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ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

Contaminants discussed in the subsequent sections of this public health assessment will be evaluated to determine whether exposure to them has public health significance. All the contaminants detected are not included in this document. Instead, ATSDR has selected certain contaminants that require further evaluation in this public health assessment.

ATSDR selects and discusses contaminants based on several factors: concentrations of environmental contaminants on and off the air station, field and laboratory data quality, sampling design, and comparison of chemical concentrations to public health assessment comparison values for carcinogenic and non-carcinogenic health effects. Community health concerns are also considered when selecting the contaminants presented in this public health assessment.

Listing a chemical contaminant in the data tables that follow does not mean that it will cause adverse health effects. Instead, the list indicates which contaminants will be evaluated further in the public health assessment. The potential adverse health effects from those selected contaminants will be discussed in the Public Health Evaluation section of this document. When selected in one medium, a contaminant will be reported in all media in which it is found.

The comparison values for ATSDR public health assessments are developed by environmental and health agencies to provide an estimate of chemical concentrations present in each environmental medium (air, water, soil) that should be evaluated for possible health effects if exposure to the contaminants occurs. In many cases, the values have been derived from animal studies or occupational studies. Health effects are related to the exposure dose, the routes of entry into the body, and the amount of chemical absorbed by the body.

The data tables include the following abbreviations for these comparison values.	
CREG	Cancer Risk Evaluation Guide. CREGs are public health assessment comparison values that correspond to one excess cancer in a million persons exposed over a lifetime. CREGs are calculated from standard cancer risk, adult body weight, adult ingestion rate, and EPA's cancer slope factor (toxicity values for carcinogenic effects).
EMEG	Environmental Media Evaluation Guide. EMEGs are media-specific values that correspond to ATSDR's Minimal Risk Level (MRL). They are calculated by using ATSDR's conservative exposure assumptions that would protect the most sensitive populations.
MCL	Maximum Contaminant Level. MCLs represent contaminant concentrations that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an ingestion rate of two liters of water per day. MCLs are enforceable regulatory standards.
Secondary MCL	Secondary Maximum Contaminant Level. Secondary MCLs are non-enforceable drinking water limits that may affect the aesthetic qualities (i.e. taste and color) and the public's acceptance of drinking water (9).
MCLG	Maximum Contaminant Level Goals. MCLGs are drinking water health goals. MCLGs are set at a level at which no known or anticipated adverse human health effects occur. MCLGs are not enforceable standards.
MRL	Minimal Risk Level. Developed by ATSDR, MRLs are estimates of daily exposure to a chemical that is not likely to cause adverse non-carcinogenic health effects. MRLs are based on the most current information available.
NOAEL	No Observed Adverse Effect Level. The NOAEL is a dose of chemical in a study or group of studies that clearly shows no adverse health effects.
RfD	Reference Dose. EPA's RfD is an estimate (with uncertainty spanning perhaps a factor of ten) of the daily exposure of a person to a contaminant that is unlikely to cause adverse health effects. The RfD is operationally derived from the NOAEL (from animal and human studies) by a consistent application of uncertainty factors that reflect various types of data used to estimate RfDs and an additional modifying factor, which is based on a professional judgement of the entire database on the chemical.

Additionally, individual chemicals may be grouped into general chemical classifications based on their similar physical properties. The following abbreviations are used in the sections of the public health assessment that follow.

Abbreviations	
Inorganic Chemicals	Organic chemicals contain carbon; inorganic chemicals do not contain carbon. VOCs, PCBs, and some pesticides are organic chemicals. Elemental metals such as lead, mercury, cadmium, silver, nickel, and others are inorganic chemicals. Other non-metal inorganic chemicals include boron, antimony, and magnesium.
Nitrates/Nitrites	Nitrate (NO_3^-) and nitrite (NO_2^-) are naturally occurring inorganic ions, which are part of the nitrogen cycle. Natural animal wastes containing organic nitrogen decompose in soil and water by microbial bacteria to first form ammonia, which is then oxidized to nitrate. Nitrate is the predominate form of nitrogen found in groundwater and surface water. In agricultural areas, nitrogen-based fertilizers are the major source of contamination of groundwater and surface water. Nitrate-containing compounds in the soil are generally soluble and readily migrate in groundwater.
PCBs	Polychlorinated Biphenyls. These chemicals are very stable and persistent in the environment. They are used as heat transfer liquids in transformers, hydraulic fluids, lubricants, and in plasticizers, surface coatings, inks, and adhesives. They are also used as pesticide extenders and for microencapsulation of dyes for carbonless duplicating paper. There are 209 chemicals are classified as PCBs.
VOCs	Volatile organic compounds. The chemicals in this group readily evaporate or volatilize into gases when exposed to air. This chemical class includes carbon tetrachloride, chloroform, PCE, TCE, DCE, benzene,toluene, xylenes, etc.

A. On-station contamination

The information for this section was obtained from the Solid Waste Air Quality Assessment Test Report and MCAS El Toro Aquasorb Treatment System Monitoring Report (listed in the "References" section of this document). There is currently no quantitative data on the concentrations of suspected contaminants listed in Table 1 (i.e., waste oils, solvents, JP-5 fuel, etc). Consequently, discussion of on-station contamination sources and pathways for soil, air and surface water must necessarily wait until site-specific information is available.

Groundwater

In July 1989, MCAS began groundwater treatment. The groundwater treatment system consists of three wells (PS-1, PS-3, and PS-4) that extract groundwater from the western perimeter of the air station at a rate of 5 - 10 gallons per minute. The groundwater pumped from each well merges into one line that enters two granular activated carbon (GAC) filters. The filtered water then enters a storage tank before it is used to irrigate the station's golf course. To monitor the effectiveness of the treatment system, sampling valves have been inserted at six locations: one valve at each well outlet, at the combined inlet where the three wells merge, in between the first and second carbon filter, and at the effluent stage as the treated water exits the system (10).

The extracted groundwater is analyzed for VOCs only. At the combined inlet prior to filtration, TCE has been detected at a maximum concentration of 160 parts per billion (ppb). Tetrachloroethylene (PCE) has been detected at a maximum concentration of 100 ppb. Since July 1989, TCE has been detected in all 38 samples prior to treatment. PCE has been detected in 34 of the samples prior to treatment. Other VOCs detected at levels below comparison values include 1,2 DCE, acetone, methylene chloride, chloroform, and 2-butanone.

Table 2:

Contaminants detected in On-Station Groundwater

CONTAMINANT	CONCENTRATION RANGE - (ppb)	COMPARISON VALUE (ppb)	REFERENCE
Tetrachloroethylene	0.5 - 100	0.7	CREG
Trichloroethylene	0.1 - 160	3.2	CREG

Adapted from Reference (5).

CREG = Cancer Risk Evaluation Guide

The source of groundwater contamination has not been determined. Groundwater treatment by MCAS at the current filtration rate is not sufficient to slow the rate of contamination migration to off-station areas.

Figure 1 illustrates the TCE plume, which appears to originate at MCAS, extends approximately three miles northwest of the station boundary, and covers a total area of 2900 acres (5).

Soil Gas and Air

Air and soil gas samples were taken between April and June 1990 at several locations within the boundaries of the four landfill sites: Site 2 - Magazine Road Landfill (OU-2), Site 3 - Original Landfill (OU-2), Site 5 - Perimeter Road Landfill (OU-2), and Site 17 - Communications Station Landfill (OU-2). Contractors for the Marine Corps sampled soil gas and ambient air (11).

Air samples were taken at two to three inches above ground surface. Soil gas samples were taken between seven and eight feet below ground surface. Air and soil gas samples were analyzed for VOCs, oxygen, and nitrogen content. VOCs detected include methane, vinyl chloride, benzene, ethylene dichloride, TCE, PCE, and chloroform. Concentrations of VOCs detected in air were below comparison values. Some soil gases were detected at levels above comparison values. However, at this time there is no human exposure to the subsurface soil gases due to its inaccessibility.

Potential Contamination

Past and present activities at MCAS present the potential for on-station contamination of air, water, and soil. Escaped organic vapor emissions from waste handling and processing, and wind-borne soil and dust are examples of potential air contamination. Soils may be contaminated from past storage practices, spills, leaks, or seepage. Contaminants may migrate through soils or surface water to the groundwater system. Portions of the station are leased for agricultural activities, and food crops may be grown in contaminated soil or irrigated with contaminated water.

The RI/FS Work Plan and the RCRA Facility Assessment, Preliminary Review at MCAS have separated environmental contamination into three operable units: OU-1, OU-2, and OU-3. OU-1 consists of an off-station plume of VOC-contaminated groundwater which will be discussed in the following section. OU-2 consists of five sites suspected of being the on-station sources of the VOC contamination, and OU-3 represents 16 sites identified as potential Solid Waste Management Units during the RCRA Preliminary Review.

Table 1 lists the contaminant sites according to applicable operational unit and potential waste type. Four of the OU-2 sites are landfills where VOCs and other materials were disposed. The five OU-2 sites, 16 OU-3 sites, and the respective contaminants of concern were identified from historical records and interviews with station personnel as sites where contaminants have been used or known releases have occurred.

B. Off-station contamination

Groundwater

The off-station groundwater contamination near MCAS has been documented in two reports by the Orange County Water District (4,5). Ten contaminants were detected in measurable quantities, with five of those at concentrations exceeding the comparison values (Table 3). Four of the five contaminants are VOCs that are used as organic solvents for cleaning and degreasing aircraft parts and military vehicles. TCE, PCE, chloroform, and carbon tetrachloride are highly mobile in soils, and have been observed to leach rapidly into groundwater (9). In surface waters, TCE has a volatilization half-life of hours to a few days, depending on water depth and turbulence (9).

The Orange County Water District (OCWD) evaluated the effectiveness of spray and drip irrigation as a remedial treatment of TCE contaminated groundwater, and they found volatilization rates of 97 percent and 42 percent, respectively (5).

The maximum concentration of TCE was measured at a well approximately 1 mile beyond the station boundary (ET-1, 89 ppb). VOCs have been detected at depths between 165 and 450 feet, (below land surface) and have been moving northwest at a rate of 4-30 feet per day, which is considerably greater than the 1-4 feet/day regional flow rate (5). Toluene, ethylbenzene, and chlorobenzene were detected at concentrations below comparison values at depths greater than 500 feet and are believed by Orange County Water District personnel to be leaching from naturally occurring hydrocarbons which are common in this geographical area (5).

Table 3:

Contaminants Detected in Off-Station Groundwater

CONTAMINANT	CONCENTRATION RANGE - (ppb)	COMPARISON VALUE (ppb)	REFERENCE
Carbon Tetrachloride	0.4 - 61	0.27	CREG
Chloroform	0.1 - 14	5.7	CREG
Nitrate-N	100 - 140,000	10,000	MCL
Tetrachloroethylene	trace - 81	0.7	CREG
Trichloroethylene	0.1 - 89	3.2	CREG

Adapted from Reference (5).

CREG = Cancer Risk Evaluation Guide MCL = Maximum Contaminant Level

Nitrate-N was also detected in concentrations (up to 14 times the MCL) at depths less than 200 feet and greater than 500 feet, and are believed to be a result of agricultural activities (4). In a series of samples taken in 1988 and 1989, concentrations of iron and manganese greater than Secondary MCLs were detected in six of seven wells analyzed, but not at every depth within those wells. These inorganic metals were not analyzed at every site for every sampling period; therefore, no discernible distribution pattern can be identified (4).

Secondary MCLs are non-enforceable drinking water limits that may affect the aesthetic qualities (i.e., taste and color) and the public's acceptance of drinking water (10). However, the large range of these values (sometimes four times higher) in samples over different depths and times indicates that the elevated concentrations are not natural background values. These metals are common components of the well and pump machinery, and high concentrations in the water may reflect those local sources. Alternatively, the elevated concentrations may represent leaching from upgradient sources such as landfills or disposal areas.

In order to identify facilities that could contribute to the contamination near MCAS, ATSDR searched the Environmental Protection Agency's 1987, 1988, and 1989 Toxic Chemical Release Inventory (TRI). The TRI is an annual compilation of chemical manufacturers' self-reported quantity of toxic chemicals released into each environmental medium (e.g., air, soil, in surface water); the manufacturing facilities that report to the TRI must employ more than 10 people and must fall into certain industrial classification codes. Because MCAS is not a manufacturing facility, they are not required to report releases in the TRI. However, MCAS must comply with other state and federal reporting requirements regarding hazardous chemical releases.

In the database, several companies reported releases of TCE, carbon tetrachloride, chloroform, and PCE into air, and releases into wastewater discharges.

C. Quality Assurance and Quality Control

Although Quality Assurance and Quality Control information was not provided, the off-station data from the Orange County Water District were analyzed using EPA-approved methods in which Quality Control and Assurance procedures were used. The consistent reproducibility of the data indicates that the sampling and analysis is representative and verifiable. Therefore, the data used in this public health assessment are assumed to be accurate.

D. Physical and Other Hazards

Physical Hazards

Site 1 may contain unexploded ordnance that poses a physical explosive hazard for remedial workers or any persons who disturb buried material (see Appendix A for further site descriptions).

During the site tour, it was noted that Site 17 may represent a physical hazard since many household appliances were seen exposed in the landfill area and access to the site is not restricted. Children playing with the large exposed appliances may become trapped and suffocate. Children were noted walking down an adjacent hill, but there was no evidence of activity in the immediate landfill area.

Additionally, methane gas and other soil gases if present could potentially build up in confined areas of building located near landfills creating a potential physical explosive hazard. Methane is a naturally occurring gas produced during the decay of organic materials commonly found in landfills.

Other Hazards

Materials containing low level radiation have reportedly been buried at Site 1 - Explosive Ordnance Disposal Range (1). Although access to Site 1 is restricted, anyone disturbing radioactive buried material may be exposed to low level radiation.

PATHWAYS ANALYSES

To determine whether humans are exposed to contaminants migrating from a site, ATSDR evaluates the environmental and human components that lead to human exposure. This evaluation or pathways analysis consists of five elements: source of contamination, environmental medium in which contaminants may be present or may migrate, points of human exposure such as a private water well, a route of human exposure such as ingestion, inhalation or dermal contact, and people who are exposed or potentially exposed.

ATSDR identifies exposure pathways as completed, potential, or eliminated. For a completed pathway to exist, all of the five elements must be present to provide evidence that exposure to a contaminant has occurred in the past, is occurring or will occur in the future. A potential pathway indicates that at least one of the five elements is missing, but could exist. Potential pathways indicate that exposure to a contaminant could have occurred, could be occurring or could occur in the future. Pathways are eliminated when at least one of the five elements is missing and will never be present.

Past, present, and future exposure pathways that may present a public health hazard are discussed in this section.

A. Completed Exposure Pathways

Groundwater Pathway

MCAS is located at the foot of the Santa Ana Mountains in a zone of groundwater recharge (4). The sediments underlying the station are relatively coarse resulting in migration of certain contaminants in the sediments to move rapidly downward and then westward into the regional groundwater. Leaching or seepage of contaminants into groundwater has occurred.

Based on available information, the most likely contaminant source for groundwater contamination at MCAS is the historical disposal practices of VOCs at MCAS. VOCs have migrated northwest from on-station disposal areas, with the highest concentrations within permeable zones between the depths of 200-450 feet below ground surface. TCE, carbon tetrachloride, chloroform, and PCE are the VOCs detected in groundwater at concentrations above comparison values (Table 3).

A secondary source of groundwater contamination in the area may be from the off-station application and subsequent subsurface migration of agricultural fertilizers. Nitrate-N contaminated groundwater from off-station agricultural sources generally occurs at depths less than 200 feet. Intermittent monitoring of groundwater containing aluminum, iron, and manganese indicates high concentrations of those metals in groundwater, but a discrete source has not been defined.

Although groundwater contamination may be caused by different sources, human contact with contaminated groundwater represents a past, current, and future completed exposure pathway through the routes of ingestion and dermal absorption of groundwater, and inhalation of

aerosolized groundwater contaminants. No drinking water wells currently exist within the area of the contaminant plume. Contaminated groundwater is used for irrigation of agricultural areas, and is extracted for VOC decontamination both on and off station. Farm workers who contact contaminated groundwater used for irrigation would be chronically exposed to contaminants (longer than one year). Well operators, and maintenance personnel may contact contaminated groundwater extracted for treatment; however, these exposures are unlikely to occur on a long-term (chronic) basis, but would be relatively infrequent and of short duration.

Table 4:

Complete Exposure Pathways

SOURCE	ENVIRONMENTAL MEDIUM	CONTAMINANT	MAXIMUM CONCENTRATION(ppb)	EXPOSURE POINTS	EXPOSURE ROUTES	EXPOSED POPULATION	EXPOSURE TIME
MCAS Storage, handling, use, and disposal of hazardous chemicals	Groundwater	Carbon Tetrachloride	61	Irrigation Wells	Unintentional ingestion, dermal absorption, and inhalation of volatilized chemicals	Farm Workers	Past Present Future
		Chloroform	14				
		Tetrachloroethylene	81	Extraction and Treatment Wells		Well Operators and Maintenance Personnel	
		Trichloroethylene	90				
Agricultural Activities on station and off-station	Groundwater	Nitrate-N	140,000	Irrigation Wells	Unintentional ingestion, dermal absorption, and inhalation of volatilized chemicals	Farm Workers	Past Present Future
		Aluminum	2400				
		Manganese	1600	Extraction and Treatment Wells		Well Operators and Maintenance Personnel	
		Iron	4000				

B. **Potential Exposure Pathways**

Groundwater Pathway

No drinking water wells currently exist within the area of the contaminant plume. However, farm workers' may drink contaminated water from irrigation hoses while in the field.

At the maximum rate of contaminant migration and in the absence of current remedial action, two down gradient potable wells could be affected in one and a half to five years (5). The Orange County Water District is currently evaluating the feasibility of installing additional wells within the TCE plume and using the treated water as a public drinking water supply.

The potential for human exposure to the contaminated groundwater exits at drinking water wells approximately 2 - 3 miles downgradient of the TCE contaminant plume. As assessed by the Orange County Water District, groundwater, at the maximum flow velocity of 30 ft/day, could be contaminated in approximately 500 days, although ongoing remediation by the Orange County Water District will slow the rate of contaminant migration (5).

Other Potential Exposure Pathways

Although only limited environmental data are available for on-station air and soil gas, and no environmental data are available for surface water, soil, or sediment, other potentially completed exposure pathways exist for humans to contact on-station contaminated media through inhalation, dermal contact with, and ingestion of contaminated soil, sediment, and surface water.

Additionally, the streams draining MCAS act as recharge sources for underlying groundwater (4). If surface water contaminants are present, they will be an additional contaminant source for groundwater, but provide little potential for direct human exposure.

C. **Eliminated Exposure Pathways**

Edible Food Pathway

Oranges, strawberries, and asparagus are grown on and off station, and are irrigated with contaminated groundwater. Contaminant concentrations in these foodstuffs are not available. The levels of contaminants that would be present from groundwater irrigation systems would be so low as to be considered negligible due to the nature of VOCs to rapidly evaporate. Additionally, bioaccumulation of VOCs in edible fruits and vegetables is not of concern because plants do not readily absorb these chemicals (12). Therefore, the consumption of these foods has been eliminated as an exposure pathway.

PUBLIC HEALTH IMPLICATIONS

Chemicals released into the environment do not always result in human exposure. Human exposure to a chemical contaminant can only occur if people come in contact with the contaminant either by ingestion (eating or drinking a substance containing the chemical), inhalation (breathing air containing the chemical), or by dermal absorption (skin contact of a substance containing the chemical).

To understand the type and severity of health effects that may be caused from exposure to a specific chemical contaminant, several factors related to the interaction of the chemical with the individual must be considered. Such factors include the amount or chemical dose to which a person is exposed, the frequency and duration of exposure, the route the chemical enters the body (ingestion, inhalation or dermal absorption), and the multiplicity (combination of chemicals) of exposure. Estimated exposure doses take into consideration a persons body weight, the concentration of chemical present, the duration and frequency of exposure, and if known, the amount of chemical likely to be absorbed by the body.

Health effects are also related to such characteristics as age, sex, nutritional and health status, life style, and family traits, all of which may influence how a specific chemical is absorbed (taken up by the body); metabolized (broken down by the body); and excreted (eliminated from the body).

To determine the possible health effects produced by specific chemicals, ATSDR considers physical and biological factors as well as a variety of information, such as scientific literature, research reports, and reports from other federal, state, and local health and environmental agencies.

A. Toxicologic Evaluation

The following sections evaluate the potential health effects from identified contaminant exposure at and near MCAS. The toxicological evaluation of each contaminant assesses probable health effects from exposure to the contaminant. Health effects are related to contaminant concentration, exposure route, exposure frequency, and the potentially exposed population. Populations known or suspected of being sensitive to the contaminant are included. Information will be presented in relation to those pathways identified as completed exposure pathways.

At this time, the only known completed exposure pathways exist for farm workers and well operators through accidental ingestion, dermal absorption, and inhalation of volatilized contaminants from groundwater. Past and current exposures to untreated groundwater and current exposures to treated groundwater do not present a health concern because of the low levels of contaminants detected in the groundwater and the tendency for exposure to be brief, and to involve exposure in open air settings. On the basis of existing information, ATSDR has concluded that carbon tetrachloride, chloroform, nitrate-N, PCE, and TCE at the concentrations present in groundwater are not of public health concern for farm workers and well operators.

Carbon tetrachloride

Carbon tetrachloride is widely used as a degreasing agent and as a household spot remover. It is also used to make refrigerator fluid and propellants used in aerosol cans. Carbon tetrachloride binds readily to organic soil components. It is persistent in the environment and is broken down by chemical reactions in air at a half life rate of 30 to 100 years (13).

EPA has categorized carbon tetrachloride as a probable human carcinogen because evidence shows that it causes liver cancer in animals. It has been detected in wells not used for drinking water purposes at a maximum concentration of 61 ppb. Farm workers would be chronically exposed (greater than one year) to groundwater contaminants by inhaling aerosolized contaminants from groundwater, by accidental ingestion of contaminated groundwater, and by dermal contact with contaminated groundwater. Workers who operate the groundwater treatment systems would be intermittently exposed (less than one year) to groundwater contaminants by inhaling aerosolized contaminants from groundwater, by accidental ingestion of contaminated groundwater, and by dermal contact with contaminated groundwater.

Short term exposure to carbon tetrachloride at levels 2 - 163 times higher (100 - 10,000 ppb) than levels detected in groundwater can cause skin irritation, nausea, vomiting, and headache. Long term exposure to levels 20,000 - 200,000 ppb can cause nephritis (kidney effects) and cirrhosis of the liver, jaundice, and elevated concentrations of liver enzymes in serum (13). When the maximum level of carbon tetrachloride detected is converted to an estimated dose of contaminant ingested per day, (0.00048 mg/kg/day), that dose is 1.5 times lower than EPA's oral reference dose (RfD) of 0.0007 mg/kg/day. The RfD is an estimate of daily exposure of people that is likely to be without an appreciable risk of causing non-cancerous, long-term adverse health effects. When compared to the cancer risk comparison values, exposure to the highest concentration of carbon tetrachloride detected in groundwater would not be expected to cause any increased cases of cancer. Therefore, based on the available information, exposure to carbon tetrachloride from irrigation wells does not present a health concern.

Chloroform

Chloroform is used in the pesticide, paper, and pharmaceutical industries. It is commonly released from automobile exhaust, chlorinated drinking water, and chlorinated swimming pool water. Many foods including seafood, diary products, meats, vegetables, breads, and beverages may contain small but measurable amounts of chloroform (14). EPA has categorized chloroform as a probable human carcinogen based on evidence that it causes liver cancer in animals. It has been detected in monitoring wells at a maximum concentration of 14 ppb.

Farm workers would be chronically exposed (greater than one year) to groundwater contaminants by inhaling aerosolized contaminants from groundwater, by accidental ingestion of contaminated groundwater, and by dermal contact with contaminated groundwater. Workers who operate the groundwater treatment systems would be intermittently exposed (less than one year) to groundwater contaminants by inhaling aerosolized contaminants from groundwater, by accidental ingestion of contaminated groundwater, and by dermal contact with contaminated groundwater.

Occupational exposures to levels 5.5 times greater (77 ppb) than maximum levels detected in groundwater have caused tiredness and depression. Chronic occupational exposures (1-4 years) to 400 ppb have caused hepatitis and liver enlargement (14). When the maximum

level of chloroform detected is converted to an estimated dose of contaminant ingested per day, (0.0061 mg/kg/day), that dose is 81 times lower than both the Minimal Risk Level (MRL) of 0.01 mg/kg/day and the Reference Dose, of 0.01 mg/kg/day. MRLs are ATSDR's estimate of daily human exposure to a chemical that is not likely to cause adverse (non-cancerous) health effects. When compared to the cancer risk comparison values, ingestion of groundwater containing the highest concentration of chloroform detected in groundwater, would not be expected to cause an increase in cancer cases. Therefore, chloroform at the levels detected in groundwater does not pose a health concern.

Tetrachloroethylene (PCE)

Tetrachloroethylene (also called perchloroethylene or PCE) is used in dry cleaning, and as a metal parts degreaser. It is a common component of household spot removers, cleansers, and water repellants. Because experiments have shown that PCE causes liver cancer in mice, EPA has categorized it as a probable human carcinogen (15). It has been detected in wells not used for drinking water at a maximum concentration of 100 ppb.

Farm workers would be chronically exposed (greater than one year) to groundwater contaminants by inhaling aerosolized contaminants from groundwater, by accidental ingestion of contaminated groundwater, and by dermal contact with contaminated groundwater. Workers who operate the groundwater treatment systems would be intermittently exposed (less than one year) to groundwater contaminants by inhaling aerosolized contaminants from groundwater, by accidental ingestion of contaminated groundwater, and by dermal contact with contaminated groundwater.

Acute exposure to PCE at levels 1200 times higher (101,000 ppb) than levels detected in groundwater can cause dizziness, sleepiness, headache, and elevated levels of liver enzymes. At concentrations of 9000 ppb, PCE can cause eye and upper respiratory tract irritation. Chronic exposure to 200,000 ppb can cause cirrhosis of the liver, and toxic hepatitis (13). When the maximum level of PCE detected is converted to an estimated dose of contaminant ingested per day, (0.000648 mg/kg/day), that dose is 15 times lower than the RfD of 0.01 mg/kg/day. When compared to the cancer risk comparison values, the highest concentration of PCE detected in groundwater would not be expected to cause an increase in cancer cases. Based on this information, PCE at the levels seen in groundwater does not pose a health concern.

Trichloroethylene (TCE)

Trichloroethylene is mainly used as a metal part degreaser. However, it is also found in typewriter correction fluid, paint removers, and adhesive glues. TCE is categorized as a probable human carcinogen based on evidence that shows it causes liver cancer in animals (12). It has been detected in wells not used for drinking water at a maximum concentration of 160 ppb.

Farm workers would be chronically exposed (greater than one year) to groundwater contaminants by inhaling aerosolized contaminants from groundwater, by accidental ingestion of contaminated groundwater, and by dermal contact with contaminated groundwater. Workers who operate the groundwater treatment systems would be intermittently exposed (less than one year) to groundwater contaminants by inhaling

aerosolized contaminants from groundwater, by accidental ingestion of contaminated groundwater, and by dermal contact with contaminated groundwater.

Short term exposure to TCE at levels 300 to 1666 times higher (27,000 - 150,000 ppb) than levels detected in groundwater may cause irritation of eyes/throat, nausea, drowsiness, and liver and kidney effects. Long term exposure to TCE at levels of 85,000 ppb may cause vertigo, short-term memory loss, and adverse liver and kidney effects (12). When compared to health related comparison values, the highest concentrations of TCE detected in groundwater, would not be expected to cause an increase in cancer cases. Exposure through accidental ingestion, acute ingestion, inhalation, and dermal contact to the maximum level of TCE detected is not considered to be a public health hazard.

Nitrate-N

Nitrate-N, possibly introduced from the use of fertilizers, has been detected in off-station groundwater at levels of 140,000 ppb. Ingestion of nitrates from drinking water sources containing such high levels have been associated with methemoglobinemia in infants, a condition involving the oxidation of hemoglobin resulting in oxygen depleted blood (17). However, because groundwater is not used as a drinking water source, the only completed exposure pathway to contaminants would be to farm workers and workers who operate the groundwater treatment systems. Exposures to groundwater contaminants would occur by accidentally ingesting contaminated groundwater and by contacting contaminated groundwater on the skin. People are not being exposed to levels of nitrates that would be expected to cause adverse health effects.

Table 5:

Health Related Comparison Values For Exposure To Contaminants Detected in Off-Station Groundwater

CONTAMINANT	ESTIMATED EXPOSURE DOSE mg/kg/day	HEALTH GUIDELINES		
		VALUE mg/kg/day	SOURCE	EXCEEDED BY ESTIMATED EXPOSURE DOSE
Carbon Tetrachloride	0.000488	0.0007	RfD	No
Chloroform	0.000122	0.01	RfD/MRL	No
Nitrate-N	1.12	1.6	RfD	No
Tetrachloroethylene	0.000648	0.01	RfD	No
Trichloroethylene	0.00072	3.0	MRL	No

Comparison Values from IRIS database and ATSDR

NA = Data Not Available

RfD = Reference Dose

MRL = Minimal Risk Level (ingestion)

B. **Health Outcome Data Evaluation**

Due to the low levels of contaminants detected, and the limited exposure to these contaminants through unintentional contact, adverse health effects are not likely to occur. Based on this information and the absence of community health concerns, an analysis of Health Outcome Data has not been conducted at this time. However, if at some time either of those two conditions change, the pertinent health data base(s) will be reviewed.

C. **Community Health Concerns Evaluation**

As previously indicated, a member of the local community group did not express any community health concerns, and no concerns were reported to station personnel, county health officials, or state health officials.