential tap water (41). MCB performed sampling of the system and found that gasoline had entered the Holcomb Boulevard distribution system. The system was immediately shut down and flushed out. Emergency back up water was then pumped from the VOC contaminated Hadnot Point system into the Holcomb Boulevard distribution lines. Tap water samples taken from Berkeley Manor Elementary School in the Holcomb Boulevard system on January 31, 1985 contained TCE at 1,148 ppb and DCE at 407 ppb (Table 3). Contaminants measured at several points in the Holcomb Boulevard system were consistent with samples taken from the Hadnot Point Water treatment plant on the same date. Therefore, the source of TCE and DCE in the Holcomb Boulevard system originated from the contaminated emergency water supplied by the Hadnot Point system. People were switched backed to the clean Holcomb Boulevard system 12 days later when the generator fuel line was repaired (41).

Human Exposure Route and Public Health Implications

Our exposure estimates assume that people were exposed to VOCs in drinking water during the time tap water sampling data showed contamination of the water systems. People drinking or bathing with water supplied by Hadnot Point and Tarawa Terrace water distribution systems during 1982 to 1985 were exposed to VOCs. Most likely, contamination was present prior to 1982, but there is no sampling information to confirm this assumption. Due to the random use of contaminated wells (water demand did not require all wells to be in use at the same time), we estimated exposures to be intermittent, occurring off and on, for three years, 1982-1985. The base residents and employees exposed included adults, children and fetuses.

Holcomb Boulevard distribution system received contaminated drinking water for 12 days in 1985 when a broken pipe emergency required that back-up water be piped in from the Hadnot Point system which contained VOC contamination. Therefore, people drinking or bathing with water from Holcomb Boulevard water distribution system from January 27 to February 7, 1985 were exposed to VOCs on a short-term basis (less than 14 days).

In general, exposure to VOCs in water can occur from ingestion, inhalation, or skin contact with contaminated water. Because these chemicals readily change from liquid form to vapor, showering, bathing, and cooking can contribute to the estimated exposure dose. Reports in the scientific literature indicate that while showering, people generally inhale an amount of VOCs equivalent to drinking 2 liters of water (44). Our VOC exposure estimates assume exposure to VOCs from ingesting 2 liters of water per day and inhaling an equivalent concentration of VOCs during showering. The estimated exposure doses for people drinking contaminated water in these three systems are presented in Table 4 and Appendix D-2.

For the following discussion of health effects, ATSDR focuses on TCE because it was most frequently detected and present at much higher concentrations than the other VOCs such as PCE. TCE is similar to PCE in chemical composition and in the way the body metabolizes it. However, we have evaluated the effects of each chemical separately and those results are presented in Table 4. We also qualitatively consider the combined effects of the chemicals on the body when evaluating the likelihood of cancer.

Non-cancerous Effects

Non-cancerous adverse health effects are not expected to occur in the adults who were exposed to VOCs by drinking or bathing in the contaminated water at MCB Camp Lejeune. During the 1940s and early 1950s, TCE and PCE were used to anesthetize patients during operations. A review of available information on those people and also information on occupational exposures indicate that short-term exposure to TCE, regardless of route (ingestion, inhalation, or skin absorption) at concentrations of 100 to 10,000 times greater (160,000-1,000,000 ppb) than those detected at MCB Camp Lejeune depress the central nervous system causing headache, dizziness, nausea, vomiting, and intoxication (45). Long-term exposure to TCE at 200,000-400,000 ppb which is 142 to 285 times higher than the levels detected at MCB Camp Lejeune as reported in

the scientific literature caused vertigo, short-term memory loss and harmful liver and kidney effects (45). Because the concentrations of TCE detected in the drinking water at MCB Camp Lejeune are so much lower (100 to 10,000 times lower) than the levels causing the above effects, it is unlikely that adults would have developed non-cancerous adverse health effects.

Certain people are potentially more sensitive to the effects of VOCs. These more sensitive groups include chronic consumers of alcohol, people with heart disease, people taking disulfiram (a medication used to treat alcoholism), and people taking the anticoagulant warfarin (46). These medications increase the toxicity of VOCs on the liver.

Cancerous Effects

Typically, ATSDR uses human epidemiological and occupational studies when evaluating the likelihood of cancerous effects or cancer risk. However, too few epidemiological studies have been carried out on low level exposure to VOCs to make sound cancer estimates. Therefore, we decided to base our assessment of cancer risk from exposure to VOCs at MCB Camp Lejeune on the data from animal studies. The International Agency for Research in Cancer (IARC) classifies TCE and PCE as "possibly carcinogenic to humans" based on "sufficient" evidence of carcinogenicity in animals and "inadequate" evidence in humans. The animal studies evaluated the cancer effects from known exposure to VOCs. Based on these animal studies, mathematical formulas were derived using factors to convert animal data into values relevant to humans.

Using cancer risk estimates, ATSDR determined that cancerous health effects are unlikely in adults who were exposed to VOCs in drinking water at MCB Camp Lejeune (Appendix D-2). Although cancer is not expected to occur, not enough scientific information on humans is available to rule out the possibility of cancerous health effects from low dose exposure to VOCs. A few epidemiological studies have suggested that exposure to VOCs may be associated with leukemia, non-Hodgkins lymphoma, and bladder and kidney cancer (47,48,49,50). The exposure doses in these studies were similar to what was estimated for people at MCB Camp Lejeune. However, there are too few studies to see any definite pattern of cancers related to VOC exposure. In addition, these studies are further limited methodologically because of the difficulty of verifying and quantifying people's exposure to VOCs. However, because the results of the epidemiological studies suggest a possibility of cancer from exposure to VOCs, more studies are needed to adequately address the issue of human cancer associated with VOC exposure.

However, at this time, ATSDR is not planning a follow-up cancer evaluation at MCB Camp Lejeune for the following reasons. A simple review of cancer statistics from the North Carolina cancer registry would not be useful because cancer registries contain cancer cases diagnosed each month for a specific county. When exposures occur, generally all residents of the county are not equally affected. Instead the people exposed would be a smaller, localized group such as the small group of residents at Tarawa Terrace, MCB Camp Lejeune. Therefore, evidence

of difference in cancer rates in groups this small may be hidden within the rates of cancer for the entire county.

Additionally, a cancer evaluation is also not feasible at this time because the expected delay between the time of exposure to a carcinogen and the development of cancer is between 10 and 20 years for most cancers. This creates two problems. First, for those exposed to carcinogens in the 1982-1985 timeframe, would just now be beginning to be diagnosed with cancer. Therefore, the number of cancer cases occurring in the exposed population could not be accurately determined for another 10 years. Secondly, the average stay of residents at MCB Camp Lejeune at that time was three years, and most of the exposed individuals who develop cancer are likely to have moved before they are diagnosed. Hence, most of the cancer cases that occur among exposed individuals would not be recorded in the North Carolina cancer registry as occurring to MCB Camp Lejeune residents. This would make identification of exposed individuals who get cancer very difficult. Therefore, a cancer evaluation is not being planned.

Only one epidemiological study was found that evaluated the effects of VOC exposure on children. The study in Woburn, Massachusetts, suggested an association between access to VOC contaminated drinking water and childhood leukemia (50). The contaminant levels in the wells were TCE 267 ppb, PCE 21 ppb, chloroform 12 ppb and other VOCs. The wells were used 59% of the time and water was blended with water from six other municipal wells, thus lowering the actual concentrations of VOCs people would be drinking at their taps. Conversely, concentrations of VOCs at MCB Camp Lejeune are from the tap water samples and represent the actual concentrations MCB Camp Lejeune residents received. Additionally, questions such as whether or not the children studied drank contaminated water, how long their water was contaminated, and what VOC concentrations would have been at the tap if the water was mixed with other wells. Because of these significant questions, we cannot adequately address the likelihood of either cancerous or non-cancerous health effects on children.

Adverse Birth Outcomes

Women may experience adverse pregnancy outcomes from exposure to toxic substances even when their own health is not threatened (51, 52). Therefore, fetuses are potentially more sensitive to the effects of VOCs. Several epidemiologic studies suggested the possibility that pregnant women exposed to VOCs (at levels similar to those detected at MCB Camp Lejeune) may have an increased risk of adverse pregnancy outcomes. The outcomes include birth defects such as heart malformations, neural tube defects, oral clefts, low birth weight, and increased fetal death (51, 52-57). Some of these studies have significant limitations, including questions about whether all of the study population were exposed, how long exposure took place, and the exact concentrations of VOCs to which these mothers were exposed. Due to these limitations, more studies are needed to better evaluate the relationship between VOC exposure and adverse pregnancy outcomes. Our birth outcome study should further the understanding of such an association.

Summary and Follow-up

Human exposure to TCE, PCE, and 1,2-DCE in drinking water systems at MCB Camp Lejeune have been documented over a period of 34 months, but likely occurred for a longer period of time. Included in the population which used this water were approximately 6,000 residents in base family housing. This population consisted of a large proportion of young married women. Even though adverse health effects are not expected in adults, concern was raised about potential toxic effects on developing fetuses. This concern is important to the population that has already been exposed. Over 1,600 babies were born at the base hospital each year from 1980 to 1985, during the known exposure period (59). Approximately 114 babies each year were born to women who used the contaminated water.

A review of birth outcomes is planned. This review should further the understanding of the health effects of low-dose VOC exposure, particularly since VOCs are commonly used and frequently contaminate groundwater. Therefore, we have recommended that a study be done by our agency. The primary objective of the study is to determine if mothers who lived in houses supplied with drinking water contaminated with TCE, PCE, and 1,2-DCE had an increase in the number of cases of 1) full-term babies who had low birth weight, 2) pre-term births, and 3) fetal deaths. When the data is available birth defects such as cleft palate and heart anomalies may be taken into account. However, many birth defects are not usually diagnosed at birth, but several months later, so they would not be recorded on birth certificates and therefore they would not be available from our review of the certificates. Confounders such as smoking which is known to contribute to low birth weight, will be taken into account. Data from North Carolina birth and fetal death certificates are available to study adverse pregnancy outcomes among all women who lived at MCB Camp Lejeune in areas supplied with VOC contaminated water. The study period will include the years of known exposure (1982-1985) and a period of suspected exposure (1968-1982). The study will begin in January 1995.

Conclusion and Public Health Action Plan for VOC Exposure (Tap Water)

Conclusion:

Prior to 1986, people drinking and showering with water from the Tarawa Terrace, Hadnot Point, and the Holcomb Boulevard water distribution systems on base were exposed to volatile organic compounds (VOCs). There is information documenting drinking water contamination in the Tarawa Terrace and Hadnot Point water systems from 1982 until 1985, although contamination could have been present longer. Contamination in the Holcomb Boulevard system was only present for two weeks, January 27 - February 7, 1985. At the estimated exposure levels, we do not expect non-cancerous health effects in adults. However, there is not enough scientific information on the adverse health effects these compounds might have on children. Additionally, fetuses are potentially more sensitive to VOCs. Studies have suggested an association between low birthweight, late fetal death and exposure to VOCs. Even though ATSDR determined that cancerous health effects are unlikely, not enough scientific information is available to rule out the possibility of cancerous health effects from low dose exposure to VOCs such as these at MCB Camp Lejeune.

Completed Action:

In 1985, MCB Camp Lejeune ceased use of VOC contaminated drinking water wells at Hadnot Point, Tarawa Terrace, and Holcomb Boulevard.

Planned Action:

ATSDR is planning to conduct a study of adverse pregnancy outcomes among all women who lived at MCB Camp Lejeune in housing areas which were supplied with VOC contaminated water. This information should further the understanding of the health effects of low-dose VOC exposure. This analytical epidemiologic study will help add to the body of knowledge concerning VOCs in drinking water.*

Recommended Action:

No further actions are recommended at this time.

II. POTENTIAL HEALTH HAZARDS - POSSIBLE EXPOSURE SITUATIONS

ATSDR concluded that three other situations were potential public health hazards (Table 5). More information is required to adequately evaluate the level of public health risk. MCB Camp Lejeune is in the process of collecting further data on base wide groundwater contamination and at the Site 43. No further action is planned for Site 48 and fish and shellfish in the New River.

A. Groundwater Contamination (Base wide)

ATSDR is concerned that base drinking water wells may be at risk for contamination. Although 14 wells have been closed because of groundwater contamination with VOCs and fuels, approximately 68 additional wells are still in operation on-base. These wells provide an average of 8.3 million gallons of water daily to MCB Camp Lejeune. Approximately 20 other wells are not in use due to low water pumping volume (39,38). Almost all of these wells tap a tertiary sand and limestone aquifer that is permeable to contamination (60).

In some areas, contaminant plumes have been identified and groundwater treatment is being conducted to reduce groundwater contamination. Investigations are ongoing to identify and treat groundwater contamination through the Underground Storage Tank and Remedial Investigation studies.

Summary and Follow-up

We estimate that future exposures to contaminated water could reach levels high enough to cause health concern, as happened in the past. The contamination from the underground fuel tanks and other sources has not been completely defined. We strongly recommend that further sampling be done to define the geometry of the contaminant plumes and the direction and velocity of plume movement and to identify the sources of contamination. Investigations at MCB Camp Lejeune are ongoing to define and characterize groundwater contamination. We recommend that individual wells be sampled no less than semi-annually to prevent contamination of water distribution systems and to protect people from exposure to contaminated drinking water. Additionally, we recommend that the base continue to monitor water from the distribution systems quarterly. If monitoring indicates contamination, individual wells should be sampled to determine which ones are contaminated so they can be closed or their water treated. As a result of our recommendations, MCB Camp Lejeune is currently developing a water monitoring plan of action to prevent exposure to contaminated drinking water.

If groundwater monitoring indicates that the contaminated groundwater is moving toward on- or off-base drinking water supplies, measures should be taken to prevent people from coming into contact with it. The closest off-base drinking water wells are over one-half mile from the base boundary. Typically, groundwater flows toward the New River. ATSDR is concerned that base drinking water wells are highly susceptible to contamination. Because the wells are not currently sampled, ATSDR's recommendations if implemented will prevent people from drinking contaminated water. MCB Camp Lejeune currently monitors groundwater contamination caused by underground storage tanks and Installation Restoration Program sites to prevent on or off base water supplies from being adversely impacted.

Conclusions and Public Health Action Plan for Groundwater Contamination (Base wide)

Conclusions:

1. The groundwater contamination from the underground fuel tanks and hazardous substance sources may not be completely defined in some areas. Camp Lejeune uses numerous wells to supply the base with drinking water; almost all of these wells use a tertiary sand aquifer that is permeable to contamination. If contamination reached the wells, we estimate that future exposures could be, as they were in the past, at levels high enough to cause health concern.

2. Groundwater contamination on base does not appear to pose a threat to the safety of off-base county and community water wells at this time. Groundwater contamination on base has not been found to have migrated off base. The typical groundwater flow direction would be toward the New River and the Atlantic Ocean and away from community wells.

Completed Actions:

1. MCB Camp Lejeune has identified on-base groundwater contamination. In some areas, contaminant plumes have been delineated.

2. MCB Camp Lejeune operates groundwater treatment facilities to clean-up groundwater contamination.

3. MCB Camp Lejeune monitors groundwater contamination caused by underground storage tanks and Installation Restoration Program sites to prevent on- or off-base water supplies from being adversely impacted.

Planned Actions:

1. Investigations to define and characterize groundwater contamination at MCB Camp Lejeune are ongoing.

2. As a result of ATSDR's recommendations to routinely monitor individual supply wells to prevent contamination of water distribution systems and to protect people from exposure to contaminated drinking water, MCB Camp Lejeune is currently developing a plan of action to sample supply water wells semi-annually and to sample the water distribution systems quarterly to prevent exposure to contaminated drinking water.

Recommended Action:

1. Continue to characterize the extent of the groundwater contamination on base. If monitoring indicates that the contaminated groundwater is moving toward on- or off-base drinking water supplies, measures should be taken to prevent people from coming into contact with it. If the contaminated groundwater is moving towards areas where the groundwater use is unknown, conduct a thorough well survey of those areas.

2. When it is drafted, provide ATSDR a copy of the Plan of Action for the sampling of supply water wells (semi-annually) and the water distribution systems (quarterly).

Table 5 - Potential Health Hazard Situations

PATHWAY NAME	CONTAMINANT	POTENTIAL EXPOSURE PATHWAY ELEMENTS					TIME	COMMENTS
		SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	POTENTIALLY EXPOSED POPULATION		
Groundwater Base wide	VOCs and Fuels	Underground Leaking Fuel Tanks and other disposal areas	Groundwater	On-Base Drinking Water Wells	Ingestion, Inhalation	Base Workers and Base Residents	Future	Sixty-eight drinking water wells are still in operation on-base. Almost all of these wells utilize a tertiary sand and limestone aquifer, which is permeable to contamination. Groundwater contamination is confirmed but has not been clearly delineated in some areas. Groundwater treatment is being conducted in some areas.
Fish and Shellfish In New River	Possibly Mercury, Pesticides, and PAHs	Site 48 and other possible sources such as surface water, groundwater, and other discharges	Fish and Shellfish from the New River	Eating Possibly Contaminated Fish and Shellfish	Ingestion	People Eating Contaminated Fish	Past Present Future	Low levels of mercury detected in New River sediments and surface water are of concern because of mercury's toxicity and its tendency to biomagnify up the food chain. The New River is heavily fished and shellfished.
Physical Hazards and Soil Contamination (Site 43)	Physical hazards and possible soil contamination	Site 43	Soil and Debris	Debris and Soil	Contact with physical hazards and soil	Children and other people who come in contact with physical hazards and soil	Past Present Future	Because of the close proximity of family housing and the lack of access restrictions to Site 43, the site represents a physical hazard and possible health hazard. Site 43 has exposed debris and possible soil contamination.

B. Possible Fish and Shellfish Contamination (New River and Site 48)

ATSDR is concerned that fish and shellfish in the New River may be contaminated with hazardous substances at levels of health concern. The Site 48 (Operable Unit 3) study area covers approximately 4 acres and contains three buildings, one of which was used as a photographic laboratory from 1955 to 1990. The site is bordered by the New River to the east, a tributary of the river to the north, building AS 811 to the south, and Longstaff Road to the west. Mercury from the lab was reportedly disposed of at the site.

MCB Camp Lejeune conducted Remedial Investigations of Site 48. Soil and groundwater samples were collected near the buildings. New River sampling included fish, sediment, and surface water. Soil and groundwater samples did not show any detectable mercury. However, sediment and surface water sampling data from the New River near Site 48 showed low levels of mercury possibly indicating that mercury was disposed in the river and not on the ground near the buildings. Three fish were collected from different locations in the river, but none were collected near the detected mercury. The fish showed low levels of pesticides, polyaromatic hydrocarbons (PAHs), VOCs, and metals. ATSDR is concerned that the three fish may not be representative of fish population routinely consumed by people. More fish would be needed collected to be statistically representative. Therefore, ATSDR recommends that greater numbers of fish of various species be analyzed using the state's standard detection limits.

Additionally, we cannot determine the human health hazards of eating shellfish from the New River because no shellfish were collected. Reports indicate that shellfish (crab, shrimp, oysters, clams, or mussels) could not be caught by the netting method used. For this reason, ATSDR recommends that fishing surveys be conducted of the people fishing in the New River. Information on species caught, method of preparation, and consumption rate of fish could be obtained. Moreover, fish actually caught by those people who routinely catch them could be chemically analyzed to give a realistic idea of the level of contamination in the fish and shellfish.

Other sources of contamination may come from surface water runoff, creeks, streams, and tributaries on base which flow into the New River. Included in MCB Camp Lejeune investigations at Site 28, Orde Pond Recreational Area is the portion of the New River adjacent to the recreational area. Sediment sampling of the New River adjacent to the Site 28 showed elevated lead levels. Since no one can access this area from the Orde Pond Recreational Area, it does not represent a direct hazard. However, it does contribute to contamination of the New River and ATSDR's overall concern of eating potentially contaminated fish from the river. Additionally, at many locations on base, groundwater recharges the New River so contaminated groundwater may be contributing to contamination found in the river (3).

The New River is used for commercial and recreation fishing, shrimping, shellfishing, boating, and swimming. It is a tidal river, which may cause contaminants to move both upstream and downstream with the tidal changes. Currently, no fishing or shellfishing bans are in place.

Summary and Follow-up

The low levels of mercury in sediments near Site 48 are of concern because of mercury's high toxicity and its tendency to bioaccumulate and biomagnify up the food chain. Other chemicals may also be present in fish and shellfish. Because the New River is used as a popular fishing area, additional fish and shellfish sampling is required to determine if people consuming seafood from the New River are being exposed to hazardous chemicals at levels that would pose a health hazard.

Conclusions and Public Health Action Plan for Possible Fish and Shellfish Contamination (New River and Site 48)

Conclusions:

1. Soil and groundwater samples did not show any detectable mercury. However, sediment and surface water sampling data from the New River near Site 48 showed low levels of mercury which possibly indicates that mercury may have been disposed of in the river and not on the ground near the buildings.

2. ATSDR cannot determine if consumption of fish from the New River poses a public health concern at this time due to the inadequate number of fish analyzed and the lack of shellfish collected. Additionally, because sampling results indicate low levels of contamination in the sediment and surface water, ATSDR remains concerned about the public health implications of eating New River seafood.

Completed Action:

MCB Camp Lejeune has completed the Remedial Investigation Remedial Investigation, Proposed Remedial Action Plan, and Record of Decision for Operable Unit 3 (Site 48).

Planned Actions:

1. MCB Camp Lejeune determined that the site will be left as is (no clean up action planned). No additional actions are planned at this time.

Recommended Actions:

1. Analyze greater numbers of fish of various species from the New River using the state's standard detection limits.

2. Conduct fishing surveys of the people fishing in the New River to determine species caught, method of preparation, and consumption rates. Analyze these fish and shellfish for Total Analyte List and Total Compound List to give a realistic idea of contamination in the fish and shellfish.

C. Physical Hazards and Possible Soil Contamination (Site 43)

Site 43 presents both a physical hazard and a potential health hazard due to soil contamination. Site 43 - Agan Street Dump is located near the old wastewater treatment plant and covers an area of about 20 acres. Boards, trash, fiberglass, an old tank, and wastewater treatment plant sludge were disposed of on the ground surface. The years of operation are not known (62). Family housing units are approximately 500 feet from the site. Because no physical barriers prevent children from accessing the site, they can climb on old tanks and other debris and injure themselves. Additionally, children can come into contact with possible soil contamination. ATSDR recommends that due to the close proximity of family housing access to Site 43 should be prevented. Additionally, to evaluate the public health implications, we recommend surface soil samples be collected (0-3") at this site.

Conclusions and Public Health Action Plan for Physical and Possible Soil Contamination (Site 43)

Conclusions:

1. Trash and various debris scattered in the woods at this site represent a physical hazard to children walking onto the site from the nearby family housing area.
2. Surface soil sampling results may indicate a potential human health threat to children who may come in contact with contaminated soil.

Completed Action:

MCB Camp Lejeune has completed the Remedial Investigation for this site.

Planned Actions:

1. MCB Camp Lejeune is currently completing the Proposed Remedial Plan for this site.

Recommended Actions:

1. Prohibit access to those areas at Site 43 that represent a physical hazard and potential health hazard.
2. Conduct additional surface soil sampling at 0-3" to determine the levels of contaminants to which people would be exposed, so appropriate protective action can be taken.

III. NO APPARENT HEALTH HAZARDS

ATSDR concluded that two other situations were no apparent public health hazards. In these situations, people are using these areas and contamination could be present from past disposal practices. However, in both situations, certain conditions exist (e.g., the area was covered with clean fill or the contaminant concentrations would be diluted) that make it unlikely that the exposure doses would be at levels of health concern.

A. Fish Contamination (Site 6, 9, and 82)

Both Wallace Creek and Bear Head Creek are designated as Class SB surface waters by the North Carolina Department of Health and Natural Resources. This ranking indicates that these creeks/rivers are suitable for fish and wildlife habitats; aesthetically pleasing; suitable for recreational boating and, in some places, for swimming. Fishing is a popular sport in the area; therefore, we are particularly concerned about possible fish contamination.

MCB Camp Lejeune sampled sediment, surface water, and fish from Wallace and Bear Head Creeks. TCE, PCE and other VOCs, PAHs, pesticides, and PCBs were detected at low levels in sediment, surface water and fish of Wallace Creek and Bear Head Creeks and may be attributable to surface water and possibly groundwater discharge from Sites 6, Site 9, and Site 82 (Operable Unit 2), which are contaminated with pesticides, solvents, paints, and various construction debris (40). Fish collected by electroshock, seines, and lines were of edible size and species (except the gar) (40).

Summary and Follow-up

Using the maximum contaminant concentrations detected in fish to estimate exposures, ATSDR concluded that no adverse health effects either cancerous or non-cancerous would be expected to occur in people ingesting fish from Wallace and Bear Head Creeks. Fish tissue samples taken from the creeks showed low levels of VOCs, PCBs, and pesticides at which adverse health effects are have not been reported.

Conclusion and Public Health Action Plan for Fish Contamination at Sites 6,9, and 82.

Conclusion:

Contaminants detected at low levels in fish from Wallace and Bear Head Creeks are not expected to cause any adverse health effects (cancerous or non-cancerous) in people who routinely eat fish from these creeks.

Completed Action:

MCB Camp Lejeune has recently completed the Remedial Investigation and a Supplemental Aquatic Survey for Sites 6, 9, and 82 (Operable Unit 2), including detailed fish sampling results for Wallace and Bear Head Creeks.

Planned Action:

No additional actions are planned at this time.

Recommended Action:

ATSDR is not recommending any additional actions for Site 6, 9, and 82 at this time.

B. Soil Contamination (Site 69)

It is unlikely that this site poses or will pose a public health hazard; however, ATSDR's evaluation of sampling data of this site, will be included in the final release of this public health assessment. Site 69 - Rifle Range Chemical Dump is a six-acre site in a heavily wooded area east of the intersection of Range Road and Sneads Ferry Road. From the early 1950s to 1976, all hazardous materials generated or used at the base were deposited here in unlined trenches or pits; at least twelve disposal events are documented for the site. Various pesticides, pentachlorophenol, TCE, gas cylinders, PCBs, chloroacetophenone gas, and numerous other hazardous materials were buried at this site. The total amount of waste present on this site is estimated at 93,000 cubic yards; however, the waste was covered with clean fill dirt and the site is now fenced (62). It is unlikely that contaminated soil from Site 69 could migrating from this site because it is buried. However, contamination was detected in groundwater monitoring wells at the site. MCB Camp Lejeune is considering groundwater treatment actions at this time. An elementary school is located within 2 miles. Because exposure to soil is unlikely to occur at this site, MCB Camp Lejeune recommends that the soil remain in place. ATSDR has requested the Remedial Investigation and Proposed Remedial Action Plan for this site.

Conclusions and Public Health Action Plan for Soil Contamination at Site 69

Conclusion:

ATSDR has not yet been provided with the sampling data of this site for public health evaluation. The scheduled release data for the documents is January 1995. From the information we have such as the remote wooded location of the site, the fence prohibiting access, and the plans not to dig up soil thus preventing potential release of contaminants, it is unlikely that this site poses a public health hazard. However, ATSDR's evaluation of the sampling data will be included in the final release of this document.

Completed Action:

MCB Camp Lejeune installed a fence around this site to prevent exposures to contaminants.

Planned Actions:

1. MCB Camp Lejeune is currently finalizing the Remedial Investigation for this site.
2. MCB Camp Lejeune is considering groundwater treatment operations to clean up contaminated groundwater and to protect base supply wells.

Recommended Action:

Provide ATSDR with the Remedial Investigation and Proposed Remedial Action Plan when they become available.

IV. NO HEALTH HAZARD

ATSDR concluded that two other situation were definitely not public health hazards.

A. Suspected Soil Contamination (Site 28)

Site 28 - Orde Recreational Area was previously known as Site 28 - Hadnot Point Burn Dump, a 23-acre burn dump which operated from 1946 to 1971. Solid wastes, including mixed industrial waste, trash, oil-based paints, pesticides and other refuse, were brought to the dump to be burned in an open pit to reduce waste volume. When the site was closed in 1971, the ashes were covered with dirt brought in from other areas on base. The volume of fill dirt was estimated to be between 185,000 and 379,000 cubic yards. The ground was then graded and planted with grass (3).

Today, the area is a recreational park for base personnel, their families, and their guests. The park includes Orde Pond, a 3 acre fishing pond, and playground and picnic areas. Surface soil contamination in the recreational area is unlikely because of the amount of fill that covers the waste. However, MCB Camp Lejeune will conduct surface soil sampling here to be certain the area is safe.

B. Suspected Fish Contamination (Site 28)

In reviewing past environmental sampling document, ATSDR had concerns about reported results from the 1984 fish sampling. In response to ATSDR concerns, MCB Camp Lejeune expedited its fish sampling by 5 months. Preliminary results from 1994 fish sampling in Orde Pond (part of Site 28) indicate that fish are not contaminated; therefore, fish consumption from Orde Pond is not considered a public health hazard.

Between 1971 and 1973, a man-made pond, Orde Pond, was dug at the previous burn dump after it had been covered by clean dirt. The area was then opened as a recreational area (3). Bluegill, sunfish, and bass were stocked in the pond. The last time fish were stocked was 1989 (63). Fishing is permitted with a North Carolina state fishing license and a MCB Camp Lejeune fishing permit. Only military employees, their dependents, and their guests are allowed to fish at the pond; the pond is used for recreational fishing and not subsistence fishing. The pond is not used for swimming and the steep bank prevents toddlers from playing in the sediments.

Conclusions and Public Health Action Plan for Suspected Soil and Fish Contamination at Site 28

Conclusions:

1. Site 28 - Orde Pond Recreational Area does not pose a public health hazard because sampling data of fish from Orde Pond and surface soil of the playground area do not show contamination.

2. Included in MCB Camp Lejeune investigations at this site, is the portion of the New River adjacent to the Orde Pond Recreational Area. Sediment sampling of the New River adjacent to the site showed elevated lead levels. Since no one can access this area from the Orde Pond Recreational Area, it does not represent a direct hazard. However, it does contribute to contamination of the New River and ATSDR's overall concern of eating potentially contaminated fish from the river.

Completed Action:

MCB Camp Lejeune completed a Remedial Investigation for this site, which analyzed surface water and fish samples from the pond, surface soil, groundwater, and sediments of the New River adjacent to the site.

Planned Action:

MCB Camp Lejeune is currently finalizing the Proposed Remedial Action Plan and Record of Decision for this site.

Recommended Action:

Provide ATSDR with the Remedial Investigation and Proposed Remedial Action Plan when they become available.

COMMUNITY HEALTH CONCERNS EVALUATION

Several health concerns were raised by citizens living at or around MCB Camp Lejeune during one-on-one meetings with ATSDR staff or during meetings with MCB personnel.

1. **Is the New River contaminated? Are fish from the river contaminated?**

   Low levels of pesticides, mercury, PAHs, and VOCs have been detected in river sediments and/or surface water. Shellfish and fish can bioaccumulate and bioconcentrate contaminants in the New River, and this could present a public health hazard. MCB Camp Lejeune has sampled a small number of fish from the New River. Fish tissue contained low levels of contaminants that do not represent a public health hazard. However, these few samples may not be statistically representative of the fish commonly consumed. Therefore, ATSDR recommends that additional fish as well as a variety of shellfish be sampled to determine if people are consuming seafood that may be hazardous.

2. **One family reports that their children, who attended the day care center at Site 2, suffer from allergies. Could their current allergies be caused by their exposure to pesticides in the past?**

   ATSDR researched the available scientific literature to determine if there is any correlation between pesticide exposure and general allergies. No link between pesticide exposure and general allergies was identified.

   Exposure to the pesticides found at Site 2, DDT and chlordane, could possibly cause a subsequent allergic response to additional exposures to DDT or chlordane, but would not cause general allergies to other substances such as cats, dusts, or grasses. DDT and chlordane have not been used in the U.S. since the 1970s. If the child is no longer being exposed to DDT and chlordane, then the child would not be expected to currently have allergic responses. Moreover, one would not likely see a sustained reaction over the past twelve years since the time the day care center was closed.

3. **Does groundwater contamination on base pose a threat to the safety of county and community water wells?**

   No, not at this time. The closest off-base drinking water wells are one-half mile from the base boundary. We have not found that groundwater contamination on-base has moved off-base. In addition, public water wells are routinely tested to ensure safe drinking water.

ATSDR does recommend that MCB Camp Lejeune continue to test for groundwater contamination on base. If monitoring shows that the contaminated groundwater is moving toward on- or off-base drinking water supplies, measures should be taken to ensure that people do not come in contact with the contaminants. If the contaminated groundwater is moving towards areas where the groundwater use is unknown, we recommend that a thorough well survey be conducted of those areas. However, we do not think it is likely that off-base wells will become contaminated. The typical groundwater flow direction is toward the regional waterways (creeks, the New River and the Atlantic Ocean) and away from off-base wells.

MCB Camp Lejeune is cleaning up the groundwater near the Hadnot Point Industrial Area by pumping the water and treating it. Treating the water while it is inside the base should also reduce the possibility of groundwater contamination migrating off-base.

4. **Would rashes and illnesses reported by workers while installing a fence around the Rifle Range Chemical Dump (Site 69) be attributable to exposure to hazardous chemicals?**

   Since these employees were installing a fence, they probably had contact with surface and subsurface soil. Soil sampling has been conducted at this site, but the results are pending. However, even with soil sampling information, we would need more specific medical information before we could evaluate whether exposure caused the reported symptoms. In the case of rashes, causality would be difficult to determine because rashes have so many different causes.

5. **Are children attending an elementary school near the Rifle Range Chemical Dump (Site 69) being exposed to contaminants in the environment that will result in adverse health effects?**

   It is unlikely that soil contaminants from Site 69 are migrating at this time because the wastes are buried. Additionally, the site is fenced. The school is located far enough away (two miles) that dust from clean-up operations would not present a public health problem. However, ATSDR recommends that MCB Camp Lejeune use appropriate measures (e.g., use dust control procedures and conduct air monitoring) during any site clean up.

6. **Could illnesses reported by two workers on Storage Lots 201 and 203 (Site 6) be related to exposure?**

   We would need to have additional information before we could answer this question. In particular, we would need to know what types of illnesses these workers were reporting, the setting in which the illnesses occurred; the workers' occupations, ages, and sexes; and their clinical symptoms. Further, we would have to know the substances to which they were exposed. Without all this information, ATSDR cannot determine if any health problems that developed in the workers are attributable to exposures.

7. **What will be done with contaminated soils and water found on base when they are removed from the base?**

   Remedial investigations are still underway for some of the sites on the base. These investigations must be complete before a decision is made on what will be done with contaminated soils and materials. Federal and state agencies will consider alternative clean-up plans and will ask the public for its opinion on them.

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APPENDICES

APPENDIX A - Public Health Assessment Conclusion Categories

APPENDIX A - ATSDR Public Health Assessment Conclusion Categories

Category	Definition	Criteria
A. Urgent public health hazard	This category is used for sites that pose an urgent public health hazard as the result of short-term exposures to hazardous substances.	• evidence exists that exposures have occurred, are occurring, or are likely to occur in the future AND • estimated exposures are to a substance(s) at concentrations in the environment that, upon short-term exposures, can cause adverse health effects to any segment of the receptor population AND/OR • community-specific health outcome data indicate that the site has had an adverse impact on human health that requires rapid intervention AND/OR • physical hazards at the site pose an imminent risk of physical injury
B. Public health hazard	This category is used for sites that pose a public health hazard as the result of long-term exposures to hazardous substances.	• evidence exists that exposures have occurred, are occurring, or are likely to occur in the future AND • estimated exposures are to a substance(s) at concentrations in the environment that, upon long-term exposures, can cause adverse health effects to any segment of the receptor population AND/OR • community-specific health outcome data indicate that the site has had an adverse impact on human health that requires intervention
C. Indeterminate (potential) public health hazard	This category is used for sites with incomplete information.	• limited available data do not indicate that humans are being or have been exposed to levels of contamination that would be expected to cause adverse health effects; data or information are not available for all environmental media to which humans may be exposed AND • there are insufficient or no community-specific health outcome data to indicate that the site has had an adverse impact on human health
D. No apparent public health hazard	This category is used for sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.	• exposures do not exceed an ATSDR chronic MRL or other comparable value AND • data are available for all environmental media to which humans are being exposed AND • there are no community-specific health outcome data to indicate that the site has had an adverse impact on human health
E. No public health hazard	This category is used for sites that do not pose a public health hazard.	• no evidence of current or past human exposure to contaminated media AND • future exposures to contaminated media are not likely to occur AND • there are no community-specific health outcome data to indicate that the site has had an adverse impact on human health

APPENDIX B - Site-Specific Background Information

APPENDIX B-1
List of MCB Camp Lejeune's Initial Assessment Sites

1 French Creek Liquids Disposal Area
2 Former Nursery/Day Care Center
3 Old Creosote Plant
4 Sawmill Road Construction Debris Dump
5 Piney Green Road
6 Storage Lots 201 and 203
7 Tarawa Terrace Dump
8 Flammable Storage Warehouse, Building TP-451 and TP-452
9 Fire Fighting Training Pit at Piney Green Road
10 Original Base Dump
11 Pest Control Shop
12 Explosive Ordnance Demolition (EOD)--G-4
13 Golf Course Construction Dump Site
14 Knox Area Rip-Rap
15 Montford Point Dump Site (1948-1958)
16 Montford Point Burn Dump (1958-1972)
17 Montford Point Area Rip-Rap
18 Watkins Village (E) Site
19 Naval Research Lab Dump
20 Naval Research Lab Incinerator
21 Transformer Storage Lot 140
22 Industrial Area Tank Farm
23 Roads and Grounds, Building 1105
24 Industrial Area Fly Ash Dump
25 Base Incinerator
26 Coal Storage Area
27 Naval Hospital Area Rip-Rap
28 Hadnot Point Burn Dump
29 Base Sanitary Landfill
30 Sneads Ferry Road-Fuel Tank Sludge Area
31 Engineering Stockade-G4 Rang Road
32 French Creek
33 Onslow Beach Road
34 Ocean Drive
35 Camp Geiger Area Fuel Farm
36 Camp Geiger Area Dump Near Sewage Treatment Plant
37 Camp Geiger Area Surface Dump
38 Camp Geiger Construction Dump
39 Camp Geiger Construction Slab Dump
40 Camp Geiger Area Borrow Pit
41 Camp Geiger Dump Near Former Trailer Park
42 Building 705, BOQ Dump
43 Agan Street Dump
44 Jones Street Dump
45 MCAS JP Fuel Farm and Rapid Refuel Area
46 MCAS Main Gate Dump
47 MCAS Rip-Rap Near Stick Creek
46 MCAS Main Gate Dump
47 MCAS Rip-Rap Near Stick Creek
48 MCAS Mercury Dump Site
49 MCAS Suspected Minor Dump
50 MCAS Small-Craft Berthing Rip-Rap
51 MCAS Football Field
52 MCAS Direct Refuel Depot
53 MCAS Warehouse Building 3525 Area (Oiled Roads)
54 Crash Crew Fire Training Burn Pit
55 Air Station East Perimeter Dump
56 MCAS Oiled Roads to Marina
57 Runway 36 Dump
58 MCAS Tank Training Area
59 MCAS Infantry Training Area
60 EOD K-326 Range
61 Rhodes Point Road Dump
62 Race Course Area Dump
63 Vernon Road Dump
64 Marines Road-Sneads Ferry Road MOGAS Spill
64 Engineer Area Dump
66 AMTRAC Landing Site and Storage Area
67 Engineers TNT Burn Site
68 Rifle Range Dump
69 Rifle Range Chemical Dump
70 Oak Grove Field-Surface Dump
71 Oak Grove Buried Dump
72 Oak Grove Coal Pile
73 Courthouse Bay Liquids Disposal Area
74 Mess Hall Grease Pit Area
75 MCAS Basketball Court Site
76 MCAS Curtis Road Site
A MCAS Officers' Housing Area

APPENDIX B-2
Summary of Site Evaluations

Highlighted sites are Health Priority Sites discussed further in this public health assessment

Operable Unit	Site Number	Site Name	Contaminated Media[1]					Evaluations
			Ground water	Soil	Surface Water	Sediment	Food Chain	
OU-1	21	Transformer Storage Lot 140	•	•	NA[2]	NA	NA	Groundwater and surface water contamination at this site contribute to ATSDR's overall concern for potential human health hazards. However, no one is coming in contact with sediments or soil. Therefore, there was no need to analyze this further.
	24	Industrial Area Fly Ash Dump	•	NA	•	•	NA	Groundwater and surface water contamination at this site contribute to ATSDR's overall concern for potential human health hazards. However, no one is coming in contact with sediments. Therefore, there was no need to analyze this further.
	78	Hadnot Point Industrial Area	•	•	NA	NA	NA	Groundwater contamination at this site contributes to ATSDR's overall concern for potential human health hazards. However, no one is coming in contact with soil at this site. This site was not originally included in the 22 priority site, but was subsequently added to OU-1.
OU-2	6	Storage Lots 201 and 203	•	•	•	•	•[2]	Groundwater, surface water, and fish (food chain) contamination at this site contribute to ATSDR's overall concern for potential human health hazards. However, no one is coming in contact with sediments or soil at this site.
	9	Fire Fighting Training Pit at Piney Green Road	•	NA	•[2]	•[2]	•[2]	Groundwater, surface water, and fish (food chain) contamination at this site contribute to ATSDR's overall concern for potential human health hazards. However, no one is coming in contact with sediments or soil at this site.
	82	Piney Green Road VOC Site	•[2]	•[2]	•[2]	•[2]	•[2]	Groundwater, surface water, and fish (food chain) contamination at this site contribute to ATSDR's overall concern for potential human health hazards. However, no one is coming in contact with sediments or soil at this site. This site was not originally included in the 22 priority sites, but was subsequently added to OU-2.
OU-3	48	MCAS Mercury Dump Site	NA	•	•	•	ND[3]	Low level mercury contamination in sediments near this site, the uses of the New River, and the likelihood that mercury biomagnifies up the food chain contribute to ATSDR's overall concern for potential human health hazards.
OU-4	41	Camp Geiger Dump Near Former Trailer Park	•	NA	•	•	NA	Groundwater and surface water contamination at this site contribute to ATSDR's overall concern for potential human health hazards. However, no one is coming in contact with sediments or soil at this site since the trailer park has been closed.
	69	Rifle Range Chemical Dump	•	NA	•	•	NA	Groundwater and surface water contamination at this site contribute to ATSDR's overall concern for potential human health hazards. However, no one is coming in contact with sediments or soil at this site. A fence surrounding the site was installed in 1993.
	74	Mess Hall Grease Pit Disposal Area	•	•	NA	NA	NA	Groundwater contamination at this site contributes to ATSDR's overall concern for potential human health hazards. However, no one is coming in contact with sediments or soil at this site.
OU-5	2	Former Nursery/Day Care Center	•	•	•	•	NA	Human exposure to contaminated soil at this site is categorized as a health hazard.

Food Chain are considered plants and animals which are food sources for humans. Fish and shellfish are considered food chain entities.

Summary of Site Evaluations (Continued)

Operable Unit	Site Number	Site Name	Contaminated Media[1]					Evaluations
			Ground water	Soil	Surface Water	Sediment	Food Chain	
OU-8	43	Agan Street Dump	☐	•[4]	ND	☐	☐	Physical hazards and soil contamination are no longer a public health concern since a fence was installed to prevent people from coming in contact with rusted tanks, debris, and possible soil contamination. Samples of surface water runoff did not contain contamination. This site was not originally included in the 22 priority sites, but was subsequently added to OU-6.
	54	Crash Crew Fire Training Burn Pit	•	•	ND	•	NA	Groundwater contamination at this site contributes to ATSDR's overall concern for potential human health hazards. However, no one is coming in contact with sediments or soil at this site.
	88	MCAS Tank Area AS 419 - AS 422	☐	☐	☐	☐	☐	This site was not originally included in the 22 priority sites, but was subsequently added to OU-6. ATSDR has requested further information regarding this site.
OU-7	1	French Creek Liquids Disposal Area	•	NA	•	•	NA	Groundwater and surface water contamination at this site contributes to ATSDR's overall concern for potential human health hazards.
	28	Hadnot Point Burn Dump	•	NA	•	•	ND[5]	Preliminary fish sampling reports indicate that fish in Orde Pond are not contaminated. Surface soil sampling will be conducted to determine if surface soil is contaminated. However, with the tremendous volume of clean fill covering the site, surface soil contamination is unlikely.
	30	Sneads Ferry Road-Fuel Tank Sludge Area	•	NA	ND	ND	NA	Groundwater contamination at this site contributes to ATSDR's overall concern for potential human health hazards. Current soil investigations are underway.
OU-8	16	Montford Point Burn Dump (1968-1972)	☐	☐	☐	☐	☐	This site was not originally included in the 22 priority sites, but was subsequently added to OU-8. ATSDR has requested further information regarding this site.
OU-9	86	Engineer Area Dump	☐	☐	☐	☐	☐	This site was not originally included in the 22 priority sites, but was subsequently added to OU-9. ATSDR has requested further information regarding this site.
	73	Courthouse Bay Liquids Disposal Area[7]	•	NA	ND	•	NA	Groundwater contamination at this site contributes to ATSDR's overall concern for potential human health hazards.
OU-10	35	Camp Geiger Area Fuel Farm	•	•	ND	•	NA	Groundwater contamination at this site contributes to ATSDR's overall concern for potential human health hazards.
OU-11	7	Tarawa Terrace Dump	☐	☐	☐	☐	☐	This site was not originally included in the 22 priority sites, but was subsequently added to OU-11. ATSDR has requested further information regarding this site.
	80	Paradise Point Golf Course Pesticide Area	☐	☐	☐	☐	☐	This site was not originally included in the 22 priority sites, but was subsequently added to OU-11. ATSDR has requested further information regarding this site.
OU-12	3	Old Creosote Plant	☐	☐	☐	☐	☐	This site was not originally included in the 22 priority sites, but was subsequently added to OU-12. ATSDR has requested further information regarding this site.
OU-13	63	Vernon Road Dump	☐	☐	☐	☐	☐	This site was not originally included in the 22 priority sites, but was subsequently added to OU-13. ATSDR has requested further information regarding this site.

Summary of Site Evaluations (Continued)

Operable Unit	Site Number	Site Name	Contaminated Media[1]					Evaluations
			Ground water	Soil	Surface Water	Sediment	Food Chain	
-	22	Industrial Area Tank Farm	•	NA	NA	NA	NA	This site was included in the original 22 priority sites. A separate investigation of Hadnot Point Industrial Area was conducted. Therefore, this site is not is not included in the Operable Unit Installation Restoration Program. Groundwater contamination (benzene, etc) was detected in base drinking water supply well 602. That well has not been used since 1984. Groundwater contamination at this site contributes to ATSDR's overall concern for potential human health hazards from exposure to contaminated drinking water.
-	45	Campbell Street Underground Fuel Storage Area	•	NA	•	•	NA	This site was included in the original 22 priority sites. Groundwater, surface water, and sediment contamination at this site contribute to ATSDR's overall concern for potential human health hazards. ATSDR is requesting additional information regarding the follow-up activities at this site and the rationale for this site's exclusion from the IRP.
-	68	Rifle Range Dump	ND	NA	NA	NA	NA	This site was included in the original 22 priority sites. No contamination was detected in groundwater at this site indicating that contamination has not migrated from the landfill. Groundwater well monitoring would ensure that this site is not contributing to the base wide groundwater contamination. No further investigations or clean-up activities were recommended in the 1990 Site Summary Report.
-	75	MCAS Basketball Court Site	ND	NA	NA	NA	NA	This site was included in the original 22 priority sites. No contamination was detected in the groundwater at this site indicating that contamination has not migrated from the site. The geophysical survey, did not detect the presence of any buried objects. No further investigations or clean-up activities were recommended in the 1990 Site Summary Report.
-	76	MCAS Curtis Road Site	ND	NA	NA	NA	NA	This site was included in the original 22 priority sites. No contamination was detected in the groundwater at this site indicating that contamination has not migrated from the site. The geophysical survey, did not detect the presence of any buried objects. No further investigations or clean-up activities were recommended in the 1990 Site Summary Report.
-	A	MCAS (H) Officers' Housing Area	ND	NA	ND	ND	NA	This site was included in the original 22 priority sites. No contamination was detected in the groundwater or surface water at this site indicating that contamination has not migrated from the site. No further investigations or clean-up activities were recommended in the 1990 Site Summary Report.

1 - Contaminated Media as documented in Site Summary Report, September 1990
2 - Contamination as documented in the Remedial Investigation Report for Operable Unit 2, June 1993.
3 - Contamination not detected as reported in the Status of Installation Restoration Program Activities at Marine Corps Base, Camp Lejeune North Carolina, June 18, 1993.
4 - Information obtained during ATSDR site visit October 1993.
5 - Preliminary Fish Sampling Data received from MCB Camp Lejeune January 1994.

NA - "Not Analyzed", medium not sampled
ND - "Not Detected" medium sampled, contamination was not detected
• - documented contamination in that medium
☐ - ATSDR has requested information regarding these sites, but has not yet received that information.

Sites 22,45,68,75,76, and A were included in the original 22 priority sites, but are not included in the current Installation Restoration Program.
Sites 78,82,43,86,16,65,7,80,3, and 63 were not originally part of the 22 priority sites, but were subsequently added to the IRP for further investigation.

APPENDIX C - LEAD INFORMATION

APPENDIX C-1
Lead Sampling of Buildings in Hadnot Point Drinking Water Distribution System

NOTE: In June 1993, MCB flushed the water lines six hours prior to sampling to determine if flushing had any impact on the lead levels. Only a few taps were initially analyzed in this manner. When the results indicated that flushing seemed to reduced lead levels, it was performed (no sooner than) six hours prior to the third sampling round ending 12/31/93 as stated in the "Rule".

Sample #	Building	Location	Ending 12/31/92	4/1/93	Flush 6/31/93	Ending 12/31/93
HP1-01	H 25	Kitchen Faucet	0.002	0.002	----	<0.002
HP1-02	H 26	Kitchen Faucet	0.002	0.002	----	0.002
HP1-03	H 27	Kitchen Faucet	0.002	0.003	----	<0.002
HP1-04	H 49	Kitchen Faucet	0.002	0.002	----	<0.002
HP1-05	H 50	Kitchen Faucet	0.002	0.002	----	0.003
HP1-06	H 51	Kitchen Faucet	0.002	0.002	----	0.002
HP1-07	H 52	Kitchen Faucet	----	0.002	----	<0.002
HP1-08	H 53	Kitchen Faucet	0.002	0.002	----	<0.002
HP1-09	H 54	Kitchen Faucet	0.002	0.002	----	<0.002
HP1-10	H 55	Kitchen Faucet	0.004	0.002	----	0.052*
HP1-11	H 56	Kitchen Faucet	0.002	0.002	----	<0.002
HP1-12	H 57	Kitchen Faucet	0.002	0.006	----	0.008
HP1-13	H 58	Kitchen Faucet	0.002	0.002	----	<0.002
HP1-14	H 59	Kitchen Faucet	0.005	0.002	----	<0.002
HP1-15	H 60	Kitchen Faucet	0.002	0.002	----	0.002
HP1-16	H 61	Kitchen Faucet	0.002	0.002	----	<0.002
HP1-17	H 62	Kitchen Faucet	0.002	0.002	----	0.002
HP1-18	H 63	Kitchen Faucet	0.002	0.004	----	<0.002
HP1-19	H 65	Kitchen Faucet	0.002	0.002	----	<0.002
HP1-20	H 66	Kitchen Faucet	0.002	0.002	----	0.007
HP1-21	H 67	Kitchen Faucet	0.002	0.002	----	0.002
HP1-22	H 68	Kitchen Faucet	0.002	0.002	----	<0.002
HP1-23	H 69	Kitchen Faucet	0.002	0.009	----	<0.002
HP2-24	FC 40	Auto Shop Kitchen Faucet	0.256*	0.002	0.003	0.002
HP2-25	FC 50	Kitchen Faucet	0.007	0.007	----	0.003
HP2-26	FC 115	Field Maint. Shed Deep Sink	0.508*	0.061*	0.006	0.002
HP2-27	FC 120	Auto Shop Deep Sink	0.018*	1.130*	0.013	0.008

HP2-28	FC 195	Elec. Main Deep Sink	0.047*	0.060*	0.018*	<0.002
HP2-29	FC 253	Elec. Main Deep Sink	0.484*	0.689*	0.074*	0.075*
HP2-30	FC 255	Auto Shop Deep Sink	1.990*	0.016*	0.053*	0.049*
HP2-31	FC 263	Deep Sink	2.720*	0.014	----	0.006
HP2-32	FC 270	Deep Sink	0.011	0.011	----	0.006
HP2-33	FC 330	Deep Sink	0.002	0.005	----	0.002
HP2-34	FC 571	BEQ - Deep Sink	0.013	0.120*	0.004	0.003
HP2-35	FC 573	BEQ - Deep Sink	0.012	0.334*	0.004	0.004
HP2-36	FC 574	BEQ - Deep Sink	0.010	0.121*	0.007	0.018*
HP2-37	679	Deep Sink	0.002	0.002	----	<0.002
HP2-38	50	Admin Deep Sink	1.110*	0.044*	0.008	0.032*
HP2-39	H 1	Deep Sink	0.009	0.004	----	0.002
HP2-40	1003	Kitchen Faucet	0.003	0.006	----	0.003
HP2-41	1057	Bar Faucet	0.003	0.002	----	0.008
HP2-42	1006	Enlisted Club Bar Sink	1.350*	0.002	0.011	0.004
HP2-43	1854	Auto Shop Deep Sink	0.6888	0.026*	0.039*	0.002
HP2-44	1860	Maint. Deep Sink	0.321*	0.002	0.002	<0.002
HP2-45	1880	Auto Shop Deep Sink	0.240*	1.450*	0.003	0.008
HP2-46	H 28	Kitchen Faucet	0.002	0.018*	----	<0.002
HP2-47	HP 1000	Mens Sink	0.009	0.005	----	0.009
HP2-48	HP 215	Deep Sink	0.012	0.023	----	0.003
HP2-49	HP 275	Deep Sink	0.008	0.003	----	<0.002
HP2-50	HP 235	Deep Sink	0.004	0.006	----	0.003
HP2-51	HP 245	Deep Sink	0.003	0.012	----	0.003
HP2-52	HP 255	Deep Sink	0.002	0.002	----	0.006
HP2-53	HP 265	Deep Sink	0.213*	0.002	----	0.002
HP2-54	HP 275	Deep Sink	0.002	0.002	----	0.002
HP2-55	HP 285	Deep Sink	0.005	0.002	----	0.003
HP2-56	HP 295	Deep Sink	0.013	0.002	----	<0.002
HP2-57	HP 405	BEQ - Deep Sink	0.002	0.458*	0.007	<0.002
HP2-58	HP 415	BEQ - Deep Sink	0.013	0.226*	0.010	0.008
HP2-59	HP 425	BEQ - Deep Sink	0.006	10.1*	0.196*	0.006
HP2-60	HP 435	BEQ - Deep Sink	0.008	0.997*	0.008	0.006

* indicates lead levels above EPA's Action Level of 0.015 ppm

APPENDIX C-2
Lead Sampling of Buildings in Marine Corps Air Station Drinking Water Distribution System

NOTE: In June 1993, MCB flushed the water lines six hours prior to sampling to determine if flushing had any impact on the lead levels. Only a few taps were initially analyzed in this manner. When the results indicated that flushing seemed to reduced lead levels, it was performed (no sooner than) six hours prior to the third sampling round ending 12/31/93 as stated in the "Rule".

Sample #	Building	Location	Ending 12/31/92	4/1/93	Flush 6/31/93	Ending 12/31/93
MCAS2-01	AS 427	Deep Sink	0.002	0.002	----	0.011
MCAS3-02	AS 212	Deep Sink	0.003	0.008	----	0.002
MCAS3-03	AS 215	BEQ?- Deep Sink	0.042*	0.031*	0.012	0.003
MCAS2-04	AS 3003	Bath Sink	0.003	0.002	----	0.004
MCAS2-05	AS 4035	BEQ - Deep Sink	0.189*	0.032*	0.059*	0.013*
MCAS2-06	AS 4038	Bar Sink	0.015*	0.002	----	0.006
MCAS3-07	AS 302	Deep Sink	0.002	0.012	----	0.007
MCAS2-08	AS 216	Deck 2 Mens	0.005	0.038*	0.003	0.009
MCAS2-09	AS 4012	Kitchen Faucet	0.002	0.002	----	<0.002
MCAS2-10	AS 143	Gas Station Garage Sink	0.005	0.072*	<0.002	<0.050*
MCAS2-11	AS 702	BEQ - Deep Sink	0.005	0.072*	<0.002	<0.002
MCAS2-12	AS 704	Deep Sink	0.002	0.002	----	<0.002
MCAS2-13	AS 2818	Shower	0.033*	0.042*	----	0.013
MCAS2-14	AS 217	Ground Operations Deck 2 Bath	0.043*	0.024*	0.011	0.014
MCAS2-15	AS 232	Mens Bath	0.002	0.007	----	0.002
MCAS3-16	G 480	Armory - Deep Sink	0.003	0.055*	0.004	0.003
MCAS3-17	AS 201	Deep Sink	0.019*	0.009	----	0.003
MCAS3-18	AS 211	Deck 3 Womens	0.002	0.002	----	0.011
MCAS3-19	AS 320	Deep Sink	0.002	0.003	----	<0.002
MCAS3-20	AS 402	Deep Sink	0.002	0.002	----	0.058*
MCAS3-21	AS 539	Kitchen Sink	0.002	0.002	----	0.002
MCAS3-22	G 530	Deep Sink	0.004	0.004	----	0.003
MCAS3-23	G 540	Deep Sink	0.014	0.014	----	0.012
MCAS3-24	G 520	Deep Sink	0.002	0.003	----	<0.002
MCAS3-25	TC 601	Womens Bath	0.005	0.016*	----	0.009
MCAS3-26	AS 804	Bath Sink	0.002	0.004	----	0.024*
MCAS3-27	AS 831	Bath Sink	0.002	0.002	----	0.198*
MCAS3-28	AS 843	Op Bldg Mens Bath	0.026*	0.003	0.003	<0.002
MCAS3-29	TC 1110	Hdqtrs. Deep Sink	0.005	0.066*	0.003	<0.002
MCAS3-30	AS 901	Kitchen Sink	0.003	0.007	----	<0.002
MCAS3-31	AS 903	Transmitter Bldg Mens Sink	0.108*	0.004	0.003	0.003
MCAS3-32	AS 200	Deep Sink	0.002	0.019*	----	0.002
MCAS3-33	AS 4015	BEQ - Deep Sink	0.928*	0.016*	0.008	0.003

MCAS3-34	AS 4020	BEQ - Deep Sink	1.000*	0.031*	<0.002	<0.002
MCAS3-35	AS 4025	BEQ - Deep Sink	0.206*	0.003	0.014	0.006
MCAS3-36	AS 4030	BEQ - Deep Sink	0.077*	0.222*	0.016*	0.002
MCAS3-37	AS 236	Chapel - Kitchen Sink	0.002	0.027*	0.002	<0.002
MCAS3-38	AS 4100	Hanger Deep Sink	0.024*	0.100*	0.009	0.019*
MCAS3-39	AS 4126	Subway Fes	0.002	0.002	----	<0.002
MCAS3-40	AS 4141	Deep Sink	0.002	0.002	----	<0.002
MCAS3-41	G 522	Deep Sink	0.002	0.002	----	0.007
MCAS3-42	G 523	Deep Sink	0.002	0.002	----	0.003
MCAS3-43	G 524	Deep Sink	0.003	0.010	----	0.009
MCAS3-44	G 531	BEQ - Deep Sink	0.003	0.024*	0.002	0.023*
MCAS3-45	G 532	Deep Sink	0.017*	0.005	----	0.021*
MCAS3-46	G 533	Deep Sink	0.009	0.016*	----	0.013
MCAS3-47	G 534	Deep Sink	0.006	0.011	----	0.471*
MCAS3-48	G 541	Deep Sink	0.007	0.004	----	0.005
MCAS3-49	G 542	Deep Sink	0.012	0.012	----	0.019*
MCAS3-50	G 543	Deep Sink	0.002	0.002	----	<0.002
MCAS3-51	G 544	Deep Sink	0.003	0.004	----	0.005
MCAS3-52	G 551	Deep Sink	0.002	0.008	----	<0.002
MCAS3-53	G 552	Deep Sink	0.002	0.002	----	0.012
MCAS3-54	G 553	BEQ - Deep Sink	0.049*	0.002	0.015	0.037*
MCAS3-55	G 554	Deep Sink	0.009	0.005	----	0.005
MCAS3-56	G 560	Staff Club Ladies Bath	0.698*	0.321*	0 006	0.778*
MCAS3-57	G 770	Deep Sink	0.002	0.002	----	0.010
MCAS3-58	G 770	Dental Deep	0.880*	0.186*	----	0.005
MCAS3-59	AS 122	Mens Bath	0.009	0.009	----	<0.002
MCAS3-60	AS 312	BEQ - Mens Room	0.320*	0.006	0.006	0.002

* indicates lead levels above EPA's Action Level of 0.015 ppm

APPENDIX C-3
Lead Sampling of Buildings in Holcomb Boulevard Drinking Water Distribution System

Sample #	Building	Location	Ending 12/31/92	4/1/93
HB1-01	TT 328	Kitchen Faucet	0.002	0.002
HB1-02	TT 332	Kitchen Faucet	0.002	0.002
HB1-03	TT 338	Kitchen Faucet	0.002	0.002
HB1-04	TT 340	Kitchen Faucet	0.002	0.060*
HB1-05	TT 350	Kitchen Faucet	0.002	0.002
HB1-06	TT 352	Kitchen Faucet	0.002	<0.002
HB1-07	TT 356	Kitchen Faucet	0.002	0.003
HB1-08	TT 360	Kitchen Faucet	0.002	0.002
HB1-09	TT 364	Kitchen Faucet	0.002	<0.002
HB1-10	TT 368	Kitchen Faucet	0.002	0.002
HB1-11	TT 372	Kitchen Faucet	0.002	0.002
HB1-12	TT 376	Kitchen Faucet	0.002	0.002
HB1-13	TT 380	Kitchen Faucet	0.002	0.002
HB1-14	TT 388	Kitchen Faucet	0.002	<0.002
HB1-15	TT 396	Kitchen Faucet	0.002	0.003
HB1-16	TT 400	Kitchen Faucet	0.002	<0.002
HB1-17	TT 404	Kitchen Faucet	0.002	0.003
HB1-18	TT 408	Kitchen Faucet	0.002	0.002
HB1-19	TT 412	Kitchen Faucet	0.002	0.002
HB1-20	TT 416	Kitchen Faucet	0.002	0.007
HB1-21	PP 3245	Kitchen Faucet	0.002	0.002
HB1-22	PP 3246	Kitchen Faucet	0.002	0.002
HB1-23	PP 3247	Kitchen Faucet	0.002	0.002
HB1-24	PP 3248	Kitchen Faucet	0.002	0.002
HB1-25	PP 3249	Kitchen Faucet	0.002	0.002
HB1-26	PP 3230	Kitchen Faucet	0.002	0.002
HB1-27	PP 3231	Kitchen Faucet	0.002	0.002
HB1-28	PP 3232	Kitchen Faucet	0.002	0.002
HB1-29	PP 3233	Kitchen Faucet	0.002	0.002

HB1-30	PP 3234	Kitchen Faucet	0.002	0.002
HB1-31	PP 3235	Kitchen Faucet	0.002	0.002
HB1-32	PP 3215	Kitchen Faucet	0.002	0.002
HB1-33	PP 3216	Kitchen Faucet	0.002	0.002
HB1-34	PP 3217	Kitchen Faucet	0.002	0.002
HB1-35	PP 3218	Kitchen Faucet	0.002	0.002
HB1-36	PP 3200	Kitchen Faucet	0.002	0.002
HB1-37	PP 3201	Kitchen Faucet	0.002	0.002
HB1-38	PP 3202	Kitchen Faucet	0.002	0.002
HB1-39	PP 3203	Kitchen Faucet	0.002	0.003
HB1-40	PP 3004	Kitchen Faucet	0.002	0.002
HB1-41	PP 3008	Kitchen Faucet	0.002	0.002
HB1-42	PP 3009	Kitchen Faucet	0.002	0.002
HB1-43	PP 3010	Kitchen Faucet	0.002	0.002
HB1-44	PP 3011	Kitchen Faucet	0.002	0.002
HB1-45	PP 3012	Kitchen Faucet	0.004	0.002
HB1-46	PP 3013	Kitchen Faucet	0.002	0.002
HB1-47	PP 3014	Kitchen Faucet	0.002	0.002
HB1-48	PP 3015	Kitchen Faucet	0.002	0.002
HB1-49	PP 3016	Kitchen Faucet	0.002	0.003
HB1-50	PP 3017	Kitchen Faucet	0.002	0.002
HB1-51	PP 2909	Kitchen Faucet	0.002	0.002
HB1-52	PP 2910	Kitchen Faucet	0.002	0.002
HB1-53	PP 2911	Kitchen Faucet	0.002	0.002
HB1-54	PP 2912	Kitchen Faucet	0.002	0.002
HB1-55	PP 2913	Kitchen Faucet	0.003	0.002
HB1-56	PP 2914	Kitchen Faucet	0.002	0.002
HB1-57	PP 2915	Kitchen Faucet	0.002	0.002
HB1-58	PP 2916	Kitchen Faucet	0.002	0.002
HB1-59	PP 2917	Kitchen Faucet	0.002	0.002
HB1-60	PP 2918	Kitchen Faucet	0.002	0.002

* indicates lead levels above EPA's Action Level of 0.015 ppm

APPENDIX C-4

Lead Sampling of Buildings in Courthouse Bay Drinking Water Distribution System

Sample #	Building	Location	Ending 12/31/93
CB1-01	BB 17	Kitchen Faucet	<0.002
CB1-02	BB 18	Kitchen Faucet	<0.002
CB1-03	BB 19	Kitchen Faucet	<0.002
CB1-04	BB 20	Kitchen Faucet	0.002
CB1-05	BB 21	Kitchen Faucet	<0.002
CB1-06	BB 22	Kitchen Faucet	<0.002
CB1-07	BB 23	Kitchen Faucet	<0.002
CB1-08	BB 24	Kitchen Faucet	<0.002
CB2-09	A 47	Deep Sink in Shop Bath	0.013
CB2-10	BB 8	Deep Sink - Male Bath	0.009
CB2-11	BB 45	Mop Basin Utility Closet	0.005
CB2-12	BB 48	Deep Sink	0.009
CB3-13	BB 54	Faucet - Male Bath	0.004
CB3-14	A 2	Sink 1 on Lt Side Male	0.002
CB3-15	BB 294	Faucet Mens Bath	0.020*
CB3-16	BB 2	Deep Sink Mens Bath	0.019*
CB3-17	BB 3	Deep Sink Female Bath	0.007
CB3-18	BB 5	Deep Sink Utility Closet	0.006
CB3-19	BB 7	Deep Sink	0.005
CB3-20	BB 9	Deep Sink in Office	0.028*
CB3-21	BB 10	Deep Sink in Male Bath	0.003
CB3-22	BB 11	Deep Sink in Male Bath	0.014
CB3-23	BB 12	Deep Sink 1 in Male Bath	0.004
CB3-24	BB 13	Deep Sink 1 LS Male	0.005
CB3-25	BB 14	Deep Sink SNCO Bath	0.009
CB3-26	BB 16	Deep Sink	0.008
CB3-27	BB 27	Faucet Male Bath	1.750*
CB3-28	BB 28	Right Faucet MALD	0.010
CB3-29	BB 38	Faucet in Head	0.014
CB3-30	BB 49	Deep Sink Maint. Shop	0.014
CB3-31	BB 50	Deep Sink	0.009
CB3-32	BB 51	Left Sink in Bath	0.010
CB3-33	BB 52	Gear Locker Deep Sink	0.008
CB3-34	BB 177	Faucet in Head	0.015
CB3-35	BB 245	Laundry Room Deep Sink	0.010
CB3-36	BB 250	Laundry Room Deep Sink	0.006
CB3-37	BB 255	Laundry Room Deep Sink	0.012
CB3-38	BB 260	Laundry Room Deep Sink	0.009
CB3-39	BB 265	Laundry Room Deep Sink	0.010
CB3-40	BB 270	Laundry Room Deep Sink	0.012

* indicates lead levels above EPA's Action Level of 0.015 ppm

APPENDIX C-5

Lead Sampling of Buildings in Onslow Beach Drinking Water Distribution System

Sample #	Building	Location	Ending 12/31/93
OB1-01	BA 119	Kitchen Faucet	0.014
OB1-02	BA 120	Kitchen Faucet	0.002
OB1-03	BA 146	Bathroom Faucet	0.005
OB2-04	BA 134	Bathroom Sink	0.012
OB3-05	BA 101	Deep Sink	0.643*
OB3-06	BA 102	Deep Sink Left Side	0.006
OB3-07	BA 103	Deep Sink	0.012
OB3-08	BA 104	Left Deep Sink	0.006
OB3-09	BA 105	Right Deep Sink	0.021*
OB3-10	BA 113	Recon Office Sink	0.002
OB3-11	BA 128	Deep Sink	0.434*
OB3-12	BA 130	Main Shop Sink	0.013
OB3-13	SBA 142	BR Sink Faucet	0.014
OB3-14	BA 147	Kitchen Faucet	0.005
OB3-15	BA 143 #1	Bathroom Faucet	0.077*
OB3-16	BA 143 #2	Bathroom Faucet	0.005
OB3-17	BA 143 #3	Kitchen Faucet	0.003
OB3-18	BA 144 #2	Bathroom Faucet	0.369*
OB3-19	BA 144 #3	Kitchen Faucet	0.325*
OB3-20	BA 144 #7	Kitchen Faucet	0.003

Lead Sampling of Buildings in Rifle Range Drinking Water Distribution System

Sample #	Building	Location	Ending 12/31/93
RR1-01	RR 39	Kitchen Faucet	0.003
RR1-02	RR 40	Kitchen Faucet	0.006
RR1-03	RR 41	Kitchen Faucet	0.007
RR1-04	RR 42	Kitchen Faucet	0.005
RR1-05	RR 43	Kitchen Faucet	0.002
RR2-06	RR 6	Kitchen Faucet	0.003
RR2-07	RR 49	Bar Sink	0.031*
RR3-08	RR 1	Deep Sink Rt Side	0.017*
RR3-09	RR 2	Deep Sink Rt Side	0.003
RR3-10	RR 3	Mop Basin 1st Scullie	0.003
RR3-11	RR 4	Deep Sink Lt Side	0.005
RR3-12	RR 5	Deep Sink Head 2	0.007
RR3-13	RR 8	Deep Sink	0.025*
RR3-14	RR 10	Deep Sink Employee	0.002
RR3-15	RR 11	Deep Sink Rt Side	0.004
RR3-16	RR 15	Deep Sink Corner	0.002
RR3-17	RR 48	Deep Sink Office	0.002
RR3-18	RR 9	Deep Sink Rt Side	0.003
RR3-19	RR 17	Faucet 1st in Head	0.005
RR3-20	RR 20	Faucet 1st in Head	0.017*

* indicates lead levels above EPA's Action Level of 0.015 ppm

APPENDIX C-6

Blood Lead Levels of Base Residents or Workers (reported January 1994)

No.	Work Area	Residence	Months[1]	Blood Lead Level[2]	No.	Work Area	Residence	Months	Blood Lead Level
1	-	HP425	12	4.5	53	-	HP425	9	7.8
2	-	HP425	12	7.6	54	-	HP425	11	5.7
3	-	HP425	4	1.1	55	-	HP425	12	2.9
4	-	HP425	12	7.2	56	-	HP425	11	5.2
5	-	HP425	10	2.1	57	-	HP425	12	3.0
6	-	HP425	10	0.5	58	-	HP425	12	2.8
7	-	HP425	12	0.5	59	-	HP425	12	9.1
8	-	HP425	12	0.4	60	-	HP425	12	2.3
9	-	HP425	12	0.2	61	-	HP425	12	4.2
10	-	HP425	2	0.7	62	-	HP425	12	3.1
11	-	HP425	3	0.2	63	FC253	-	11	6.3
12	-	HP425	12	1.9	64	FC253	-	25	3.7
13	-	HP425	12	1.7	65	FC253	-	1	3.1
14	-	HP425	14	1.7	66	FC253	-	13	4.6
15	-	HP425	6	0.8	67	FC253	-	7	4.3
16	-	HP425	14	2.5	68	FC253	-	16	1.4
17	-	HP425	12	1.2	69	FC253	-	6	0.6
18	-	HP425	8	12.4*	70	FC253	-	3	0.8
19	-	HP425	6	2.7	71	FC253	-	3	2.9
20	-	HP425	3	0.8	72	FC253	-	15	0.4
21	H+S	2083 T	0	0.5	73	FC253	-	11	2.4
22	-	HP425	48	3.3	74	FC253	-	13	0.6
23	-	HP425	12	6.7	75	FC253	-	5	9.2
24	-	HP425	36	3.7	76	FC253	-	4	3.4
25	-	HP425	6	1.8	77	FC253	-	37	6.2
26	-	HP425	1	0.1	78	FC253	-	9	4.5
27	-	HP425	1	2.0	79	FC253	-	15	5.5
28	-	HP425	24	11.4*	80	FC253	-	32	4.9
29	-	-	0	0	81	FC253	-	7	5.6
30	-	HP425	12	8.1	82	FC253	-	7	1.9
31	-	HP425	12	3.1	83	FC253	-	3	4.7
32	-	HP425	24	2.2	84	FC253	-	12	5.9
33	-	HP425	1	7.6	85	FC253	-	2	0.8
34	-	HP425	12	2.9	86	FC253	-	16	5.3
35	-	HP425	5	5.4	87	FC253	-	15	6.7
36	-	HP425	11	3.6	88	FC253	-	5	8.8
37	-	HP425	6	9.5	89	FC253	-	47	5.7
38	-	HP425	12	6.3	90	FC253	-	4	7.8
39	-	HP425	13	4.8	91	FC253	-	21	3.9
40	-	HP425	12	6.8	92	FC253	-	13	6.6
41	-	HP425	12	4.7	93	FC253	-	13	1.0
42	-	HP425	24	5.6	94	FC253	-	3	5.6
43	-	HP425	5	1.2	95	FC253	-	4	7.8
44	-	HP425	10	5.1	96	FC253	-	25	9.2
45	RIVER	HP57	30	0.2	97	FC253	-	9	8.3
46	-	HP425	1	5.4	98	FC253	-	40	6.9
47	-	HP425	8	5.2	99	FC253	-	13	9.7
48	-	HP425	12	7.2	100	FC253	-	21	10.0*
49	-	HP425	13	5.7	101	FC253	-	13	6.1
50	-	HP425	11	3.1	102	FC253	-	14	4.2
51	-	HP425	12	5.1	103	FC253	-	0	3.2
52	-	HP425	12	6.2					

1 - denotes the number of months in residence
2 - denotes the blood lead levels measured in ug/dL (micrograms per deciliter) blood
* - elevated blood lead level over CDC recommended level of 10 ug/dL

APPENDIX C-7
Educational Lead Flyer

Lead in Drinking Water

We now have sampling results from buildings at Camp Lejeune using the medium-sized water distribution systems; Hadnot Point, Holcomb Boulevard, and Marine Corps Air Station - New River and the small-sized water distribution systems; Courthouse Bay, Rifle Range, and Onslow Beach. These results indicated that many of the buildings on base have lead levels above the Environmental Protection Agency's (EPA) action level of 15 parts per billion (ppb). The results from the buildings sampled ranged from < 2 ppb to 10,000 ppb. Although many of the buildings had elevated lead levels, the lead levels in 60 single family homes tested in Tarawa Terrace neighborhoods were not elevated. Schools and day care facilities also did not have elevated levels of lead in drinking water.

Lead can get into drinking water several different ways including; corrosion of lead piping, lead-based solder, and brass water faucets. Lead is not naturally present in the local groundwater. Currently, we are working with the State of North Carolina to reduce the amount of lead that gets into drinking water. Additionally, plans are now in place to replace piping in several of the affected buildings.

The following pages provide information on the health effects of lead exposure, ways to reduce your exposure, and the available blood lead screening test. It also lists organizations you can call for more information.

How might I be exposed to lead in drinking water?

The major contributors of lead in drinking water come from lead-containing brass fixtures and pipe solder, which are commonly used in public buildings, schools, and homes. In some areas lead is also naturally present at low levels in groundwater, which may be used for drinking water. Additionally, tea and coffee made with tap water containing lead may have an increased lead concentration due to evaporation of the water, particularly if the coffee or tea sits on a hot plate.

How can lead affect my health?

Studies on lead's health effects are based on blood lead levels (μg/dL, micrograms per deciliter), not the amount of lead detected in water or some other medium. The health effects of lead are not immediately apparent. Some health effects may not produce noticeable signs or symptoms such as decreased IQ or mild behavioral disorders which can occur when blood lead levels are $\leq$ 10 μg/dL in children. Lead is not readily eliminated from the body, but is stored in the bones and teeth. Exposure to high levels of lead can badly damage the brain, red blood cells, and kidneys of adults (40 - 100 μg/dL) and children (35 - 50 μg/dL). Acute effects of exposure to high lead levels are nausea, vomiting, and headache. Lead exposure in adults may increase blood pressure. High levels of blood lead (40 μg/dL) may affect sperm or damage other parts of the male reproductive system making it difficult for a couple to have children.

Unborn babies and children are especially sensitive to the effects of lead. If a pregnant woman is exposed to lead, it can be carried to the unborn child and is associated with premature birth, low birth weight, and decreased mental ability. In infants and young children, lead exposure has been shown to decrease intelligence (IQ) scores, slow their growth, and cause hearing problems in children with blood lead levels $\leq$ 10 μg/dL. These effects can last as children get older and interfere with successful performance in school.

What are some factors that can influence lead's effects?

The amount of lead you absorb can not be directly correlated with the amount in drinking water due to several factors. These factors include the dose (how much lead is in your body), the duration (how long you were exposed), and your individual characteristics such as age, sex, nutritional status, life style, and overall state of health and they influence the type and severity of harmful health effects.

Age is a key factor. Children and unborn infants are more sensitive to the harmful effects of lead. Nutrition also plays a role in how much lead is absorbed by the body. If a person doesn't have a well-balanced diet rich in iron and calcium, more lead will be absorbed. The consumption of alcoholic beverages also increases the amount of lead absorbed. Tobacco use causes an increase in blood lead levels partly because tobacco products contain lead.

What are other sources of lead exposure?

You can also be exposed to lead and lead compounds from breathing air, and eating soil and foods that contain lead. Breathing air with dust that contains lead or swallowing lead-containing soils that might be found near areas with heavy automobile traffic are also sources of exposure.

Adults may also be exposed to lead through occupational exposure which may occur through plumbing work where lead-base solder and brass fixtures are used. Other sources of occupational lead exposure may be from automobile or mechanical repair operations, battery or radiator reclamation, electronics work, welding, lead-based paints, and lead-containing sheet metal work. Certain hobbies may also contribute to your lead exposure such as ceramics, artisan painting, stained glass, and furniture refinishing.

Children may be exposed to lead by swallowing nonfood items such as chips of lead-containing paint. Children who put toys, other items, or their hands in their mouths may also swallow lead if lead-containing dust and dirt are on these.

How can I reduce my exposure to lead in drinking water?

Short-term remedies you can take individually to reduce the lead concentrations in your drinking water and thus your exposure to lead are included below. You cannot see, taste, or smell lead in your drinking water, so it is important to perform these precautionary steps.

1) Let the water run from the tap for 30 seconds to 2 minutes before using it for drinking or cooking. The longer water stays in a building's pipes, the more lead it may contain. Water that has sat in the pipes for more than four hours should be flushed for 3 to 5 minutes: for example, first thing in the morning and when you arrive home in the evening. A good indication of when to stop flushing the cold water tap is when the water becomes noticeably colder.

2) Use cold water even for cooking or making infant formula because water from the hot water tap dissolves lead more quickly.

If a water sampling test for lead indicates that your tap water at home or at work contains lead in excess of 15 ppb even after flushing, then you may want to consider taking the following additional measures.

1) You may chose to use bottled water instead of tap water for drinking or cooking purposes.

2) You may chose to use a water purification system. Purification systems range in size and cost from the water pitcher filtration systems to entire home-sized purification systems.

Is there a medical test to determine if I have been exposed to lead?

If you are concerned about your blood lead levels either because of the lead levels in your drinking water or other possible lead exposure sources, there is a simple medical test available to screen for blood lead levels.

What recommendations has the federal government made to protect human health?

In 1991, EPA issued the Final Lead and Copper Rule. The primary purpose of this rule is to protect public water supply users from chemical contamination produced by corrosion of drinking water piping systems. The rule establishes threshold levels for lead and copper measured at consumer water taps.

EPA recommends that drinking water contain less than 15 ppb. If lead levels exceed 15 ppb, further sampling is required at the tap and at the source to confirm elevated lead levels. Recommendations for water treatment to reduce the lead at the tap are required to be submitted to the state for approval.

How can I get more information?

To find more about the health effects of lead or to have a blood lead test contact:

Naval Hospital Camp Lejeune
Occupational Health and Preventive Medicine Department
Camp Lejeune, North Carolina
451-5707

For general information on lead exposure contact:

Dr. Fredric Rosenberg
Agency for Toxic Substance and Disease Registry
1600 Clifton Road
Atlanta, Georgia 30333
404-639-6215

For general information on lead in drinking water contact:

U.S. Environmental Protection Agency
Office of Water
Safe Drinking Water Hotline
1-800-426-4791
Monday - Friday, 8:30 am to 5:00 pm EST.

For written information, call 1-800-LEAD-FYI (1-800-532-3394) and leave your name and mailing address.

APPENDIX D - Exposure Specific Estimates

APPENDIX D-1

Pesticide Exposure Estimates for Site 2

Chemical	Maximum Concentration Detected (ppm)	Ingestion Rates: Pica Child (mg/day)	Ingestion Rates: Non-Pica Child (mg/day)	Ingestion Rates: Adult (mg/day)	Exposure Factor	Estimated Dose: Pica Child (mg/kg/day)	Estimated Dose: Non-Pica Child (mg/kg/day)	Estimated Dose: Adult (mg/kg/day)	Cancer Slope Factor (1/[mg/kg/day])	Exposure Duration	Cancer Risk: Adult
Parking Lot (1989-1993)											
Chlordane	0.31	n/a	n/a	100	1	n/a	n/a	0.000000	1.3	0.122	7.02E-08
DDD	1200	n/a	n/a	100	1	n/a	n/a	0.001714	0.24	0.122	5.02E-05
DDE	30	n/a	n/a	100	1	n/a	n/a	0.000043	0.34	0.122	1.78E-06
DDT	930	n/a	n/a	100	1	n/a	n/a	0.001329	0.34	0.122	5.51E-05
Lawn (1989-1993)											
Chlordane	7.4	n/a	n/a	200	0.045	n/a	n/a	0.000001	1.3	0.057	7.05E-08
DDD	1200	n/a	n/a	200	0.045	n/a	n/a	0.000154	0.24	0.057	2.11E-06
DDE	30	n/a	n/a	200	0.045	n/a	n/a	0.000004	0.34	0.057	7.48E-08
DDT	3000	n/a	n/a	200	0.045	n/a	n/a	0.000386	0.34	0.057	7.48E-06
Parking Lot (1966-1982)											
Chlordane	45.7	n/a	100	100	1	n/a	0.000286	0.000065	1.3	0.071	6.03E-06
DDD	644	n/a	100	100	1	n/a	0.004025	0.000920	0.24	0.071	1.57E-05
DDE	68.7	n/a	100	100	1	n/a	0.000429	0.000098	0.34	0.071	2.37E-06
DDT	7500	n/a	100	100	1	n/a	0.046875	0.010714	0.34	0.071	2.59E-04
Playground (1966-1982)											
Chlordane	0.39	5000	200	n/a	1	0.000122	0.000005	n/a	1.3	0.071	n/a
DDT	6.7	5000	200	n/a	1	0.002094	0.000084	n/a	0.34	0.071	n/a

n/a = not applicable

Assumptions:

Body Weight
child = 16 kilograms
adult = 70 kilograms

Exposure Factor (unitless)
4 days per week for 32 weeks (Lawncare workers)
default of 1 (All others)

Exposure Duration (unitless)
4 years out of 70 years (Lawncare and office workers)
5 years out of 70 years (Day care workers and attendees)

Where: $\frac{\text{Max Conc} \times \text{Ing Rate} \times \text{Exp Fac}}{\text{Body Weight}}$ = Est Dose x Cancer Slope x Exp Duration = Cancer Risk (cancer risk is based on a lifetime exposure of 70 years)

APPENDIX D-2

VOC Exposure Estimates

Chemical	Maximum Concentration (ppm)	Ingestion Rate Child (L/day)	Ingestion Rate Adult (L/day)	Exposure Factor	Estimated Dose Child (mg/kg/day)	Estimated Dose Adult (mg/kg/day)	Cancer Slope Factor (1/[mg/kg/day])	Exposure Duration	Cancer Risk Adult
Hadnot Point (1982-1985)									
TCE	1.4	1	2	0.57	0.099750	0.045600	0.011	0.043	2.16E-05
DCE	0.4	1	2	0.57	0.028500	0.013029	0.091	0.043	5.10E-05
Methylene Chloride	0.054	1	2	0.57	0.003848	0.001759	0.0075	0.043	5.67E-07
Vinyl Chloride	0.003	1	2	0.57	0.000214	0.000098	N/A	-	-
Tarawa Terrace (1982-1985)									
PCE	0.215	1	2	0.57	0.015319	0.007003	0.052	0.043	1.57E-05
TCE	0.008	1	2	0.57	0.000570	0.000261	0.011	0.043	1.23E-07
DCE	0.012	1	2	0.57	0.000855	0.000391	0.091	0.043	1.53E-06
Holcomb Blvd (1985)									
TCE	1.15	1	2	0.57	0.081937	0.037457	0.011	0.014	5.77E-06
DCE	0.407	1	2	0.57	0.028999	0.013257	0.091	0.014	1.69E-05

N/A = Not Available

Assumptions:

Body Weight
child = 16 kilograms
adult = 70 kilograms

Exposure Factor (unitless)
4 out of 7 days per week

Exposure Duration (unitless)
3 out of 70 years (Hadnot Pt. and Tarawa Terrace)
1 year out of 70 years (Holcomb Blvd)

Where: $\frac{\text{Max Conc} \times \text{Ing Rate} \times \text{Exp Fac}}{\text{Body Weight}}$ = Est Dose x Cancer Slope x Exp Duration = Cancer Risk (cancer risk is based on a lifetime exposure of 70 years)