ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

HORMIGAS GROUND WATER PLUME SITE
CARRETERA 785 KM 4.9,
CAGUAS, PUERTO RICO 00725
OCTOBER 31, 2013

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

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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

In addition, this document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. The revised document was released for a 45-day public comment period. Subsequent to the public comment period, ATSDR will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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1600 Clifton Road, N.E., MS F-09
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PUBLIC HEALTH ASSESSMENT

HORMIGAS GROUND WATER PLUME SITE
CARRETERA 785 KM 4.9,
CAGUAS, PUERTO RICO 00725

Prepared by:

Division of Community Health Investigations
Science Support Branch
Agency for Toxic Substances and Disease Registry

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List of Abbreviations

ADAF	Age Dependent Adjustment Factor
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	Below ground surface
CDC	Centers for Disease Control and Prevention
cis-1,2-DCE	cis-1,2- Dichloroethylene (or cis-1,2-Dichloroethene)
COC	Chemical of Concern
CREG	Cancer Risk Evaluation Guide
CT	Central Tendency
CV	Comparison Value
EF	Exposure Frequency
EMEG	Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
gpm	Gallons per minute
HRS	Hazard Ranking System
HRSA	Health Services and Resources Administration
IARC	International Agency for Research on Cancer
IRIS	Integrated Risk Assessment System
kg	Kilogram
L	Liter
LTHA	Lifetime Health Advisory
mg/L	Milligram per liter
MCL	Maximum Contaminant Level
MRL	Minimal Risk Level
NOV	Notice of Violation
NPL	National Priorities List
ppb	Parts per billion
PCE	Tetrachloroethylene (or Perchloroethylene)
PHA	Public Health Assessment
PRASA	Puerto Rico Aqueduct and Sewer Authority
PRDNR	Puerto Rico Department of Natural Resources
PRDOH	Puerto Rico Department of Health
PREQB	Puerto Rico Environmental Quality Board
RfD	Reference Dose
RI	Remedial Investigation
RMEG	Reference Media Evaluation Guide
SVOC	Semivolatile Organic Compound
TCE	Trichloroethylene (or Trichloroethene)
µg/L	Microgram per liter
VOC	Volatile Organic Compound

Summary

Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) is committed to ensuring that people who live near the Hormigas Ground Water Plume have the best information possible to safeguard their health. The Hormigas Ground Water Plume is within the Municipality of Caguas, Puerto Rico

Tetrachloroethylene (PCE), is a manufactured, volatile organic compound (VOC). In 2006, elevated TCE levels were identified in one of the wells (Eufracia well) that supplied the Hormigas Water System. The violation was reported to the Puerto Rico Department of Health (PRDOH), and in 2009, the Hormigas Water System was taken out of service. Also in 2009, during sampling completed by the U.S. Environmental Protection Agency (USEPA), additional VOCs (trichloroethylene (TCE) and cis-1,2-dichloroethylene (cis-1,2-DCE)) were reported in the Eufracia well. The source of the contamination is not known, and the U.S. EPA is currently working to determine the source of those chemicals. In 2009, the U.S. EPA proposed the Hormigas Ground Water Plume site to the National Priorities List (NPL or "Superfund"), the list of sites throughout the United States and its territories with known releases or threatened releases of hazardous substances, pollutants, or contaminants. The NPL is intended primarily to guide the U.S. EPA in determining which sites warrant further investigation. ATSDR is required to conduct public health activities on all sites proposed to the NPL.

The purpose of this Public Health Assessment (PHA) is to determine whether 1) the community was, is, or could be harmed by exposure to VOCs in the Hormigas well water, and 2) what public health actions need to be taken to reduce harmful exposures. Because of limited available data, ATSDR focused its evaluation on exposure to VOCs in the Hormigas supply wells. Other potential exposure pathways might be evaluated as more data are collected from the site.

A draft of the PHA was released in March 2013 for public comment. The PHA and the accompanying fact sheet were revised in response to comments received. Appendix D contains responses to the comments.

Conclusions

ATSDR reached three important conclusions in the PHA:

Conclusion 1	No one is currently exposed to contaminants in water from the Hormigas water supply wells.
Basis for Conclusion 1	In 2009, the Puerto Rico Aqueduct and Sewer Authority (PRASA) removed the Hormigas Water System from service and replaced it with the Cidra Water System.

Conclusion 2	People who used/drank water from the Hormigas Water Supply system before the system was taken out of service in 2009 are unlikely to have adverse health effects from using the water.
Basis for Conclusion 2	ATSDR used conservative (health-protective) assumptions of exposure (e.g., ATSDR assumed people drank the maximum amount in the well for 11 years of exposure) to look at potential effects on health from past use of the water from the Hormigas system. Exposures to contaminants in the Hormigas system before its closure in 2009 were below levels of health concern.

Conclusion 3	U.S. EPA has not been able to identify the source of the contamination found in the Eufacia well in the Hormigas Water Supply system.
Basis for Conclusion 3	U.S. EPA sampled the soil in the area to determine a contamination source. U.S. EPA has not identified a source, but as part of its investigation, it continues to take samples of water and soil in the area. Identifying the source will help prevent contamination of other area water resources.

Public Health Action Plan

The residents formerly served by the Hormigas Water Supply wells are now served by the Cidra Water Supply system, which is a municipal source owned by PRASA. Authorities will continue to monitor the Cidra Water Supply system and report results to the Puerto Rico Department of Health (PRDOH).

During its Remedial Investigation (RI), U.S. EPA continues its efforts to identify the source of the Hormigas Water System contamination.

A Draft of the PHA for Public Comment was released in March 2013. Comments received were addressed, and the responses are included as Appendix D.

For More Information

For further information about this public health assessment, please call ATSDR at 1-800-CDC-INFO and ask for information about the "Hormigas Ground Water Plume Site." If you have concerns about your health, you should contact your health care provider.

Purpose and Statement of Issues

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this Public Health Assessment (PHA) to evaluate—based on the information currently available—past exposure to chemicals in drinking water from the Hormigas Ground Water Plume site. The public health issue at the site is VOC-contaminated groundwater in the Hormigas Sector, within the municipality of Caguas, Puerto Rico.

Volatile Organic Compounds (VOCs) are manufactured chemicals used in industry. In 2006, VOCs were detected in one of the supply wells. In 2009, authorities removed the Hormigas system from service. Residents now receive water from the Cidra filtration plant. At the time of this PHA, the VOC contamination source had not yet been identified.

The U.S. Environmental Protection Agency (USEPA) proposed the Hormigas Ground Water Plume site for inclusion on the National Priorities List (NPL) on October 21, 2010; the listing was finalized on March 10, 2011. ATSDR is directed by Congress to conduct public health activities on all sites proposed to the NPL.

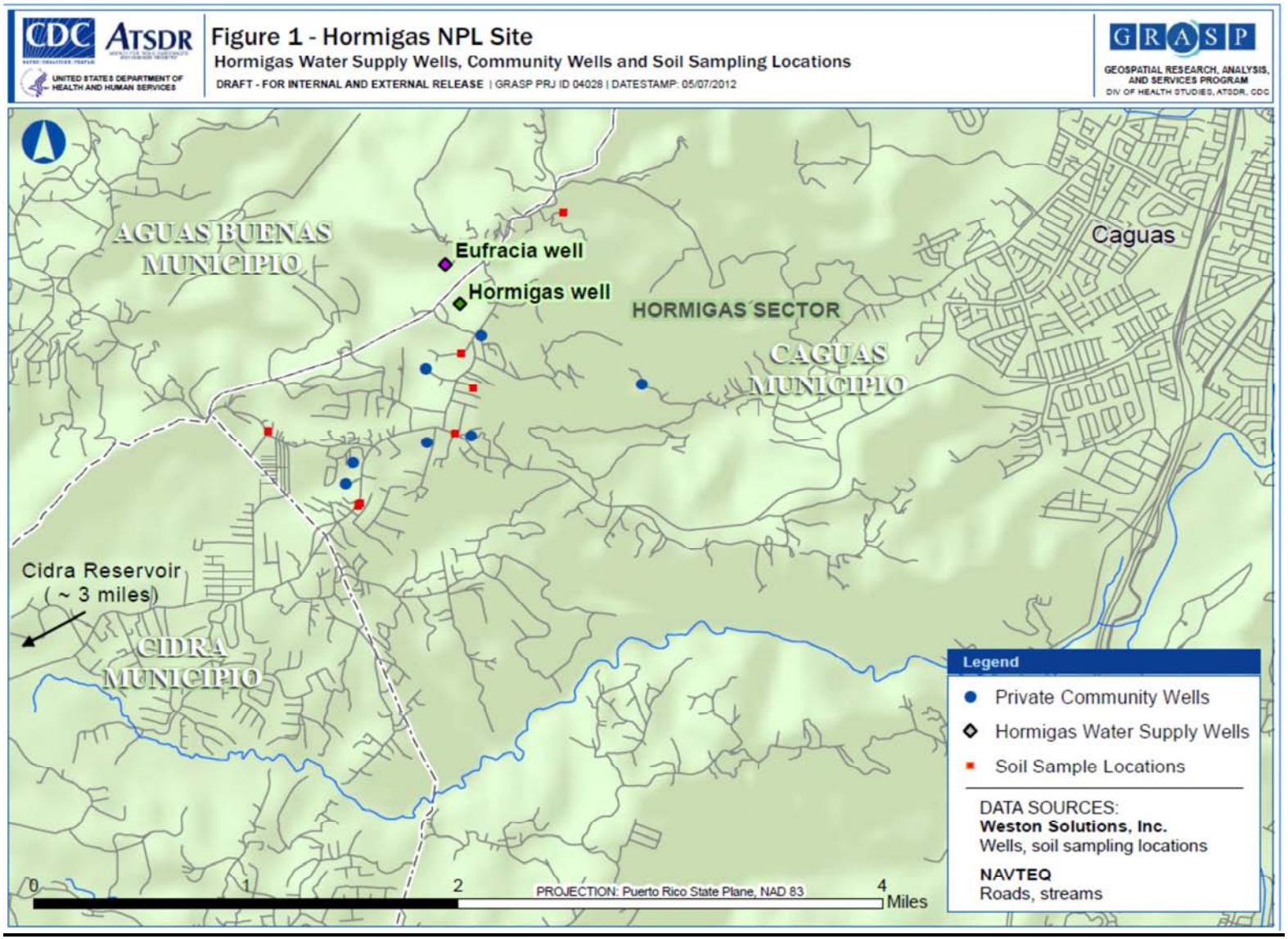
Given the limited data available for the site, this evaluation focuses only on past exposure of residents who obtained water from the Hormigas water supply system before it was taken out of service. The U.S. EPA plans a Remedial Investigation (RI) that will provide additional data. The RI data will identify the nature and extent of contamination and will attempt to identify the source of contamination in the Eufracia water supply well.

Background

Introduction and Site Description

The Hormigas Site is of an area of subsurface groundwater contamination in the Hormigas Sector at the Carretera 785 Km 4.9, within the municipality of Caguas, Puerto Rico, 00725 (see Figure 1 for location of the Hormigas Sector).

Figure 1. Site Location Map



According to Hormigas water supply wells owner Puerto Rico Aqueduct and Sewer Authority (PRASA), the system consisted of

- A 20% contribution from the two Hormigas water wells (Hormigas well and Eufracia well, and
- An 80% contribution from the Cidra water filtration plant (PRASA 2011). The water filtration plant obtained its water from the Cidra reservoir, approximately 3 miles to the southwest of the Hormigas water supply wells.

When it was in operation, the Hormigas system served approximately 5,500 persons. After the two Hormigas water supply wells were taken out of service, the Cidra filtration system wholly (100%) supplied water for the Hormigas system customers. ATSDR requested that PRASA provide information regarding the location of the residents who received water from the Hormigas water supply wells before the wells were removed from service. PRASA said that the residences were within the Hormigas Sector, but could not provide exact locations. Appendix C contains photographs of the Hormigas and Eufracia wells.

The area around the Hormigas water supply wells is primarily a middle-class neighborhood with well-kept homes. Several businesses (e.g., garages, retail stores) are on area main roads. Using 2010 U.S. Census data, the estimated population within 1½ miles of the Hormigas water supply wells is 9,354, of which 75.3% are adults aged 18 and older. Women 15 to 44 years of age (childbearing age) make up 21.4% of the population, and 6% of the population is children 5 years of age and younger. Senior citizens (age 65 years and older) make up 11.7% of the area population. A total of 3,634 housing units are within 1½ miles of the Hormigas water supply wells (US Census Bureau 2012). Almost all of the population is of Hispanic origin.

Groundwater

The aquifer of concern in the Hormigas area is called CaHT2. It is located in volcaniclastic bedrock, meaning that the aquifer is in volcanic rock. The Hormigas and Eufracia wells are finished in the bedrock aquifer at depths of 360 feet (Eufracia) and 400 feet (Hormigas) below ground surface (bgs) (USEPA 2010). When they were in service, the wells supplied water at a rate of 100 gallons per minute (gpm) (Hormigas well) and 150 gpm (Eufracia well) (PRASA 2011).

Residents in several area neighborhoods obtain their drinking water from private community wells. These wells are not owned by PRASA, but are owned and maintained by the community. The wells serve 30 to 700 persons and are within 2 miles of the Hormigas supply wells. These private community wells were sampled during U.S. EPA's 2009 Site Discovery Initiative (USEPA 2010; Figure 1). The wells are in the same aquifer as the Hormigas water supply wells. Their depths range from 350 to 485 feet bgs. At the time of the site visit, none of the private community wells had been registered with the Puerto Rico Department of Natural Resources (PRDNR). When ATSDR visited the private community wells, PRDNR was present. PRDNR is following up with the owners to

ensure that the wells are registered. Appendix C contains site location maps and photographs of the Hormigas and Eufracia wells.

Regional groundwater flow is toward the east-northeast, meaning that water in the aquifer flows in this direction (USEPA 2010). U.S. EPA is preparing an RI that will better define groundwater flow direction in the specific area of the Hormigas Water Supply wells.

Site History and Previous Investigations

We obtained background information for the Hormigas Ground Water Plume Site ("the Hormigas Site") from the U.S. EPA's Hazard Ranking System (HRS); U.S. EPA used that information to add the site to the NPL (USEPA 2010). We obtained additional information from PRASA and PRDOH during our April 2011 site visit (PRASA 2011).

In August 2006, PRASA detected the VOC tetrachloroethylene (PCE) in the Eufracia well. The PCE amount was above the U.S. EPA's Safe Drinking Water Act (SDWA) Maximum Contaminant Level (MCL). After PRASA reported this value to PRDOH, the Commonwealth of Puerto Rico issued a Notice of Violation in November 2007, and an Administrative Order in February 2008. PRASA then sampled the well more frequently to monitor the contamination. After the initial, elevated concentration in 2006, PRASA did not detect PCE in the Eufracia well. Nevertheless, PRASA closed the Hormigas well system, disconnected the wells in February 2009, and connected the affected homes to the Cidra water supply system.

In September 2009, U.S. EPA collected two groundwater samples from the Eufracia well. The results confirmed the presence of PCE at concentrations exceeding the MCL (Table 1). Trichloroethylene (TCE) and cis-1,2-Dichloroethene (cis-1,2-DCE)—PCE breakdown products—were also detected in the Eufracia well, with TCE at concentrations above the MCL. During earlier sampling rounds neither TCE nor cis-1,2-DCE were detected in the Eufracia well.

During the 2009 sampling effort, U.S. EPA was only able to sample the Eufracia well—the Hormigas well pump was broken. Before the well pump broke, however, PRASA's compliance sampling at the Hormigas well did not at any time report PCE, TCE, or cis-1,2-DCE in the well water.

Table 1. 2009 U.S. EPA Sampling Results for the Eufracia Well

Contaminant	*Sample (µg/L)*	*Duplicate Sample (µg/L)*	*MCL (µg/L)*
Tetrachloroethene (PCE)[a]	280	260	5
Trichloroethene (TCE)	60	59	5
Cis-1,2-Dichloroethylene (cis-1,2-DCE)	49	50	70

[a] – A concentration of 29 µg/L PCE was detected in the Eufracia well is 2006.
MCL = Maximum Contaminant Level from U.S. EPA
µg/L = micrograms of chemical per liter of water

In 2009, as part of the U.S. EPA's Site Discovery Initiative, private community supply wells in the area of the Hormigas supply wells were sampled for a standard set of contaminants as well as for

VOCs (USEPA 2010; Figure 1). No contaminants were found at levels of health concern in any of the private community supply wells.

As part of the 2009 Site Discovery Initiative (USEPA 2010), U.S. EPA conducted a soil investigation near the Hormigas water supply wells. U.S. EPA's purpose was to identify potential groundwater contamination sources (Figure 1). Soil samples were taken at eight businesses near the Hormigas water supply wells, but not at the supply wells themselves. Although PCE was detected in the soil at one business location, the concentration was low (below the appropriate health-based screening level). A contamination source was not identified.

On October 21, 2010, due to elevated levels of PCE in the Eufracia Well, the U.S. EPA proposed the Hormigas Ground Water Plume site for inclusion on the NPL. U.S. EPA finalized the listing on March 10, 2011.

During a U.S. EPA contractor's site visit, two previously unknown water wells were found in the area of the Eufracia well (M. Valentino, CDM, personal communication with K. Scruton, ATSDR, June 1, 2011). Whether in the past these wells were used as community wells or private wells is unknown. The two wells were abandoned and had not been sampled, so whether the water was contaminated is similarly unknown. U.S. EPA will include these wells in their Remedial Investigation.

Other Hazardous Waste Sites in the Area

The closest NPL site to the Hormigas Site is the Cidra Ground Water Contamination Site (PRN0000204538), to the southwest of the Hormigas water supply wells (Figure 1). The Cidra site is a series of groundwater wells in Cidra, Puerto Rico. The Cidra site has groundwater contaminated with the same chemicals as reported at the Hormigas Site (i.e., PCE, TCE, and cis-1,2-DCE). And again, as with the Hormigas Site, the source of contamination for the Cidra site remains unknown (USEPA 2004).

After authorities removed the Hormigas water supply system from service in 2009, people previously served by that system received household water from the PRASA filtration plant in Cidra. According to PRASA, the Cidra system obtains its water from the Cidra surface water reservoir, approximately 3 miles southwest of the Hormigas water supply wells—not from the reportedly contaminated Cidra groundwater wells (PRASA 2011). No contaminants have been detected in the Cidra filtration system water.

ATSDR Involvement

Congress has mandated ATSDR to conduct a public health evaluation of sites proposed to U.S. EPA's National Priority List. This PHA is our evaluation of the Hormigas Ground Water Plume site and its potential health implications. From April 4 to 8, 2011, ATSDR visited the site and surrounding area.

During the site visit, ATSDR met with the following stakeholders:

- U.S. EPA Region 2
- PRASA
- PRDOH
- PR Environmental Quality Board (PREQB)
- PR Department of Natural Resources (PRDNR)
- Municipality of Caguas

All of the stakeholders met and toured the Hormigas System wells (Eufracia and Hormigas wells), the community wells, and the soil sampling locations. No stakeholder reported current concerns regarding area water quality. Given that the Hormigas water supply system is no longer in service, our evaluation focuses on past community exposures to the VOCs in water provided by that water supply system.

Table 2 is a timeline for actions and sampling completed for the Hormigas Ground Water Plume site.

Table 2. Timeline for Hormigas Ground Water Plume Site

Action/Activity	Date
Hormigas Water Supply Wells Installed	1980 (Hormigas well); 1998 (Eufracia well)
PRASA detects Tetrachloroethylene (PCE) in Eufracia Well	August 2006
Commonwealth of Puerto Rico issues Notice of Violation (NOV) to PRASA	November 2007
Commonwealth of Puerto Rico issues an Administrative Order to PRASA	February 2008
PRASA closes the Hormigas water supply wells	February 2009
U.S. EPA samples the Eufracia well and detects PCE, Trichloroethylene (TCE) and cis-1,2-Dichloroethylene (cis-1,2-DCE)	September 2009
U.S. EPA conducts a Site Discovery Initiative (sampled community wells and soil in the area)	August-December 2009 (community water); February 2010 (soil samples)
Site is Proposed to the National Priority List (NPL) by U.S. EPA	October 21, 2010
Site is placed on the NPL by U.S. EPA	March 10, 2011
ATSDR conducts site visit in order to prepare a Public Health Assessment (PHA)	April 2011
ATSDR released Draft for Public Comments	March 2013

Discussion

Data Used in the Evaluation

The U.S. EPA Hazard Ranking System (HRS) package (USEPA 2010) was the major data source for this PHA. U.S. EPA Region 2 provided the references listed in the package. In addition, during the site meetings held in April 2011 we received from stakeholders sampling data for the Hormigas Site as well as other site-specific information (PRASA 2011). The sampling data evaluated in this PHA include

- PRASA's periodic sampling of the Eufracia and Hormigas water supply wells that began in 1997 and ended in 2007. The wells were installed in 1980 (Hormigas well) and 1998 (Eufracia well). Routine sampling data from 1980 to 1997 for the Hormigas well were not found. In this PHA we evaluated all available data.
- Additional data available from U.S. EPA, PRASA, and PRDOH include the community well sample results and soil tested at seven nearby businesses during U.S. EPA's Site Discovery Initiative (USEPA 2010; Figure 1). In addition, PRASA provided compliance data for the Cidra filtration system currently used as household water for those residents previously served by the Hormigas water supply system. After comparing data for the private community wells, soil sampling, and Cidra compliance testing with appropriate screening values, no chemical was identified as a concern (Appendix A).
- The only data quantitatively evaluated in this PHA were the data from the Hormigas water supply system (Eufracia well). The evaluation was limited to the Hormigas water system because the water from this system was contaminated and the community used this water in the past. We did not find that the water from the Cidra filtration system and private community wells—or the soil from businesses in the surrounding area—was contaminated, nor did we find that the water or the soil posed a health risk to the community.

Before we summarize the results of our evaluation of the water from the Eufracia well, we discuss briefly the process by which ATSDR evaluates such environmental sampling data.

Pathway Analysis

ATSDR examines exposure pathways to determine whether people might have come in contact with chemicals from a site. Exposure pathways consist of five elements, all of which must be present (in the past, now, or in the future) for exposure to occur. The five major elements and their relation to the Hormigas Site are

1. A contamination *source*: presumed yes. The source of contamination for this site has not yet been identified, but because of the contamination present in groundwater at the Eufracia well, it is presumed.
2. Transport through an environmental *medium*: yes. VOC contamination has been detected in the Eufracia well (groundwater).

3. An *exposure point*: yes, in the past. Before the Hormigas water system was taken out of service, residents obtained drinking water from the Hormigas water supply wells, which were contaminated.
4. An *exposure route*: yes, in the past. Before the Hormigas water system was taken out of service, residents drank and bathed in the water and might have breathed in contaminant vapors from the water.
5. An *exposed population*: yes, in the past. Before the Hormigas water system was taken out of service, the Hormigas water system served approximately 5,500 persons.

Thus all exposure pathway elements were present—a completed *past* exposure pathway exists for those who used this water. Currently, the site contains no completed *present* exposure pathways. ATSDR further evaluated the past exposure pathways to determine any potential health effects associated with past exposure to contaminated water. For more information on ATSDR's pathway analysis process, please refer to Appendix A.

In the past, exposure to VOCs in water from the Hormigas site could have occurred by

- *Ingestion:* People could have drunk the water or could have eaten food prepared using the water.
- *Inhalation:* People could have breathed in VOCs that volatilized (moved into the air) from water during showering, bathing, or other household use.
- *Dermal Exposure:* People could have absorbed VOCs through their skin during showering, bathing, or other use.

When VOCs contaminate an environment, inhalation, ingestion, and dermal exposures make a significant contribution to the total exposure dose (i.e., the total amount of contaminant that can enter and can affect a person's body). A precise estimate of exposures is difficult to achieve. A common estimate is that noningestion exposures yield a contaminant dose comparable to the ingestion dose (ATSDR 2005). But this estimate might underweight exposures to people who might be exposed to VOCs from shower water for periods of 30 minutes or more per day. For the purposes of this general evaluation, however, and to account for additional exposure from inhalation and dermal exposures, we doubled the exposure dose associated with ingestion of water.

Evaluation Process

The process by which ATSDR evaluates the possible health effects of contaminants is summarized here and described in more detail in Appendix A.

- When presented with results of comprehensive environmental sampling for chemicals, ATSDR prioritizes the number of contaminants that need to be evaluated by screening the results for each chemical against *comparison values* (CVs)—concentrations of chemicals in the environment (e.g., air, water, or soil) below which no adverse human health effects are expected to occur. Still, if a contaminant is present at a level higher than the corresponding CV, that does not in itself mean that adverse health effects will occur; the contaminant is merely retained for next-step evaluation. Table A.1 of Appendix A provides the CV

screening for the Hormigas site and the identification of chemicals of concern (COCs). Several VOCs and metals exceeded CVs but are not considered COCs at the site for reasons presented and discussed in Appendix A. For further evaluation in this PHA, only the three VOCs listed below are considered COCs:

- Tetrachloroethylene (PCE)
- Trichloroethylene (TCE)
- Cis-1,2-Dichloroethylene (1,2-DCE)

- The next evaluation step focuses on identifying which chemicals and exposure situations could be a health hazard (Appendix A). We calculate *exposure doses* (i.e., estimated amounts of a contaminant that people come in contact with and get into their bodies on an equivalent body weight basis) under specified exposure situations, typically starting with "worst case" assumptions to obtain the expected highest dose. Appendix A provides the intake factors used to calculate the intake dose. Each calculated exposure dose is compared against the corresponding *health guideline*. For example, using an ATSDR minimal risk level (MRL) or U.S. EPA Reference Dose (RfD) to evaluate noncancer effects for that chemical, as appropriate. Health guidelines are considered safe doses; that is, if the calculated dose were at or below the health guideline, no adverse health effects would be expected.
- If the "worst case" exposure dose for a chemical is greater than the noncancer health guideline, then the exposure dose might be refined to reflect more closely actual exposures that occurred or are occurring at the site. The exposure dose is then compared with known health effect levels identified in ATSDR's toxicological profiles or the scientific literature. *These comparisons are the basis for concluding whether the exposure presents a health hazard.*
- To evaluate cancer risk, the lifetime average dose is calculated and compared with a U.S. EPA cancer slope factor.

This PHA's exposure evaluation focused on VOCs detected in the Eufracia well, given that in the Hormigas well, VOCs were not detected at any time. VOCs are known contaminants in groundwater, and past residential exposures are of highest concern.

Potential Health Effects from Past VOC Exposure

PRASA reported that VOCs were detected in the Eufracia well in 2006 and 2009 at concentrations that exceeded the MCL. PCE, TCE and cis-1,2-DCE were detected in the Eufracia well in 2009 at elevated concentrations (Table 1), with PCE and TCE detected at concentrations exceeding the MCL. The National Toxicology Program (NTP) has determined that PCE and TCE are *Reasonably Anticipated Human Carcinogens*. Cis-1,2-DCE has not been classified as a human carcinogen (NTP 2011).

To assess the exposure potential of the detected VOCs to cause an adverse health effect, we need an exposure dose estimate. VOCs were detected in 2006 and 2009 sampling rounds. Data were not available for either of the sampled wells for the period between 2001 and 2005. The exposure period, therefore, is conservatively estimated at 11 years—the time between the Eufracia well's installation (1998) and its removal from service (2009).

Using body weight and water intake rates, the most highly exposed period of life for drinking-water ingestion is from birth to <1 year of age. We used this child receptor to evaluate potential noncancer health effects associated with VOCs in the water supply. To provide a health-protective evaluation of cancer risk associated with exposure to VOCs in drinking water, we assumed that a child aged birth to <11 years of age was exposed to VOCs drinking water from the Hormigas water system from 1998 to 2009. In addition, we also evaluated exposure of an adult receptor to the Hormigas water system for 11 years.

In addition, given that TCE is associated with potential developmental effects in the fetus in pregnant women, we also evaluated this receptor for exposure to TCE for the period of gestation (0.77 years = 40 weeks/52 weeks).

The following populations were evaluated in this health evaluation (Table 3):

Table 3. Populations Evaluated in the PHA

Receptor	*Duration of Exposure*	*Contaminant*
Child – Birth to < 1 yr	1 year (evaluate noncancer effects)	PCE, TCE, cis-1,2-DCE
Child – Birth to < 11 yr	11 years (evaluate cancer risk)	PCE, TCE
Pregnant Woman	0.77 years (evaluate developmental effects)	TCE
Adult	11 years (evaluate noncancer effects and/or cancer risk)	PCE, TCE, cis-1,2-DCE

We assumed the above receptors were exposed to the maximum-detected concentration in the Eufracia well every day for 1 to 11 years. But during this period, household water was not wholly obtained from the Eufracia well. Thus the COC concentration used in the health evaluation was adjusted to account for the contribution of the Eufracia well to the entire Hormigas water system. The COC concentrations detected in the Eufracia well were adjusted by a factor of 20% to account for the amount of water the system obtained from the Hormigas water wells (80% from the Cidra filtration system). The concentrations were also adjusted by a factor of 60% to account for the fact that 60% of the water from the Hormigas wells was from the Eufracia well (generated 150 gpm) and 40% from the Hormigas well (generated 100 gpm). Therefore, we assumed the residents were exposed daily for up to 11 years to the following concentrations (Table 4):

Table 4. Exposure Concentrations for Health Evaluation

COC	*Maximum in the Eufracia well (µg/L)*	*Percent of contribution to the Hormigas water system*[a]	*Percent of contribution of the Eufracia well*[b]	*Exposure Concentration (µg/L)*
PCE	280	20%	60%	34
TCE	60	20%	60%	7
1,2-DCE	50	20%	60%	6

[a] – The Hormigas water wells (Eufracia and Hormigas wells) contribute 20% to the Hormigas water system (80% from the Cidra filtration system).

[b] - The production of the two Hormigas water supply wells were 150 gpm for the Eufracia (60%) and 100 gpm for the Hormigas well (40%).

The following is an example of the dose calculations performed for this evaluation. Multiplying by a factor of 2 to account for additional exposure from breathing in VOCs from water and absorbing them through skin during bathing, the daily dose of VOCs in milligrams per kg of body weight for child and adult receptors is

$$2 \times \frac{Concentration\left(\frac{\mu g}{L}\right) \times CF\left(\frac{mg\ L}{1000\ \mu g}\right) \times Water\ Intake\left(\frac{L}{day}\right) \times EF = \frac{mg}{kg/day}}{Body\ Weight\ (kg)}$$

Where

- CF is the conversion factor (convert units of µg to mg), and
- EF is the Exposure Factor that represents how long a person is in the home and is expected to drink the water (e.g., how many days a year they are at home and how many years they spend living in the home).

The EF is considered one (1) for noncancer effects, given that the exposure occurs every day over an 11-year period. For cancer effects, the EF provides for a lifetime average dose (78 years); therefore, this equation uses an EF of 11 years/78 years.

The exposure dose changes throughout life as the assumed body weight and ingestion rate changes. Appendix A provides the intake factors used to evaluate cancer and noncancer effects for the child and adult receptors listed above in Table 3. Exposure factors were obtained from the U.S. EPA Exposure Factor Handbook (EFH) (USEPA 2011a).

After a dose is derived, it is compared with toxicity values that provide an indication of whether the dose might pose a health risk to people who were or are exposed to a COC. Toxicity factors are health-protective values provided to evaluate noncancer effects (MRLs and RfDs) and cancer (slope factors (SFs)) (see Appendix A).

To evaluate potential *cancer* effects, the calculated child (birth to <11yrs) and adult doses were multiplied by U.S. EPA's SF to calculate an excess cancer risk value. Everyone has a baseline risk of developing cancer within his or her lifetime. The risk might vary with lifestyle (e.g., smoking) or

heredity. In health evaluations, the cancer risk derived from a calculated dose reflects an increased, exposure-associated cancer risk in addition to a person's baseline risk. Therefore, if a cancer risk of 1 in 1,000,000 is derived for a dose of a chemical of concern, it means that in addition to baseline cancer risk, an additional person out of a million exposed might develop cancer during his or her lifetime.

To evaluate potential *noncancer* effects, the calculated adult dose is divided by a health guideline (an MRL or RfD), if appropriate, to calculate the noncancer hazard possibly associated with exposure to the COC. If the calculated dose is below the MRL or RfD, exposure to the COC is not expected to result in adverse health effects to the exposed person. If the dose exceeds the MRL or RfD, a further evaluation determines whether the dose of a COC might result in adverse health effects. The adult dose is compared with the RfD or MRL because it represents long-term (chronic) exposure. For the child receptor, the exposure time evaluated is from birth to < 1 year of age, which represents less than chronic exposure. Therefore, the child dose is not compared with the RfD or MRL but, instead, is evaluated to see how doses compare with effect doses from the literature. Similarly, the dose derived for the pregnant female is compared with doses from the literature associated with developmental effects.

A summary of the doses and derived cancer and noncancer risks associated with the three COCs at the Hormigas Site are provided in Table 5 (cancer risk) and Table 6 (noncancer effects). Table 5 also provides a summation of the cancer risks associated with exposure of the child (birth to < 11 yr) and adult receptors exposed to PCE and TCE. A discussion of the PHA's results regarding past exposure to the three COCs is provided below:

Table 5. Summed Cancer Risk to Receptors (Eufracia Well 2009)

	Age Interval	
Chemical	birth to < 11 yrs	Adult
PCE TCE	1×10^{-6} (1 in 1,000,000)* 1×10^{-5} (1 in 100,000)*	7×10^{-7} (7 in 10,000,000)* 3×10^{-6} (3 in 1,000,000)*
TOTAL	1×10^{-5}	4×10^{-6}

*Values are rounded to one significant figure.

Table 6. Exposure Doses Used to Evaluate Noncancer Effects (Eufracia Well 2009)

Chemical/ (Water Concentration)	*Receptor*	*Calculated Dose (mg/kg/day) - Ingestion Rate x Water concentration x 2*	*RfD*	*Noncancer Hazard*
PCE (34 µg/L)	birth to <1 yr	0.01	0.006	NA
	Adult	0.002	0.006	0.4
TCE (7 µg/L)	birth to <1 yr	0.002	0.0005	NA
	Adult	0.0005	0.0005	1
	pregnant female	0.0005	0.0005	NA
cis-1,2-DCE (µg/L)	birth to <1 yr	0.002	0.002	NA
	Adult	0.0004	0.002	0.2

a The doses for the child receptor and pregnant female were not compared to the RfD because exposure of these populations represents an intermediate duration exposure (less than 1 year). The calculated doses were compared with appropriate intermediate duration adverse effect levels.
RfD= Oral Reference Dose (U.S. EPA)=

Potential for Health Effects from Past PCE Exposure:

For PCE, an example of the calculation used to derive an exposure dose for potential cancer effects in adults is provided below. We evaluated an adult weighing 80 kg drinking 2.8 L/day containing 34 µg/L PCE for 11 years (USEPA 2011a; Appendix A). Multiplying by a factor of 2 to account for additional exposure from breathing in PCE from water and dermal exposure during bathing, the daily dose of PCE in milligrams PCE per kg of body weight per day (mg/kg/day) is estimated as

$$2 \times \frac{34\frac{\mu g}{L} x \frac{mg}{1000\mu g} \times 2.8\frac{L}{day}}{80kg} = 0.002 mg/kg/day$$

Cancer Risk Evaluation (Table 5)

For evaluation of cancer risk, this dose is then adjusted by the EF of 11 years/78 years, resulting in a dose of 0.0003 mg/kg/day in an adult (Appendix A). This dose is then multiplied by an appropriate cancer slope factor. U.S. EPA provides a recently released oral cancer slope factor of 0.002 $(mg/kg/day)^{-1}$ based on liver tumors in mice (USEPA 2012). Use of this slope factor results in an estimated excess cancer risk of 7 x 10^{-7} or 7 out 10,000,000 exposed. For a child, the excess risk was 1 in 1,000,000. These excess risks correspond to a low increase in cancer risk associated with past

PCE exposure. Again, these values reflect a potential past risk, given that the water is no longer used for household purposes.

Due to the conservative assumptions used, the actual increased risk of cancer is probably much lower than this estimate. The above calculations assume that for the entire time the well was in service (11 years), past exposure to PCE was at the highest concentration detected in 2009. Using past sampling data, however, PCE was only detected in samples obtained in 2006 and 2009. Use of the maximum value, therefore, provides a conservative (i.e., health-protective) evaluation. Because a low increased risk was derived, ATSDR does not consider past exposure to PCE in drinking water to be associated with an increase in cancer risk.

Noncancer Hazard Evaluation (Table 6)

To evaluate noncancer effects associated with past PCE exposure, calculated doses for the most highly exposed receptor (child from birth to < 1 year old) were compared with doses associated with adverse effects. Using intake assumptions for this receptor (Appendix A), doses were calculated for the child aged birth to < 1 yr and for the adult receptor.

An MRL is not available for PCE. To evaluate potential adverse effects then, we used the U.S. EPA chronic RfD and the studies used as its basis. The RfD is an estimate, with safety factors built in, of the daily lifetime exposure to a contaminant unlikely to cause noncancerous health effects. Of note, a suitable comparison value is not yet available for the intermediate duration (1 year or less) of exposure experienced by a child aged birth to < 1 year. Therefore, to evaluate potential effects to the child receptor, we need to compare the estimated exposure doses with effect levels found in available studies. Because chronic exposure (1 year or more) is applicable to the adult receptor, that RfD can be used to evaluate potential effects for this population.

To evaluate the intermediate exposure duration of a child aged birth to < 1 yr, the calculated dose of 0.01 mg/kg/day is compared with exposure doses associated with this exposure duration. The ATSDR Toxicological Profile for PCE (ATSDR 1997a) provides a Lowest Observed Adverse Effect Level (LOAEL) of 100 mg/kg/day for a 6-week oral exposure of mice to PCE. The LOAEL is based on mild liver effects in the mice. The child dose of 0.01 mg/kg/day is well below the LOAEL of 100 mg/kg/day in the mouse study, indicating that PCE exposure of the birth to < 1 yr child is not likely to have resulted in adverse health effects.

For the adult receptor, we calculated an intake dose of 0.002 mg/kg/day (Table 6). Adult exposure represents chronic exposure (greater than 1 year exposure). Thus we can compare the exposure dose directly with the chronic Reference Dose (RfD) value of 0.006 mg/kg/day. The RfD is based on observed effects on the nervous system of occupationally exposed adults at doses of 2.6 mg/kg/day (Cavalleri et al. 1994) and 9.7 mg/kg/day (Echeverria et al. 1995). We calculated a hazard index of 0.4, which is below the value of 1, indicating that PCE exposure of adults to Hormigas site water is not likely to have resulted in adverse health effects.

Potential for Health Effects from Past TCE Exposure

Employing the same methods used to derive the doses for PCE, calculated exposure doses for TCE are provided in Table 5, Table 6 and in Appendix A. U.S. EPA recently released guidance that provides an updated cancer slope factor of 0.046 $(mg/kg/day)^{-1}$ for TCE (USEPA 2011b, 2011c). The guidance also provides methodology to adjust the slope factor for TCE to account for the greater susceptibility of children (Appendix A). The most appropriate CV for TCE is a CREG (cancer risk evaluation guide) of 0.76 µg/L using the same key studies that provide the basis for the oral slope factor.

Cancer Risk Evaluation (Table 5)

An estimated increased risk of cancer associated with past exposure to TCE was derived by multiplying the appropriate oral cancer slope factor by the maximum calculated dose (Table 5; Appendix A). The increased past cancer risk was 1×10^{-5}, or 1 in 100,000 for a child (aged birth to < 11 yrs). For an adult, the excess cancer risk was 3×10^{-6}, or 3 in 1,000,000 (Table 5). These estimates correspond to a low increase in cancer risk associated with past TCE exposure. Again, this reflects a potential past increased risk because the water in the Eufracia well is no longer used for household purposes.

Due to the conservative assumptions used, actual increased cancer risk is probably much lower than estimated here. The above calculations assume that the past exposure to TCE was at the highest concentration detected in 2009 for the entire time the well was in service (11 yrs). Using past sampling data, TCE was only detected in samples obtained in 2009, so use of the maximum provides a conservative (i.e., health-protective) evaluation. Given that a low increased risk was derived, ATSDR does not consider past exposure to TCE in drinking water to be associated with any increase in cancer risk.

Noncancer Hazard Evaluation (Table 6)

ATSDR is currently evaluating an MRL for TCE. But for now, we use EPA's chronic RfD and the studies used as its basis to evaluate potential adverse effects resulting from exposure. The chronic oral RfD of 0.0005 mg/kg/day is based on the three studies and two supporting studies provided in Table 7 below (USEPA 2012).

Table 7. Principal and Supporting Studies for TCE RfD (0.0005 mg/kg/day)

Study	*Effect Endpoint*	*Effect and Effect Level*
Keil et al (2009)	Decreased thymus weight (30 week drinking water study)	Human Equivalent Dose = 0.048 mg/kg/day
Peden-Adams et al (2006)	Developmental effects on the immune system (drinking water during pregnancy)	LOAEL = 0.37 mg/kg/day
Johnson et al. (2003)	Fetal heart malformations (drinking water during pregnancy)	Human Equivalent Dose = 0.0051 mg/kg/day
Additional Studies Cited by U.S. EPA (2012) to Support the RfD		
Woolhiser et al. (2006)	Increased kidney weight (inhalation for 4 weeks)	Human Equivalent Dose = 0.0079 mg/kg/day
NTP (1988)	Kidney damage (oral intake for two years)	Human Equivalent Dose – 0.0034 mg/kg/day

For the adult receptor, the calculated intake dose was 0.0005 mg/kg/day (Table 6). Adult exposure represents chronic exposure (greater than 1 year exposure). Thus we can compare the exposure doses directly with the chronic RfD value of 0.0005 mg/kg/day. The RfD is based on the studies and doses provided in Table 7 above. We calculated a hazard index of 1 (Table 6), which is equal to the value of 1, indicating that TCE exposure of adults is not likely to have resulted in adverse health effects.

A suitable comparison value is not yet available for the intermediate duration (1 year or less) of exposure experienced by the child aged birth to < 1 year. Therefore, ATSDR must compare the estimated exposure doses with effect levels from available studies to evaluate potential effects to the child receptor. Given that chronic exposure (1 year or more) is applicable to the adult receptor, we can use the RfD to evaluate potential effects for this population.

To evaluate the intermediate exposure duration of the child aged birth to < 1 yr, the calculated dose of 0.002 mg/kg/day (Table 6) is compared with exposure doses associated with this duration of exposure. This dose is below doses associated with intermediate exposure (HEC of 0.048 for a 30 week exposure (Keil et al. 2009))—and HEC of 0.0079 mg/kg/day for a 4-week exposure (Woolhiser et al. 2006). Thus a child previously exposed to the dose of TCE in the Hormigas water system is not expected to have had adverse effects because of past exposure.

For TCE, a pregnant female was also evaluated—TCE has been associated with potential effects on the developing fetus. Several limited human studies have reported potential associations between TCE exposure and developmental effects (USEPA 2012). Rodent studies are available (Table 7) that report fetal heart malformations and developmental effects on the immune system following exposure to TCE in the drinking water during pregnancy. The Human Equivalent doses calculated based on these studies will be used to evaluate potential effects on the developing fetus in pregnant women.

We assumed a typical pregnant woman weighed 73 kg and drank 2.6 L of water per day for the duration of her pregnancy (0.77 years) (Appendix A; USEPA 2011a). For the pregnant receptor then, the dose for noncancer effects was 0.0005 mg/kg/day (Table 6). This dose is well below the drinking water doses used to define the RfD based on effects on the fetus (0.37 and 0.0051 mg/kg/day – Table 7).

Using a comparison of estimated doses with appropriate health guidelines (RfD or health effect levels), adverse noncancer health effects are not likely associated with a past adult, child, or pregnant woman's developing fetus exposed to TCE in drinking water.

Potential for Health Effects from Past cis-1,2-DCE Exposure

Cis-1,2-DCE has not been identified as a carcinogen. Past cis-1,2-DCE exposure, therefore, was only evaluated for noncancer effects. Doses were calculated for a child less than 1 year of age and for an adult (Table 6).

An MRL is not available for cis-1,2-DCE. Thus we turn to the chronic RfD and the studies used as the basis for that RfD to evaluate potential adverse effects. A suitable comparison value is also not yet available for the intermediate exposure durations (1 year or less). ATSDR must therefore compare the estimated exposure doses with effect levels from available studies to evaluate potential effects to a child less than 1 year of age. Given that chronic exposure (1 year or more) is applicable to adults, the RfD can be used to evaluate potential effects for this population. The RfD is based on potential effects on the kidney in rats at a dose of 5.1 mg/kg/day (McCauley et al. 1995, 1990).

We compared the calculated dose for children less than 1 year of age (0.002 mg/kg/day, Table 6) with exposure doses associated with an intermediate duration of exposure (less than 1 year). The oral RfD for cis-1,2-DCE is based on a 90-day study in rats—an appropriate comparison with the intermediate exposure duration of the child (McCauley et al. 1995, 1990). The study modeled a benchmark dose of 5.1 mg/kg/day for kidney effects in rats. Comparing this benchmark value of 5.1 mg/kg/day with the calculated dose of 0.002 mg/kg/day indicates that past exposure of the birth to < 1 year-aged child is not likely to have resulted in adverse health effects.

For adults, an intake dose of 0.0004 mg/kg/day was calculated (Table 6). Given that adult exposure represents chronic exposure (greater than 1 year exposure), the exposure dose can be compared directly with the chronic RfD value of 0.002 mg/kg/day. A hazard index of 0.2, which is well below the value of 1, indicates that adults exposed in the past to cis-1,2-DCE exposure were not likely to experience adverse health effects.

Evaluating Oral Exposures to a Mixture of Chemicals of Concern

At hazardous waste sites, the health effects of exposure to chemical mixtures are always a concern. For exposure to contaminated water at this site, ATSDR followed existing protocols for evaluating exposures to multiple chemicals of concern (e.g., using the hazard index approach for noncancer effects of chemical mixtures) (ATSDR 2004a).

In the hazard index (HI) approach, the hazards derived for each COC are added together to obtain an overall hazard index (HI) for the chemicals that affect the same target organ. The VOCs evaluated for the Hormigas Site, however, do not clearly target the same organs. Thus the hazards calculated for the adults were not summed for the evaluation.

For cancer risk, it is appropriate to sum the cancer risks associated with each COC (PCE and TCE). The summed risks were 1 in 100,000 for the child aged birth to < 11 yrs and 4 in 1,000,000 for the adult population (Table 5). For the exposed populations, these values are considered a low additional risk.

Potential Exposure Pathways

Vapor Intrusion

If VOC levels are high enough in groundwater and the groundwater is close enough to the surface, VOCs can sometimes move through the soil above the water table or through cracks or gaps in the subsurface. If the travel pathway leads to a building's interior through a basement, crawl space, or cracks in the foundation, the contaminant might accumulate inside the building. This process is known as *vapor intrusion*. In some cases vapors from subsurface contaminants can reach levels that are of health concern. U.S. EPA recommends evaluating the potential for vapor intrusion at sites where volatile substances are suspected to be present in soil or groundwater near existing or future buildings at 100 ft of depth or less (USEPA 1989, 2002). Treatment of the vapor intrusion pathway usually involves improving ventilation of homes to allow vapors to dissipate.

For evaluation of this potential exposure pathway, ATSDR will work with U.S. EPA to ensure proper characterization of groundwater and soil gas contaminant levels .

Incidental Exposure to Surface Soil

Because the contamination source has not been identified, we do not know source area conditions or how people living, working, or playing around them might come in contact with contaminants. U.S. EPA's sampling during its Site Discovery Initiative (USEPA 2010) did not find any contamination sources in soils at businesses in the area of the Hormigas water supply wells. Consequently no credible evidence indicates that soils in the area would pose a hazard to people nearby. But as information develops throughout the remedial investigation process, ATSDR will continue to evaluate the potential for exposure to contaminated soil or other identified substances at source areas.

Child Health Considerations

ATSDR recognizes that infants and children might be more vulnerable than are adults to exposures in communities with contaminated air, water, soil, or food. This potential vulnerability results because 1) children are more likely to play outdoors and bring food into contaminated areas, 2) children are shorter and therefore more likely to contact dust and soil, 3) children's small size results in higher doses of chemical exposure per kg of body weight, and 4) developing body systems can

sustain permanent damage if toxic exposures occur during critical growth stages. Because children depend completely on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests at the site.

In its evaluation, ATSDR considered the special case of pregnant women. Exposure during pregnancy to TCE, one of the major contaminant of concern at this site, might increase the risk of heart or other birth defects in newborn children. In addition, because small children were potentially exposed to contaminated private well water, ATSDR estimated exposures specific to young children (birth to < 1 year old). Because of increased water intake and smaller body weight, a small child would have a higher exposure dose than would older children or adults. Conclusions based on exposure doses estimated for small children would therefore also be protective of older children and nonpregnant adults.

Health Outcome Data

Health outcome data can give a more thorough evaluation of the public health implications of a given exposure. Health outcome data can include mortality information (e.g., the number of people dying from a certain disease) or morbidity information (e.g., the number of people in an area getting a certain disease or illness). The review is most effective when 1) a completed human exposure pathway exists and exposure was known to occur before the health outcome was identified, 2) potential contaminant exposures are high enough to result in measurable health effects, 3) enough people are affected for the health effect to be measured, and 4) a database is available to identify rates of diseases plausibly associated with the exposure of populations of concern.

We did not review health outcome data for this site because people are not currently exposed to contaminants. The Hormigas system was taken out of service in 2009. Thus the community no longer uses contaminated water. Although ATSDR is uncertain of the actual exposure levels in the past, our health-protective calculation shows that it is unlikely the concentrations people were exposed to in the past were high enough to cause health effects. And even if we knew the levels of past exposure, the number of potentially exposed people would be too small to allow us to detect statistical differences in disease rates.

Community Health Concerns

In April 2011, ATSDR met with Hormigas community members to listen to their concerns. ATSDR also spoke with U.S. EPA, PREQB, PRDOH, and PRASA officials about concerns they may have heard from the community.

A mixed level of concern surfaced among residents about the Hormigas site. Some reported concerns when they first read the newspaper articles about the Hormigas Site, but were later relieved when they found they no longer received contaminated water. Others were concerned about whether they might have been exposed to contaminants before the Hormigas water system was removed from service and wondered about possible related health effects.

Such concerns notwithstanding, no one voiced health concerns associated with chemical exposure, and no one in the community was aware of any health concerns among other residents. One person, however, did indicate that many in the community suffered from asthma, especially in cold weather.

People indicated mixed approaches to drinking water sources. Some residents drank bottled water because of concerns about contamination. Others filtered or purified their water before drinking. Still others drank unfiltered tap water. Residents also reportedly used cisterns to store water in case of shortages or rationing during the dry season.

Conclusions and Public Health Action Plan

Conclusions

ATSDR reached three important conclusions in the PHA:

Conclusion 1

No one is currently exposed to water from the Hormigas water supply wells.

Basis for Conclusion 1

The Puerto Rico Aqueduct and Sewer Authority (PRASA) removed the Hormigas Water System from service in 2009 and replaced it with the Cidra Water System.

Conclusion 2

People who used or drank water from the Hormigas Water Supply system before the system was taken out of service in 2009 are unlikely to have adverse health effects from using the water.

Basis for Conclusion 2

ATSDR used conservative (i.e., health-protective) exposure assumptions (e.g., assume people drank the maximum amount in the well for 11 years of exposure) to look at potential effects on health from past use of the Hormigas system water. Exposures to contaminants in the Hormigas system before its closure in 2009 were below levels of health concern.

Conclusion 3

U.S. EPA has not been able to identify the source of the contamination found in the Eufacia well in the Hormigas Water Supply.

Basis for Conclusion 3

U.S. EPA sampled the soil in the area to see if they could determine a source of the contamination. U.S. EPA has not identified a source but as part of its investigation continues to take samples of water and soil in the area. Identifying the source will help prevent contamination of other area water resources.

Public Health Action Plan

- Residents formerly served by the Hormigas Water Supply wells are now served by the Cidra Water Supply system, a municipal source owned by PRASA that will undergo continual monitoring with results reported to the PRDOH.
- During its Remedial Investigation (RI) U.S. EPA will continue in its efforts to identify the source of the Hormigas Water System contamination.
- A Draft of the PHA for Public Comment was released in March 2013. Comments received were addressed and the responses are included as Appendix D.

Site Team

Karen Scruton, MS
Environmental Health Scientist
Division of Health Assessment and Consultation
Environmental Investigation and Site Assessment Branch

Lourdes Rosales-Guevera, MD
Medical Officer
Division of Health Assessment and Consultation
Environmental Investigation and Site Assessment Branch

Racquel Stephenson
Regional Representative-Region II
Division of Regional Operations

Maureen Turner
Health Communication Specialist
Division of Health Assessment and Consultation
Health Promotion and Community Involvement Branch

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APPENDICES

APPENDIX A: Explanation of Evaluation Process

APPENDIX B: Glossary of Terms

APPENDIX C: Location Maps and Photographs of the Hormigas Water System Wells

APPENDIX D: Responses to Public Comments

Appendix A. Explanation of Evaluation Process

Screening Process

In evaluating the site environmental data, ATSDR used comparison values (CVs) to determine which chemicals to examine more closely. CVs are health-based contaminant concentrations found in a specific media (air, soil, or water) and are used to screen contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water, and soil that someone might inhale or ingest each day.

As health-based concentrations, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. Different CVs are developed for cancer and noncancer health effects. Noncancer levels are based on valid toxicological studies for a chemical, with appropriate safety factors included, and the assumption that small children and adults are exposed every day. Cancer levels are based on a one-in-a-million (1×10^{-6}) excess cancer risk for an adult exposed to contaminated soil or drinking contaminated water every day for 70 years. For chemicals for which both cancer and noncancer levels exist, we use the lower level to be protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

For all of the screening tables (A.1 to A.4), the maximum detected value in water was compared to an appropriate CV value (discussed below).

CVs used in preparing this document are listed below:

Environmental Media Evaluation Guides (EMEGs) are estimated contaminant concentrations in a media where noncarcinogenic health effects are unlikely. EMEGs are derived from the Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk level (MRL).

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations that would be expected to cause no more than one additional excess cancer in one million persons exposed over a lifetime. CREGs are calculated from U.S. Environmental Protection Agency (USEPA) cancer slope factors (CSFs).

Reference Media Evaluation Guides (RMEGs) are estimated contaminant concentrations in a media where noncarcinogenic health effects are unlikely. RMEGs are derived from U.S. EPA's reference dose (RfD).

Lifetime Health Advisories (LTHAs) are derived by U.S. EPA from a drinking water equivalent level below which no adverse noncancer health effects are expected to occur over a 70-year lifetime.

Maximum Contaminant Levels (MCLs) are enforceable standards set by U.S. EPA for the highest level of a contaminant allowed in drinking water. MCLs are set as close to MCL goals (MCLGs, the level of a contaminant in drinking water below which there is no known or expected risk to health) as feasible using the best available treatment technology and taking cost into consideration.

U.S. EPA Regional Screening Levels (RSLs) are risk-based concentrations derived from standardized equations combining exposure information assumptions with U.S. EPA toxicity data. U.S. EPA considers RSLs to be protective for humans (including sensitive groups) over a lifetime.

Some CVs may be based on different durations of exposure. Acute duration is defined as exposure lasting 14 days or less. Intermediate duration exposure lasts between 15 and 364 days, and chronic exposures last 1 year or more. Comparison values based on chronic exposure studies are used whenever available. If an intermediate or acute comparison value is used, it is denoted with a small *i* or *a* before the CV (e.g., iEMEG refers to the intermediate duration EMEG).

The CV screening for the Hormigas site is provided in Table A.1. The following contaminants of concern (COCs) were identified from the CV screening: PCE, TCE and cis-1,2-DCE. Further discussion regarding the identification of the contaminants of concern (COCs) is provided below.

CV Screening and Identification of Contaminants of Concern (COCs)

Table A.1 provides the CV screening for the contaminants identified in the Eufracia and Hormigas wells during PRASA compliance sampling and U.S. EPA sampling rounds. The maximum detected values in both wells were compared to appropriate CVs. The maximum detected value for each well and the associated sampling date are provided on Table A.1. U.S. EPA was not able to sample the Hormigas well during the 2009 Site Discovery Initiative because the well pump was broken. Therefore, the only data available from the Hormigas well is PRASA compliance data that was obtained before 2009. On Table A.1, none of the contaminants that exceeded the CVs was detected in the water from the Hormigas well.

Table A.1 indicates that several different VOCs were detected in the Eufracia well at levels higher than drinking water CVs. The contaminants with the highest detected concentrations were PCE, TCE and cis-1,2-DCE. Both TCE and cis-1,2-DCE are potential breakdown products of PCE, the initial contaminant of concern at this site. These three VOCs are identified as COCs and will be evaluated further in the ensuing sections of this report.

Other contaminants were found at concentrations that exceeded the screening CVs, including benzene, two trihalomethanes (THM) (bromodichloromethane and dibromochloromethane), arsenic and copper. In addition, a CV is not available for dibromomethane so it could not be screened. The following discussion provides justification for the elimination of these contaminants as COCs for the Hormigas water system wells.

Benzene was detected in the Eufracia well at concentrations of 0.00071 mg/L and 0.0007 mg/L (duplicate) during the U.S. EPA 2009 sampling round. These concentrations were just above the CV (0.0006 mg/L) but well below the MCL of 0.005 mg/L. The detection limit for benzene was 0.0005 mg/L for all sampling events, which is comparable to the detected value as well as the CV. Benzene was only detected during this one sampling round at a concentration below the MCL and was not detected in any other sampling round in either the Eufracia or Hormigas water supply wells, therefore, benzene is not retained as a COC at the Hormigas site.

Table A.1. Identification of Contaminants of Concern in the Hormigas Water Supply Wells

Table A.1

Identification of Contaminants of Concern in the Hormigas Water Supply Wells

Constituent	Comparison Value(a)		Eufracia Well		Hormigas Well (b)	CONTAMINANT OF CONCERN (Y/N) (c)
	Non-cancer CV (ug/L)	Cancer CV (ug/L)	Maximum Detected (ug/L)	Date Detected	Maximum Detected (ug/L)	
Benzene	5 (MCL)	0.6 (CREG)	0.71	9/1/2009	ND	No
Bromodichloromethane	80 (MCL, total THM)	0.6 (CREG)	13	8/14/06 and 10/17/06	ND	No
Dibromochloromethane	80 (MCL, total THM)	0.4 (CREG)	7	8/14/2006	ND	No
Dibromomethane	NR	NR	0.89	10/17/2006	ND	No
cis-1,2,-Dichloroethene	20 (Child RMEG)/ 70 (MCL)	NR	50	9/1/2009	ND	**YES**
Tetrachloroethene	5 (MCL)	0.06 (CREG)	280	9/1/2009	ND	**YES**
Trichloroethene	5 (MCL)	0.8 (CREG)	60	9/1/2009	ND	**YES**
Arsenic	10 (MCL)	0.02 (CREG)	3.3	9/1/2009	ND	No
Copper	100 (Child Int EMEG)/ 1300 (MCL)	NR	200	9/1/2009	ND	No

(a) - Comparison Values (CVs) provided are the lowest of the following values:
ug/L = micrograms of chemical per liter of water
CREG - Cancer Risk Evaluation Guide
EMEG - Environmental Media Evaluation Guide (Child Chronic and Intermediate duration values)
LTHA - Lifetime Health Advisory
MCL - Maximum Contaminant Level
THM = total halogenated methanes
(b) - The Hormigas well was not tested during the 2009 sampling conducted by EPA because the well pump was broken.
None of the contaminants listed above were detected in the Hormigas well in previous sampling rounds by PRASA.
(c) - See text for explanation of identification of Contaminants of Concern (COCs)

In municipal water, THMs are formed as byproducts of the chlorination process. These contaminants have been consistently detected in both the Hormigas and Eufracia wells over the years of sampling. It is likely that these contaminants may be the result of household products and chlorine-treated water being disposed of in septic systems and leaching into the groundwater (NGA, 2011). Although two of the individual THMs (**bromodichloromethane** and **dibromochloromethane**) exceeded the CVs, they were detected at concentrations well below the MCL for total THMs (0.080 mg/L). The MCL for THM includes trichloromethane (also known as chloroform), dibromochloromethane, bromodichloromethane and tribromomethane (also known as bromoform). Therefore, the total THM and related compounds are not considered to be COCs at the Hormigas Site.

A CV is not available for **dibromomethane** so a screening could not be performed. Although dibromomethane is similar to the THMs, it is not included as a component of the MCL for THMs. Information regarding the toxicity of dibromomethane is not included in the Integrated Risk Information System (IRIS) provided by U.S. EPA that evaluates the potential toxicity of chemicals (USEPA 2011c). Given that this chemical was only detected once in the Eufracia well at a concentration just above the detection limit, and that it is not associated with the PCE contamination identified in the well, it is not considered further in this health evaluation.

Arsenic and **copper** were detected at concentrations that exceeded the CVs. Both metals are naturally-occurring compounds that were detected at concentrations well below the regulatory value (MCL of 0.01mg/L for arsenic and action level of 1.3 mg/L for copper). Both arsenic and copper are naturally present in the food supply and people consume copper as a requirement of a healthy diet.

Natural background levels of arsenic in groundwater average about 0.001 to 0.002 mg/L (ATSDR, 2007). The United States Geologic Society (USGS, 2002) reported that, in Puerto Rico, arsenic concentrations in at least 25% of the groundwater samples exceed 0.001 mg/L. The maximum detected concentration in the Eufracia well was 0.0033 mg/L, which is likely indicative of natural background conditions. Arsenic is not considered further as a COC in this health evaluation.

The average natural background concentration of copper in groundwater is 0.005 mg/L, although monitoring data indicate that some groundwater contains concentrations up to 2.783 mg/L (ATSDR, 2004b), which is well above the action level of 1.3 mg/L. Copper in water is generally bound to particles and is not dissolved in water. The maximum detected concentration of copper in the Eufracia well was 0.200 mg/L which is likely indicative of natural background concentrations of copper in water. Copper is not considered further as a COC in this health evaluation.

The COCs identified and evaluated for the Hormigas site are PCE, TCE and 1,2-DCE.

Data are available for the community wells and soils located near the Hormigas water supply wells as well as compliance data for the Cidra water supply system. The CV screening tables for these data are provided in Table A.2 (community wells), A.3 (soil) and A.4 (Cidra water supply). Screening of the sampling results against CVs did not result in any exceedences. There were two instances where the laboratory detection limits were above the CV values (heptachlor and arsenic in water). In these cases, the maximum detected value was screened against the MCL. Results of sampling completed

for the Cidra system were screened and two THM compounds exceeded CVs, but neither exceeded the MCL of 80 µg/L for total THMs. THMs are routinely detected in municipal sources because they are associated with the chlorination process.

Table A.2. Groundwater Data from the Community Water Wells Detected Values from 2009

Table A.2

Groundwater Data from the Community Water Wells [a]

Detected Values from 2009

all ug/L Chemical	Maximum Detected Value (ug/L)	Comparison Value (ug/L)	MCL (ug/L)	Exceed Screening Value? (Y/N)
Chloroform	**0.81**	100 (Chronic EMEG Child)	NR	N
Toluene	**0.68**	200 (Child Int EMEG)	1000	N
Heptachlor	**0.052**	0.008 (CREG)	0.4	N*
Antimony	**0.78**	4 (Child RMEG)	6	N
Arsenic	**5**	0.02 (CREG)	10	N*
Barium	**44**	2000 (Child Chronic EMEG)	2000	N
Cadmium	**0.41**	1 (Child Chronic EMEG)	5	N
Chromium	**1**	100 (MCL)	100	N
Copper	**13.4**	100 (Child Int EMEG)	1300 (Action Level)	N
Lead	**2.9**	15 (Action Level)	15 (Action Level)	N
Manganese	**142**	300 (LTHA)	50 (SMCL)	N
Mercury	**0.043**	2 (LHTA for HgCL)	2	N
Nickel	**1.1**	100 (LTHA)	NR	N
Vanadium	**2.1**	100 (Child Int EMEG)	NR	N
Zinc	**400**	3000 (Child Chronic EMEG)	5000 (SMCL)	N

a - Data obtained from the EPA Site Discovery Initiative (2010).

The data provided in the table reflects only those data detected.

The samples were evaluated for TCL analysis of VOCs, SVOCs, pesticides, PCBs, and TAL inorganics (including mercury and cyanide).

* Values were compared to the MCL value since the detection limits were above the CV.

RMEG = Reference Dose Media Evaluation Guide

CREG - Cancer Risk Evaluation Guide

EMEG - Environmental Media Evaluation Guide (Child Chronic and Intermediate duration values)

LTHA - Lifetime Health Advisory

MCL - Maximum Contaminant Level

SMCL = Secondary Maximum Contaminant Level

Table A.3. Soil Data from the Vicinity of the Hormigas Supply Wells Detected Values from 2010

Table A.3

Soil Data from the Vicinity of the Hormigas Supply Wells [a]

Detected Values from 2010

Chemical	Maximum Detected Concentration (ug/kg)	CV value (ug/kg)	Exceed Screening Value? (Y/N)
Acetone*	**9.9**	**4,000,000 (Interm EMEG - pica)**	**N**
Methylene Chloride*	**7.5**	**300,000 (RMEG Child)**	**N**
Tetrachloroethylene (PCE)	**19**	**100,000 (Acute EMEG - pica)**	**N**

*Acetone and methylene chloride are common laboratory contaminants.

a - Data obtained during the Site Discovery Initiative by EPA in 2010.

The data provided in the table reflects only those data detected.

The samples were evaluated for TCL analysis of VOCs, SVOCs, pesticides, PCBs, and TAL inorganics (including mercury and cyanide).

Table A.4. Groundwater Data from the Cidra Water Supply System Well Detected Values from 2006–2010

Table A.4

Groundwater Data from the Cidra Water Supply System Well [a]

Detected Values from 2006-2010

Chemical	Maximum Detected Value (ug/L)	Comparison Value (ug/L)	MCL (ug/L)	Exceed Screening Value? (Y/N)
Bromodichloromethane	**17**	0.56 (CREG)	80 (for total trihalomethanes)	N
Chloroform	**24**	70 (LTHA)	80 (for total trihalomethanes)	N
Dibromochloromethane	**7.3**	0.42 (CREG)	80 (for total trihalomethanes)	N
Chlorobenzene (monchlorobenzene)	**1.6**	100 (LHTA)	100	N
Total Xylenes	**0.85**	2000 (Child Chronic EMEG)	10,000	N

a - Data obtained from PRASA and PRDOH

The data provided in the table reflects only those data detected.

The samples were evaluated by PRASA for the standard list of compliance chemicals.PCBs, and TAL inorganics (including mercury and cyanide).

CREG - Cancer Risk Evaluation Guide

EMEG - Environmental Media Evaluation Guide (Child Chronic and Intermediate duration values)

LTHA - Lifetime Health Advisory

MCL - Maximum Contaminant Level

Determination of Exposure Pathways

ATSDR identifies human exposure pathways by examining environmental and human components that might lead to contact with COCs. A pathway analysis considers five principal elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population. Completed exposure pathways are those for which the five elements are evident, and indicate that exposure to a contaminant has occurred in the past, is now occurring, or will occur in the future. Potential exposure pathways are those for which exposure seems possible, but one or more of the elements is not clearly defined. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. The identification of an exposure pathway does not imply that health effects will occur. Exposures might be, or might not be, substantive. Therefore, even if exposure has occurred, is now occurring, or is likely to occur in the future, adverse human health effects might not result.

ATSDR reviewed site history, information on site activities, and the available sampling data. Using this review, ATSDR identified past household use water obtained from the Hormigas water supply system as the primary route of exposure at the Hormigas site.

Evaluation of Public Health Implications

The next step is to take those contaminants identified as COCs and further identify which chemicals and exposure situations are likely to be a health hazard. Child and adult exposure doses are calculated for the site-specific exposure scenario, using our assumptions of how often they contact the site contaminants. The exposure dose is the amount of a contaminant that gets into a person's body. Following is a brief explanation of how we calculated the estimated exposure doses for the site.

Ingestion of Groundwater

The overall exposure dose of the VOCs identified at the Hormigas site (PCE, TCE, 1,2-DCE) was estimated for infants, children aged birth to < 11 yrs and adults, given that they are considered to be the most appropriate exposed populations. The infants are considered the most highly exposed child receptor since their intake during their first year of life is primarily liquid and they have a low body weight. Given that there was a potential exposure period of 11 years (from the installation of the well until it was taken out of service), a child aged birth to < 11 yrs and an adult exposed for 11 years were evaluated in the health assessment.

The exposure factors used to derive exposure doses and evaluate these receptors are provided in Table A.5. Updated exposure factors from the U.S. EPA Exposure Factors Handbook (EFH) (USEPA 2011a) were used in this health evaluation.

Table A.5. Intake Factors Used in Risk Evaluation Hormigas NPL Site

Table A.5

Intake Factors Used in Risk Evaluation[a]

Hormigas NPL Site

Age Interval	Number of years exposed (yr)	Body Weight (kg)	Water Intake (L/day)	Ingestion Rate (Water Intake/Body Weight)
			Upper	Upper
Birth to < 1 yr	1	7.8	1.113	0.143
1 to < 2 yr	1	11.4	0.893	0.078
2 to < 6 yr	4	17.4	1.052	0.060
6 to < 11 yr	5	31.8	1.251	0.039
Adult	11	80	2.848	0.036
Pregnant Woman	0.77	73	2.589	0.035

a - Values from EPA Exposure Factors Handbook (2011a).

Noncancer Health Effects

The calculated exposure doses are then compared to an appropriate health guideline for that chemical. Health guideline values are considered safe doses; that is, adverse health effects are unlikely below this level. The health guideline value is based on valid toxicological studies for a chemical, with appropriate safety factors built in to account for human variation, animal-to-human differences, and/or the use of the lowest study doses that resulted in harmful health effects (rather than the highest dose that did not result in harmful health effects). For noncancer health effects, the following health guideline values are used.

Minimal Risk Level (MRLs) —Developed by ATSDR

An MRL is an estimate of daily human exposure – by a specified route and length of time – to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects. A list of MRLs can be found at http://www.atsdr.cdc.gov/mrls.html.

Reference Dose (RfD) —Developed by U.S. EPA

An RfD is an estimate, with safety factors built in, of the daily, life-time exposure of human populations to a possible hazard that is not likely to cause noncancerous health effects. RfDs can be found at http://www.epa.gov/iris.

If the estimated exposure dose for a chemical is less than the health guideline value, then the exposure is unlikely to cause a noncarcinogenic health effect in that specific situation. If the exposure dose for a chemical is greater than the health guideline, then the exposure dose is compared

to known toxicologic values for that chemical and is discussed in more detail in the public health assessment (see Discussion section). These toxicologic values are doses derived from human and animal studies that are summarized in the ATSDR *Toxicological Profiles*. A direct comparison of site-specific exposure and doses to study-derived exposures and doses that cause adverse health effects is the basis for deciding whether health effects are likely or not.

Cancer Health Effects

The estimated risk of developing cancer resulting from exposure to the contaminants was calculated by multiplying the site-specific adult exposure dose by U.S. EPA's corresponding CSF (which can be found at http://www.epa.gov/iris). The results estimate the maximum increase in risk of developing cancer after 70 years of exposure to the contaminant.

The actual increased risk of cancer is probably lower than the calculated number, which gives a theoretical worst-case excess cancer risk. The method used to calculate U.S. EPA's cancer slope factor assumes that high-dose animal data can be used to estimate the risk for low dose exposures in humans. The method also assumes that no safe level exists for exposure. Little experimental evidence exists to confirm or refute those two assumptions. Lastly, the method computes the upper 95th percent confidence limit for the risk. The actual cancer risk can be lower, perhaps by several orders of magnitude (USEPA 1989).

Because of uncertainties involved in estimating carcinogenic risk, ATSDR employs a weight-of-evidence approach in evaluating all relevant data (ATSDR, 1993). Therefore, the carcinogenic risk is described in words (qualitatively) rather than giving a numerical risk estimate only. The numerical risk estimate must be considered in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions. The actual parameters of environmental exposures must be given careful consideration in evaluating the assumptions and variables relating to both toxicity and exposure.

Appendix B. Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency in Atlanta, Georgia, with 10 regional offices in the United States. ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases from toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (U.S. EPA), which is the federal agency that develops and enforces laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. For additional questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway
[see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. The Superfund Amendments and Reauthorization Act (SARA) later amended this law.

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Dose
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or are exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Health outcome data
Information from private and public institutions on the health status of populations. Health outcome data can include morbidity and mortality statistics, birth statistics, tumor and disease registries, or public health surveillance data.

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
U.S. EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

Point of exposure

The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Reference dose (RfD)
A U.S. EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Risk
The probability that something will cause injury or harm.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)]

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Toxicological profile

An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as tetrachloroethylene (PCE), trichloroethylene (TCE) and cis-1,2-Dichloroethylene (cis-1,2-DCE).

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/) National Library of Medicine (NIH) (http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

For more information on the work of ATSDR, please contact:
Office of Policy, Planning and Evaluation Agency for Toxic Substances and Disease Registry 1600 Clifton Road, N.E. (Mail Stop F-61) Atlanta, GA 30333 Telephone: (770) 488-0680

Appendix C. Site Location Maps/Photographs of the Hormigas Water System Wells

Map C-1. Location of site within community

Map C-2. Location of site within community

Figure C-3. Photographs of the Hormigas Site Wells

Eufracia Well

Hormigas Well

Appendix D. Response to Public Comments

Hormigas NPL site - Public Health Assessment (PHA)

Response to comments on Public Comment Draft released March 8, 2013

Comment	Response
1. List of Abbreviations (Comment #1, page 4): It is recommended to point out that *cis*-1,2-Dichloroethylene (cis-1,2-DCE) means the same as *cis*-1,2-Dichloroethene due to is has the same Chemicals Abstracts Service (CAS) number 156-59-02, **if someone asks**. The United Stated Environmental Protection Agency (USEPA) Maximum Contaminant Levels (MCLs) and the List of National Primary Drinking Water contaminants have chosen to use the second name (*cis*-1,2-Dichloroethylene) to establish its standard, which is 70 µg/L.	**Response:** The list of abbreviations include the second name of *cis*-1,2-Dichloroethene in parentheses next to *cis*-1,2-Dichloroethylene.
2. Summary – Conclusions: Question #1 pages 5-6: The terms "acceptable risk" or "unacceptable risk" are usually used in human health risk assessments. ATSDR personnel will inform that the risk is acceptable?	**Response:** ATSDR does not typically use the terms "acceptable risk" and "unacceptable risk" in our health evaluations. In this document, ATSDR indicated that people who used/drank water from the Hormigas Water Supply system before the system was taken out of service in 2009 are unlikely to have adverse health effects from using the water.
	Response: The public comment document was released with color maps and photos but the copy may have been dark. ATSDR will try to lighten up the color maps and photos in the final document.

4. Community Health Concerns: Question #2 pages 26-27: It is established in the page 27, second paragraph the following: "No health concerns were associated with chemical exposure and none of the community members were aware of any health concerns among residents. One person did indicate that many in the community suffer asthma, especially in the cold weather." <u>This information was shared with the Puerto Rico Department of Health (PRDOH) personnel for further investigation?</u>	**Response:** PRDOH obtained a copy of the Hormigas Groundwater Plume Site PHA in March 2013. ATSDR has contacted PRDOH to ensure that they are aware of this information.
5. Hormigas Groundwater Plume Site – Caguas, Puerto Rico Public Health Assessment, Fact Sheet – March 2013: Comment #2: The PREQB is not mentioned in the fact sheet but the Superfund Program personnel participated in many meetings, conference calls and visited in many occasions the area to gather information about this Superfund Site and talked to people about their concerns. Recommendation #2: Please, if a new fact sheet is written it is recommended to include the PREQB participation.	**Response:** ATSDR apologizes for the inadvertent omission of PREQB on the fact sheet. PREQB is an important team member at the Hormigas site. An updated fact sheet will be provided with the final document and PREQB will be included.