HEALTH CONSULTATION

PUBLIC HEALTH EVALUATION

OF

PRIVATE WELL SAMPLING DATA

IN

PLYMOUTH, LITCHFIELD COUNTY, CONNECTICUT

April 28, 2011

Prepared by
The Connecticut Department of Public Health

SUMMARY

INTRODUCTION

In the summer of 2010, The Connecticut Department of Environmental Protection (CT DEP) requested that the Connecticut Department of Public Health (CT DPH) evaluate the public health significance of private well sampling data in the Burr Road (Rd)/Harwinton Avenue (Ave) area of Plymouth, Connecticut.

In 2004, two private wells in the Burr Rd/Harwinton Ave community were found to have heavy metal concentrations (lead and cadmium) above state drinking water action levels (AL). One residence was placed on a whole house filter system and the other was placed on CT DEP's bottled water program (they refused a filter system). This residence continues to receive bottled water.

Since 2004, sampling has identified 7 more private wells with heavy metals at concentrations that exceed Connecticut's ALs. Residents with the newly discovered contaminated wells are currently receiving bottled water.

CONCLUSIONS

CT DPH evaluated past and current exposures to heavy metals in the well water. CT DPH reached the following conclusions in the health consultation:

Conclusion 1

Residents who are currently using contaminated well water for showering and bathing are being exposed to metals present in the well water. Exposure levels from showering and bathing are not expected to harm their health. However, until residents receive a permanent source of clean drinking water (e.g. connection to municipal water or a whole-house filter), risks from showering or bathing will continue to accumulate over time. As exposures continue over time, risks could increase to a level that could be harmful to health.

Basis for Conclusion

Exposure is occurring but the dose is well below a level that would harm health. However, it is important to note that increases in exposure duration to cadmium, nickel, and arsenic could significantly increase cancer risk.

Next Steps

The town and CT DEP will work towards transferring everyone to public water or installing whole house filters as soon as possible.

Conclusion 2	In the past, residents were exposed to metals in their well water from drinking the water, as well as from showering and bathing. The dose of metals that residents received from drinking the water is much greater than the dose received from shower or bathing.
Basis for Conclusion	The dose from drinking the water is approximately 95% of the total dose for each of the metals.
Next Steps	The town and CT DEP will work towards transferring everyone to public Water or installing whole house filters as soon as possible.

Conclusion 3	In the past, residents who drank water with the highest levels of cadmium and nickel were exposed to these contaminants, but these exposures are not expected to harm people's health. Residents who drank water with the highest levels of arsenic were exposed to amounts of arsenic that could have harmed their health. Exposure to arsenic can damage the nervous system and over time, can lead to increased risk of skin, lung, liver, and bladder cancer.
Basis for Conclusion	Maximum exposure doses for arsenic were well above the safe dose and estimated lifetime cancer risk is moderate. However, maximum doses for nickel and cadmium do not exceed safe doses.
Next Steps	The town and CT DEP will work towards transferring everyone to public Water or installing whole house filters as soon as possible.

Conclusion 4	In the past, young children who drank water with the highest levels of lead for a period of 6 years could have received enough lead to cause their blood lead levels to increase above a level of concern. However, children who drank lower levels of lead in drinking water did not receive enough lead to cause their blood lead levels to increase above a level of concern. Elevated blood levels in children can damage the nervous system, kidneys and reproductive system.
Basis for Conclusion	Computer modeling of drinking water lead concentrations shows that exposures to elevated lead levels over a period of a long time can increase blood lead in children. Elevated blood lead levels in children can damage the nervous system, kidneys, and the reproductive system.
Next Steps	The town and CT DEP will work towards transferring everyone to public Water or installing whole house filters as soon as possible.

The conclusions and recommendations in this health consultation are based on the data and information made available to the Connecticut Department of Public Health (CT DPH). CT DPH will review additional information when received. The review of additional data could change the conclusions and recommendations listed in this document. This report was supported by funds from a cooperative agreement with the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services. This document has neither been reviewed nor cleared by ATSDR.

BACKGROUND AND STATEMENT OF ISSUE

In the summer of 2010, the Connecticut Department of Environmental Protection (CT DEP), requested that the Connecticut Department of Public Health (CT DPH) evaluate the public health significance of private well sampling data in the Burr Road (Rd)/Harwinton Avenue (Ave) area of Plymouth, Connecticut. The main focus of this health consultation will be evaluating private well sampling data from the Burr Rd/Harwinton Ave area.

The Burr Rd/Harwinton Ave area (site) of Plymouth, Connecticut is located just south of the Plymouth Reservoir and is located just north of Route 6. North Street is located west and Todd Hollow Brook is located east of the site. The area is located in a mixed residential/light industrial zoned area.

In 2004, a CT DEP consultant sampled water from 10 private wells from the Burr Rd/Harwinton Ave area as part of a well receptor survey for the MacDermid site, located at 400 Harwinton Avenue, Bristol, CT. Two wells (each serving two separate residences) were found to have heavy metal concentrations (lead and cadmium) above state drinking water action levels (AL). ALs are health-based concentrations for private well water above which, CT DEP is authorized to provide drinking water treatment or bottled water to residents. One residence was placed on a whole house filter system and the other was placed on CT DEP's bottled water program (they refused a filter system). The residence that was on the bottled water program continues to receive bottled water.

In 2009-2010, at the request of several residents, CT DEP conducted additional private well sampling in the Burr Rd/Harwinton Ave area. They identified a total of 18 residences for private well sampling in the site. These 18 residences include the 10 private wells that were sampled in 2004. CT DEP sampled 18 private wells from 18 residences in this area (one residence refused access and sampling) during the summer of 2009 to the summer of 2010. Of those 18 private well samples, 9 had heavy metal (nickel, cadmium, lead, and arsenic) concentrations that exceeded state drinking water action levels. Seven of those nine residences were placed on CT DEP's bottled water program until a more permanent solution can be put into place (whole house filters or municipal water). The other two residences with AL exceedances are the homes originally found to be contaminated in 2004 and thus are already on bottled water or a whole house filter.

The source of this contamination is unknown. Because the heavy metal contamination in some of the private wells is so high, it not believed that the groundwater contamination is due to naturally occurring heavy metals in soil. In addition, because the lead concentrations are so high in a couple of private wells, it is not believed that it is due to lead pipes or lead solder (flush and first draw samples were also conducted to enhance this conclusion). Lastly, because the private well contamination does not follow a plume-like pattern, it is not believed that it due to a single industrial source.

Demographics

The site is in Plymouth, Connecticut whose population is approximately 12,014. The total area is approximately 22.3 square miles (United States Census Bureau 2000).

According to 2009 census data, 96% of residents are Caucasian and approximately 4% are Hispanic.

Environmental Contamination and Health Comparison Values

<u>Private Well Sampling Data</u>

As stated previously, in 2009-2010, CT DEP sampled 18 private wells from the site, including the 10 wells that were previously sampled in 2004.

Four of the 18 private wells have arsenic concentrations that exceeded state drinking water AL The maximum arsenic concentration was 71 parts per billion or ppb and seven times the AL.

Five of the 18 private wells had lead concentrations that exceeded state AL. The maximum lead concentration was 120 ppb and 8 times the state drinking water AL.

Only two of the 18 private wells had nickel concentrations that exceeded the proposed state drinking water AL of 40 ppb. The maximum nickel concentration was 140 ppb and 3.5 times the proposed state drinking water AL.

Only one of the 18 private wells had a cadmium concentration that barely exceeded state drinking water AL. The maximum cadmium concentration was 8 ppb.

Table 1. Summary of Private Well Sampling Data Results from 18 Residences in the Burr Road/Harwinton Avenue Area of Plymouth, Connecticut, 2009-2010.

Contaminant	Concentration Range (ppb)	Number of Exceedances of Comparison Value/Number of Samples Taken	Comparison Value (ppb)	Comparison Value Source
Heavy Metals				
Arsenic	BDL-71	4/18	10	CT AL
Lead	BDL-120	5/18	15	CT AL
Nickel	BDL-140	2/18	40	Proposed CT AL
Cadmium	BDL-8	1/18	5	CT AL

ppb=parts per billion
BDL=Below Detection Limit
CT AL=Connecticut Action Level or Proposed Action Level. Available at:
http://www.ct.gov/dph/LIB/dph/environmental_health/EOHA/pdf/Action_Level.pdf

DISCUSSION

Exposure Pathway Analysis

To evaluate potential exposures to private well contaminants from the site, CT DPH evaluated the environmental data and considered how people might come into contact with contaminants in private well water. The possible pathways of exposure are dermal, inhalation, and ingestion. In other words, in order to be exposed to contaminants in private well water, one most come into contact with the water by touching it, breathing vaporized water particles, or drinking the water.

Past Conditions

All of the residents in the 9 homes whose private well water concentrations exceeded state drinking water ALs are now receiving bottled water (except one home with a whole-house filter system). Therefore, ingestion is evaluated only as a past exposure pathway. Six years is assumed to be the exposure duration because 7 of these 9 private wells were not contaminated the first time they were sampled in 2004.

It is important to note that the two wells that were found to have heavy metal contamination exceeding ALs in 2004 may have been contaminated prior to 2004 and therefore, exposure may exceed 6 years for residents living in those homes. In addition, these 9 wells were only analyzed for cadmium and lead in 2004. They were not analyzed for arsenic and nickel until the second round of sampling in 2009-2010. However, exposures of longer than 6 years are not evaluated in this health consultation because we do not have the historical data and the majority of private wells tested in 2004 were clean. If contamination was present before 2004, then exposure would be longer than 6 years. This uncertainty is addressed in the Public Health Implications Section of this health consultation.

In addition, adults and children were exposed to these contaminants during normal household activities (bathing and showering). Therefore, inhalation and dermal exposure during these regular household activities are considered a complete pathway in the past. Ingestion, dermal and inhalation of heavy metals through private well water in the past is evaluated further in the next section.

Current Conditions

Because residents with private wells containing heavy metals above the AL are on bottled water (or a filter system) and are no longer drinking the contaminated well water or using it for cooking purposes, ingestion is not considered a current pathway of exposure.

Since, it is our understanding that the bottled water is not used for bathing or showering, residents on bottled water most likely continue to use the contaminated water for other routine purposes such as bathing and showering. Therefore, dermal and inhalation exposure through these daily activities remains a complete current pathway and will be evaluated further in the next section of this document.

Future Conditions

Given that the town and CT DEP have expressed clear intentions to provide whole house filters and/or eventually public water within the near future, we have assumed that future exposures to contaminated drinking water will not occur.

Public Health Implications for Adults and Children

When determining the public health implications of exposure to hazardous contaminants, CT DPH considers how people might come into contact with contaminants and compares contaminant concentrations with health protective comparison values. When contaminant levels are below health-based comparison values, health impacts from exposure to those levels are unlikely. Contaminant levels exceeding comparison values do not indicate that health impacts are likely but instead warrant further evaluation. In this health consultation, CT DPH used established Action Levels[1] or proposed (AL) for private wells as health protective screening values. As stated previously, these values are health-based levels developed to be protective of children and adults with frequent, long-term exposure to contaminants in private well water. CT DPH only evaluated completed exposure pathways where private well contamination exceeded the established or proposed Connecticut Action Levels. General toxicology information on lead, arsenic, cadmium, and nickel are provided in Appendix B.

[1] If well contamination exceeds the value shown on the "Action Level List" (see below), then the Connecticut Department of Environmental Protection (CT DEP) is authorized to provide treatment or bottled water to residents, unless it is determined that the contamination is naturally occurring. The Action Levels are set by the Department of Public Health (DPH), and include the most common contaminants. If a contaminant is not on the list, CT DEP may ask DPH to evaluate the public health risk of contamination for the specific chemical

Past Conditions

Table 1 indicates that arsenic, lead, cadmium, and nickel were detected in some private wells at levels above the AL in the site. Exposure to private well water in the past is a complete exposure pathway. Only the most sensitive population (children) was included in the detailed exposure analysis. CT DPH assumed that contact with private well water occurred daily through normal routine activities like bathing, showering, and drinking for 6 years and that children ingested 1 L/day of private well water.

Noncancer Effects

Since the risk for noncancer health effects from dermal and inhalation exposure to cadmium, arsenic, and nickel are trivial as compared with the risks from ingestion of these three contaminants, only ingestion risks are included.

Arsenic

Using the maximum concentration of 71 ppb as the exposure level, the maximum daily dose from ingestion exposure is 4.2 ug/kg/day. This dose exceeds the Agency for Toxic Substances and Disease Registry's (ATSDR's) Minimum Risk Level (MRL) for chronic oral exposure of 0.3 ug/kg/day (ATSDR 2000) and EPA's reference dose (RfD) which is also 0.3 ug/kg/day (IRIS 1993) . MRLs and RfDs are estimates of daily exposure to humans that are likely to be without harmful noncancer effects. Because the maximum dose from the site exceeded the MRL and RfD, noncancer effects from past exposure to arsenic in private well water from the site can not be ruled out. Dose and risk calculations are provided in Appendix C.

To provide further perspective on noncancer risk calculations, CT DPH compared the estimated dose with effect levels from toxicology literature (Table 2). The estimated dose is lower than the effect level for serious human health effects reported in a range of toxicology studies. However, it should be noted that there is one study that reported less serious human health effects (arsenical dermatosis) at a dose lower than the dose estimated from exposure to private well water at the site.

One must also emphasize that there is a large degree of uncertainty in the noncancer risk calculation because of the lack of data on heavy metals in private well water. A single measurement is not enough data to base a decision about where arsenic (or any other contaminant) in a private well is likely to result in adverse noncancer health effects. Nevertheless, since the maximum dose exceeds one effect level from toxicology literature, one cannot rule out risk for adverse health effects.

Table 2. Estimated Doses for Arsenic: A Comparison of Average Daily Doses (ADD) from Drinking Contaminated Water in the Burr Rd/Harwinton Ave Area of Plymouth, CT to Noncancer Effect Levels From Toxicology Literature

Maximum Arsenic Dose from Private Well Water (µg/kg/day)	Effect Level from Literature (µg/kg/day)	Comment
4.4^	1.4	LOAEL for chronic oral human exposure resulting in less serious dermal effects (arsenical dermatosis) (ATSDR 2000)
	14	LOAEL for chronic oral human exposure resulting in hyperpigmentation, keratosis and possible vascular complications (Basis for EPA RfD from IRIS 1993)
	32	LOAEL for chronic oral human exposure resulting in serious dermal effects (melanosis and keratosis) (ATSDR 2000)
	46	LOAEL for chronic oral human exposure in hepato ffects (hepatomegaly) (ASTDR 2000)
	50	LOAEL for chronic oral human exposure cardio effects (blackfoot disease)) (ATSDR 2000)

^ Highest estimated ADD for noncancer effects using worst case exposure scenario

Nickel

Using the maximum concentration of 140 ppb as the exposure level, the average daily dose from ingestion is 8.2 ug/kg/day. This dose is below EPA's reference dose (RfD) which is 20 ug/kg/day (for nickel soluble salts from IRIS 1991a). Because the dose from the site is below the RfD, noncancer effects from nickel in private well water from the site are unlikely. Dose and risk calculations are provided in Appendix C.

Cadmium

Using the maximum concentration of 8 ppb as the exposure level, the average daily dose from ingestion is 0.5 ug/kg/day. This dose is at EPA's RfD which is 0.5 ug/kg/day (IRIS 1994). Because the dose from the site does not exceed the RfD, noncancer effects from cadmium in private well water from the site are unlikely. Dose and risk calculations are provided in Appendix C.

Lead

To evaluate exposure to lead, we assessed exposure to the maximum concentration (120 ppb) and 2 other lower levels found in private wells (26 and 56 ppb) using a biological model that predicts a blood lead concentration that would result from exposure to lead. The model also accounts for exposure to lead from sources other than private well water from the site (such as "background" levels of lead in air, food, dust and residential soil). The model we used is the US Environmental Protection Agency's (EPA's) Integrated Exposure Uptake and Biokinetic (IEUBK) model (August 2007). This is the most widely used model for estimating blood lead concentrations from environmental exposure. The IEUBK model is designed to predict blood lead concentrations in children 0 to 7 years of age. The model estimates a distribution of blood lead concentrations centered on the geometric mean blood lead concentration. EPA recommends that blood lead estimates be less than 10 μg/dL in at least 95% of children (EPA 2007). A blood lead level of 10 μg/dL or greater is the Centers for Disease Control level of concern for children (http://www.cdc.gov/nceh/lead/).

Table 3 below summarizes IEUBK model results assuming daily ingestion of the private well water. As shown in Table 3, the model predicts that a range of 0.2%-39% of exposed children would exceed the blood lead level of concern of 10 μg/dL. According to the model, exposure to well water contaminated with lead would increase the geometric mean blood lead level up to 8.8 ug/dL and would increase the percentage of children exceeding the blood lead level of concern up to 39%.

Therefore, the higher lead concentrations of 56 and 120 ppb in drinking water could have resulted in a percentage of elevated blood lead concentrations in children that exceeds EPA's recommendations. However, past exposure to 26 ppb lead in drinking water does not increase the percentage of children exceeding the blood lead level of concern above EPA's recommendations.

Table 3. Integrated Exposure Uptake and Biokinetic (IEUBK)* Model Results for Daily Ingestion Exposure in the Burr Rd/Harwinton, Ave Area, Plymouth, CT

Private Well Lead Concentration (ug/L)	Geometric Mean Blood Lead (ug/dL)	Percent Blood Lead Levels above 10 ug/dL
26	2.6	0.2
56	4.8	5.7
120	8.8	39

All IEUBK model defaults were used except drinking water concentration.
Age range of child, 0-7 years.
*EPA 2007

Cancer Effects

CT DPH also estimated lifetime cancer risks from exposure to arsenic, cadmium, and nickel for community members drinking and bathing and showering in the contaminated well water from the site. CT DPH did not include lifetime cancer risk from dermal exposure in the past because the estimated cancer risk is very minimal compared to cancer risk from ingestion and inhalation exposure. Since nickel and cadmium are not carcinogens via the ingestion route, only cancer risks from inhalation exposure to these two contaminants were evaluated.

For estimating cancer risk, the US EPA typically provides a potency factor for an environmental contaminant, such as arsenic. This potency factor (known as a slope factor or unit risk factor) is an upper-bound estimate of theoretical cancer risk for the general population for a lifetime of exposure to account for the possibility that potency may vary between the individuals. Though it cannot be calculated, true excess risk to an individual is likely to be less than the calculated risk.

Arsenic (Ingestion)

If a community member drank the contaminated well water from the site every day for 6 years at the maximum detected concentration of 71 ppb, it would result in a dose of 0.4 ug/kg/day. Using the US EPA's oral cancer slope factor, the maximum theoretical risk would be 5 in 10,000. This means that there might be 5 excess cancers in a population of 10,000 exposed to the contaminated well water every day for 6 years. Background rates of cancer in the United States are 1 in 2 or 3 (NCI 2001). This means that in a population of 10,000, background numbers of cases would be approximately 3,333 to 5,000. This theoretical cancer risk estimate indicates moderate increased lifetime incremental cancer risk from exposure to arsenic. If a theoretical cancer risk is greater than 1×10^{-4}, or a chance of one excess cancer risk in 10,000 cases, then it is thought to be a moderate risk of possible cancer related to that chemical exposure. If the value is equal to or less than the range of 1×10^{-4} to 1×10^{-6}, then the possible cancer risk from a chemical exposure is thought to be slight to insignificant.

Furthermore, we included some conservative assumptions in our risk estimate. This included using the maximum detected concentration of arsenic, exposure for a full 6 years. The true exposure is probably lower than what we calculated in this document. Arsenic doses and risk calculations are found in Appendix C.

Arsenic, Cadmium, and Nickel (Inhalation Exposure)

Because 3 of the 4 contaminants (cadmium, arsenic, and nickel) are carcinogens from inhalation exposure, CT DPH also estimated cancer risk from inhalation exposure to all three contaminants at maximum concentrations over a period of 6 years and added them together. This is a conservative and unlikely scenario because the maximum detected concentrations of each heavy metal were not from the same residence. In addition, cancer risk calculations from inhalation of these three contaminants are conservative because they assume that all aerosolized particles can get into the lungs. Furthermore, the unit risk is based on metal dust, which is harder to clear from lungs than fluid droplets as in this case (Xu and Weisel 2003). Therefore, we expect that actual inhalation exposure to these three contaminants while bathing or showering is very likely to be lower than the estimated risk.

The total theoretical cancer risk from exposure to the maximum concentrations to all of these contaminants is 9 excess cancer cases in 1,000,000. Background rates of cancer in the United States are 1 in 2 or 3 (NCI 2001). This means that in a population of 1,000,000, background numbers of cases would be approximately 333,333 to 500,000. This theoretical cancer risk estimate indicates minimal lifetime incremental cancer risk from inhalation exposure to the maximum levels of three contaminants found in private well water from the site.

Arsenic, Cadmium, and Nickel (Inhalation Exposure +Ingestion$_{arsenic}$ Exposure)

CT DPH also estimated total cancer risk from inhalation exposure to all three contaminants at maximum concentrations over a period of 6 years, added them together and from lifetime risk from ingestion exposure to arsenic.

The total theoretical cancer risk from exposure to the maximum concentrations to all of these contaminants is 5 excess cancer cases in 10,000. Background rates of cancer in the United States are 1 in 2 or 3 (NCI 2001). This means that in a population of 10,000, background numbers of cases would be approximately 3,333 to 5,000. This theoretical cancer risk estimate indicates moderate lifetime incremental cancer risk from inhalation exposure to the maximum levels of three contaminants and from ingestion exposure to arsenic found in private well water from the site. It is important to note that approximately 95% of the total estimated cancer risk is from ingestion exposure to arsenic. Furthermore, this cumulative cancer risk may be overestimated if exposure to each metal is linked to different cancer types.

Current Conditions

Noncancer effects from exposure to cadmium, arsenic, and nickel are not estimated under current conditions. As stated previously, ingestion is not considered a current exposure pathway, because all of the nine residences with contaminated water are currently being provided with bottled water or a filter. In addition, because noncancer and cancer effects from dermal exposure are minimal, they are not estimated. Noncancer effects from inhalation exposure are also minimal and therefore, not estimated.

Cancer Effects

CT DPH estimated cancer risk from inhalation exposure under current conditions because residents are still bathing and showering in contaminated well water and it is unknown when exactly they will be placed on a municipal water system or a whole house filter. CT DPH estimated risk from inhalation exposure to all three contaminants at maximum concentrations over a period of 6 years and added them together. As stated previously, this is a conservative and unlikely scenario because the maximum detected concentrations were not from the same residence. The total theoretical cancer risk from exposure to the maximum concentrations to all of these contaminants is 9 excess cancer cases in 1,000,000. Background rates of cancer in the United States are 1 in 2 or 3 (NCI 2001). This means that in a population of 1,000,000, background numbers of cases would be approximately 333,333 to 500,000. This theoretical cancer risk estimate indicates minimal lifetime incremental cancer risk from inhalation exposure to the maximum levels of three contaminants found in private well water from the site.

However, it is important to note that the exposure duration is assumed to be 6 years (exposure time for some community members under past conditions); the risk for cancer effects from exposure to these contaminants increases with every year of exposure and, over time, can increase the risk for cancer by a significant amount. If exposure were to continue for 35 years, the estimated cancer risk would be increased to 5 excessed cancers in 100,000.

EVALUATION OF COMMUNITY CONCERNS

1) Residents of the homes with contaminated private well water are concerned that they will get sick because they are still bathing and showering in the contaminated well water.

   The levels of cadmium, arsenic, nickel, and lead found in the private well water in the Burr Rd/Harwinton Ave area are not elevated enough to result in adverse health effects from exposure through daily household activities such as bathing and showering. However, since nickel is a skin irritant for some people, it would be prudent for the households whose private well water contains nickel to get a whole house filter installed or be transferred to municipal water in the near future.

2) Residents were especially concerned about the elevated lead concentrations in some of the private wells with regards to their young children. They wanted to know if there was anything they could do to find out if their children have high levels of lead in their blood.

   CTPH has informed residents that their physicians are required to take blood lead samples of their children when they are 1 year old and again when they are 2 years old. CT DPH has told residents to consult with their children's pediatrician if they have any concerns about lead exposure or call CT DPH's Lead program at (860) 509-7299.

CONCLUSIONS

Several private wells in the Burr Rd/Harwinton Ave area had heavy metal (lead, arsenic, cadmium, and nickel) concentrations that exceeded state drinking water ALs. Some of these homeowners and their families have been ingesting this contaminated water for up to 6 years. They are presently being provided with bottled water or a whole-house filter, but the residents that are provided with bottled water continue to use the untreated well water for bathing/showering purposes until a permanent solution is put into place in the area.

CT DPH has concluded that residents who are currently using contaminated well water for showering and bathing are being exposed to metals present in the well water. Exposure levels from showering and bathing are not expected to harm their health. However, until residents receive a permanent source of clean drinking water (eg. connection to municipal water or a whole-house filter), risks from showering or bathing will continue to accumulate over time. As exposures continue over time, risks could increase to a level that could be harmful to health.

In the past, residents were exposed to metals in their well water from drinking the water, as well as from showering and bathing. The dose of metals that residents received that residents received from drinking the water is much greater than the dose received from shower or bathing.

Young children who drank water with the highest levels of lead for a period of 6 years could have received enough lead to cause their blood lead levels to increase above a level of concern. However, children who drank lower levels of lead in drinking water did not receive enough lead to cause their blood lead levels to increase above a level of concern. Elevated blood levels in children can damage the nervous system, kidneys and reproductive system.

Residents who drank water with the highest levels of cadmium and nickel were exposed to these contaminants, but these exposures are not expected to harm people's health. Residents who drank water with the highest levels of arsenic were exposed to amounts of arsenic that could have harmed their health. Exposure to arsenic can damage the nervous system and over time, can lead to increased risk of skin, lung, liver, and bladder cancer.

RECOMMENDATIONS

1. CT DPH recommends that the town of Plymouth and CT DEP continue to work towards a permanent solution which should consist of getting residences with contaminated water a permanent source of clean drinking water.

2. CT DPH recommends that CT DEP continue to monitor the 9 contaminated private wells as well as any nearby private wells that are vulnerable to contamination from the site and provide those results to CT DPH and the Torrington Health Department for evaluation of public health risk.

3. CT DPH recommends that everyone in the 8 homes with contaminated wells (and without whole house filters) continue to avoid drinking the tap water. This is especially important for children.

PUBLIC HEALTH PLAN

Actions Taken

1. CT DPH, along with the town of Plymouth and CT DEP, held a meeting in September 2010 with the nine residences whose private wells were contaminated with heavy metals. The objective of this meeting was to provide information to the community residents about exposures and health impacts related to the private well contamination. CT DPH distributed 3 generic fact sheets at this session; on arsenic, lead, and cadmium health concerns. In addition, CT DPH distributed a general fact sheet on private well testing (Appendix B).

2. CT DPH also attended a town council meeting in December 2010 to discuss health concerns related to the private well contamination from the site. The same fact sheets were also distributed.

Actions Planned

1. CT DPH will make this health consultation available to residents of the Burr Rd/Harwinton Ave area of Plymouth.

2. CT DPH will continue to work with CT DEP and the town of Plymouth to respond to health questions and concerns regarding private well contamination from the site.

3. CT DPH will review any additional private well data for this site and update this health consultation, if necessary.

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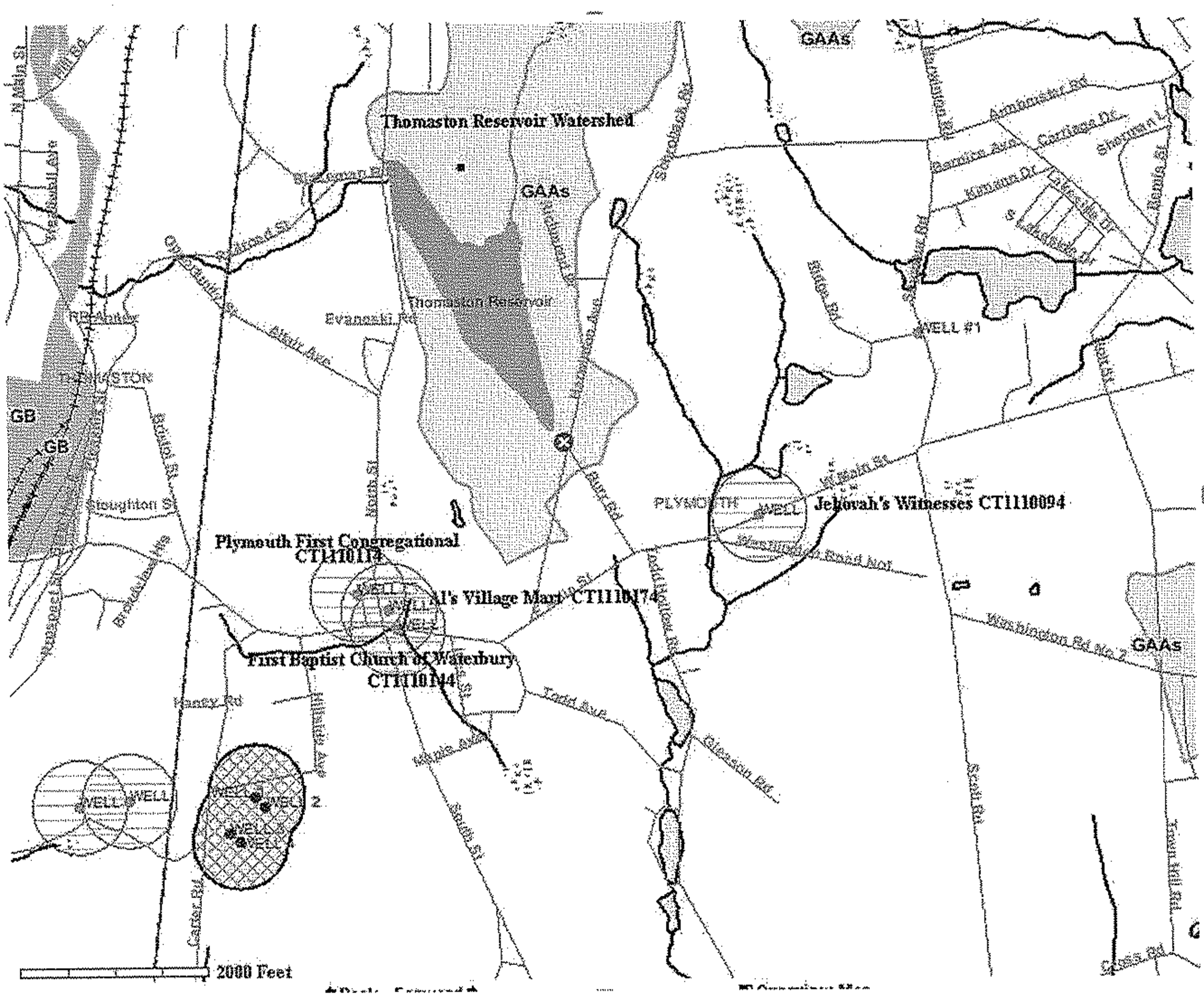
Appendix A
Map of the Burr Rd/Harwinton Avenue Area of Plymouth, CT



Appendix B
ATSDR Arsenic, Lead, Cadmium and CT DPH Private Well Fact Sheets

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

ARSENIC
CAS # 7440-38-2

Division of Toxicology and Environmental Medicine ToxFAQs™ August 2007

This fact sheet answers the most frequently asked health questions (FAQs) about arsenic. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to higher than average levels of arsenic occur mostly in the workplace, near hazardous waste sites, or in areas with high natural levels. At high levels, inorganic arsenic can cause death. Exposure to lower levels for a long time can cause a discoloration of the skin and the appearance of small corns or warts. Arsenic has been found in at least 1,149 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is arsenic?

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards.

What happens to arsenic when it enters the environment?

- Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching.
- Arsenic cannot be destroyed in the environment. It can only change its form.
- Rain and snow remove arsenic dust particles from the air.
- Many common arsenic compounds can dissolve in water. Most of the arsenic in water will ultimately end up in soil or sediment.
- Fish and shellfish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful.

How might I be exposed to arsenic?

- Ingesting small amounts present in your food and water or breathing air containing arsenic.
- Breathing sawdust or burning smoke from wood treated with arsenic.
- Living in areas with unusually high natural levels of arsenic in rock.
- Working in a job that involves arsenic production or use, such as copper or lead smelting, wood treating, or pesticide application.

How can arsenic affect my health?

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs.

Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.

Skin contact with inorganic arsenic may cause redness and swelling.

Almost nothing is known regarding health effects of organic arsenic compounds in humans. Studies in animals show that some simple organic arsenic compounds are less toxic than inorganic forms. Ingestion of methyl and dimethyl compounds can cause diarrhea and damage to the kidneys

How likely is arsenic to cause cancer?

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer. The Department of Health and Human Services (DHHS) and the EPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

How can arsenic affect children?

There is some evidence that long-term exposure to arsenic in children may result in lower IQ scores. There is also some evidence that exposure to arsenic in the womb and early childhood may increase mortality in young adults.

There is some evidence that inhaled or ingested arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of arsenic that cause illness in pregnant females, can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

How can families reduce the risks of exposure to arsenic?

- ❑ If you use arsenic-treated wood in home projects, you should wear dust masks, gloves, and protective clothing to decrease exposure to sawdust.
- ❑ If you live in an area with high levels of arsenic in water or soil, you should use cleaner sources of water and limit contact with soil.
- ❑ If you work in a job that may expose you to arsenic, be aware that you may carry arsenic home on your clothing, skin, hair, or tools. Be sure to shower and change clothes before going home.

Is there a medical test to determine whether I've been exposed to arsenic?

There are tests available to measure arsenic in your blood, urine, hair, and fingernails. The urine test is the most reliable test for arsenic exposure within the last few days. Tests on hair and fingernails can measure exposure to high levels of arsenic over the past 6-12 months. These tests can determine if you have been exposed to above-average levels of arsenic. They cannot predict whether the arsenic levels in your body will affect your health.

Has the federal government made recommendations to protect human health?

The EPA has set limits on the amount of arsenic that industrial sources can release to the environment and has restricted or cancelled many of the uses of arsenic in pesticides. EPA has set a limit of 0.01 parts per million (ppm) for arsenic in drinking water.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 10 micrograms of arsenic per cubic meter of workplace air (10 $\mu g/m^3$) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Arsenic (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR

AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

CADMIUM

CAS # 7440-43-9

Division of Toxicology and Environmental Medicine ToxFAQs™ September 2008

This fact sheet answers the most frequently asked health questions (FAQs) about cadmium. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to cadmium happens mostly in the workplace where cadmium products are made. The general population is exposed from breathing cigarette smoke or eating cadmium contaminated foods. Cadmium damages the kidneys, lungs, and bones. Cadmium has been found in at least 1,014 of the 1,669 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is cadmium?

Cadmium is a natural element in the earth's crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide).

All soils and rocks, including coal and mineral fertilizers, contain some cadmium. Most cadmium used in the United States is extracted during the production of other metals like zinc, lead, and copper. Cadmium does not corrode easily and has many uses, including batteries, pigments, metal coatings, and plastics.

What happens to cadmium when it enters the environment?

- ❑ Cadmium enters soil, water, and air from mining, industry, and burning coal and household wastes.
- ❑ Cadmium does not break down in the environment, but can change forms.
- ❑ Cadmium particles in air can travel long distances before falling to the ground or water.
- ❑ Some forms of cadmium dissolve in water.
- ❑ Cadmium binds strongly to soil particles.
- ❑ Fish, plants, and animals take up cadmium from the environment.

How might I be exposed to cadmium?

- ❑ Eating foods containing cadmium; low levels are found in all foods (highest levels are found in shellfish, liver, and kidney meats).
- ❑ Smoking cigarettes or breathing cigarette smoke.
- ❑ Breathing contaminated workplace air.
- ❑ Drinking contaminated water.
- ❑ Living near industrial facilities which release cadmium into the air.

How can cadmium affect my health?

Breathing high levels of cadmium can severely damage the lungs. Eating food or drinking water with very high levels severely irritates the stomach, leading to vomiting and diarrhea.

Long-term exposure to lower levels of cadmium in air, food, or water leads to a buildup of cadmium in the kidneys and possible kidney disease. Other long-term effects are lung damage and fragile bones.

How likely is cadmium to cause cancer?

The Department of Health and Human Services (DHHS) has determined that cadmium and cadmium compounds are known human carcinogens.

How can cadmium affect children?

The health effects in children are expected to be similar to the effects seen in adults (kidney, lung, and bone damage depending on the route of exposure).

A few studies in animals indicate that younger animals absorb more cadmium than adults. Animal studies also indicate that the young are more susceptible than adults to a loss of bone and decreased bone strength from exposure to cadmium.

We don't know if cadmium causes birth defects in people. The babies of animals exposed to high levels of cadmium during pregnancy had changes in behavior and learning ability. There is also some information from animal studies that high enough exposures to cadmium before birth can reduce body weights and affect the skeleton in the developing young.

How can families reduce the risks of exposure to cadmium?

- ❑ In the home, store substances that contain cadmium safely, and keep nickel-cadmium batteries out of reach of young children.
- ❑ Cadmium is a component of tobacco smoke. Avoid smoking in enclosed spaces like inside the home or car in order to limit exposure to children and other family members.
- ❑ If you work with cadmium, use all safety precautions to avoid carrying cadmium-containing dust home from work on your clothing, skin, hair, or tools.
- ❑ A balanced diet can reduce the amount of cadmium taken into the body from food and drink.

Is there a medical test to determine whether I've been exposed to cadmium?

Cadmium can be measured in blood, urine, hair, or nails. Urinary cadmium has been shown to accurately reflect the amount of cadmium in the body.

The amount of cadmium in your blood shows your recent exposure to cadmium. The amount of cadmium in your urine shows both your recent and your past exposure.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to cadmium in drinking water at concentrations of 0.04 ppm for up to 10 days is not expected to cause any adverse effects in a child.

The EPA has determined that lifetime exposure to 0.005 ppm cadmium is not expected to cause any adverse effects.

The FDA has determined that the cadmium concentration in bottled drinking water should not exceed 0.005 ppm.

The Occupational Health and Safety Administration (OSHA) has limited workers' exposure to an average of 5 $\mu g/m^3$ for an 8-hour workday, 40-hour workweek.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2008. Toxicological Profile for Cadmium (Draft for Public Comment). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

LEAD
CAS # 7439-92-1

Division of Toxicology and Environmental Medicine ToxFAQs™ August 2007

This fact sheet answers the most frequently asked health questions (FAQs) about lead. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to lead can happen from breathing workplace air or dust, eating contaminated foods, or drinking contaminated water. Children can be exposed from eating lead-based paint chips or playing in contaminated soil. Lead can damage the nervous system, kidneys, and reproductive system. Lead has been found in at least 1,272 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is lead?

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment. Much of it comes from human activities including burning fossil fuels, mining, and manufacturing.

Lead has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. The use of lead as an additive to gasoline was banned in 1996 in the United States.

What happens to lead when it enters the environment?

❑ Lead itself does not break down, but lead compounds are changed by sunlight, air, and water.
❑ When lead is released to the air, it may travel long distances before settling to the ground.
❑ Once lead falls onto soil, it usually sticks to soil particles.
❑ Movement of lead from soil into groundwater will depend on the type of lead compound and the characteristics of the soil.

How might I be exposed to lead?

❑ Eating food or drinking water that contains lead. Water pipes in some older homes may contain lead solder. Lead can leach out into the water.
❑ Spending time in areas where lead-based paints have been used and are deteriorating. Deteriorating lead paint can contribute to lead dust.
❑ Working in a job where lead is used or engaging in certain hobbies in which lead is used, such as making stained glass.
❑ Using health-care products or folk remedies that contain lead.

How can lead affect my health?

The effects of lead are the same whether it enters the body through breathing or swallowing. Lead can affect almost every organ and system in your body. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia. Exposure to high lead levels can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high levels of exposure to lead may cause miscarriage. High-level exposure in men can damage the organs responsible for sperm production.

How likely is lead to cause cancer?

We have no conclusive proof that lead causes cancer in humans. Kidney tumors have developed in rats and mice that had been given large doses of some kind of lead compounds. The Department of Health and Human Services

(DHHS) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens and the EPA has determined that lead is a probable human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic lead is probably carcinogenic to humans and that there is insufficient information to determine whether organic lead compounds will cause cancer in humans.

How can lead affect children?

Small children can be exposed by eating lead-based paint chips, chewing on objects painted with lead-based paint, or swallowing house dust or soil that contains lead.

Children are more vulnerable to lead poisoning than adults. A child who swallows large amounts of lead may develop blood anemia, severe stomachache, muscle weakness, and brain damage. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, lead can affect a child's mental and physical growth.

Exposure to lead is more dangerous for young and unborn children. Unborn children can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead. Some of these effects may persist beyond childhood.

How can families reduce the risks of exposure to lead?

- Avoid exposure to sources of lead.
- Do not allow children to chew or mouth surfaces that may have been painted with lead-based paint.
- If you have a water lead problem, run or flush water that has been standing overnight before drinking or cooking with it.
- Some types of paints and pigments that are used as make-up or hair coloring contain lead. Keep these kinds of products away from children
- If your home contains lead-based paint or you live in an area contaminated with lead, wash children's hands and faces often to remove lead dusts and soil, and regularly clean the house of dust and tracked in soil.

Is there a medical test to determine whether I've been exposed to lead?

A blood test is available to measure the amount of lead in your blood and to estimate the amount of your recent exposure to lead. Blood tests are commonly used to screen children for lead poisoning. Lead in teeth or bones can be measured by X-ray techniques, but these methods are not widely available. Exposure to lead also can be evaluated by measuring erythrocyte protoporphyrin (EP) in blood samples. EP is a part of red blood cells known to increase when the amount of lead in the blood is high. However, the EP level is not sensitive enough to identify children with elevated blood lead levels below about 25 micrograms per deciliter (µg/dL). These tests usually require special analytical equipment that is not available in a doctor's office. However, your doctor can draw blood samples and send them to appropriate laboratories for analysis.

Has the federal government made recommendations to protect human health?

The Centers for Disease Control and Prevention (CDC) recommends that states test children at ages 1 and 2 years. Children should be tested at ages 3–6 years if they have never been tested for lead, if they receive services from public assistance programs for the poor such as Medicaid or the Supplemental Food Program for Women, Infants, and Children, if they live in a building or frequently visit a house built before 1950; if they visit a home (house or apartment) built before 1978 that has been recently remodeled; and/or if they have a brother, sister, or playmate who has had lead poisoning. CDC considers a blood lead level of 10 µg/dL to be a level of concern for children.

EPA limits lead in drinking water to 15 µg per liter.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for lead (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

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Connecticut Department of Environmental Protection
Bureau of Water Management
Permitting, Enforcement, & Remediation Division
79 Elm St
Hartford, CT 06106-5127
(860) 424-3705
Http://www.dep.state.ct.us

FACT SHEET

Connecticut Department of Public Health
Environmental & Occupational Health Assessment Program
410 Capitol Avenue MS# 11EOH, PO Box 340308
Hartford, CT 06134-0308
(860) 509-7740
http://www.dph.state.us

4/05

WHAT YOU NEED TO KNOW ABOUT

EVALUATING PRIVATE WELL CHEMICAL SAMPLING RESULTS

The purpose of this fact sheet is to assist Connecticut citizens in understanding private well water quality sampling results. If you have further questions, please contact the agencies listed below.

What is the Purpose of Private Residential Well Sampling?

Private residential well sampling is conducted for a variety of purposes. Sometimes sampling is done as part of an investigatio n of potential ground water contamination:

- To establish a baseline water quality
- To determine contaminant concentrations and compare to standards
- To identify contaminants
- To evaluate whether a health risk exists

How Are Water Sample Results Reported?

The laboratory reports sampling results in micrograms of a substance per liter of water (ug/L) or milligrams of a substance per liter of water (mg/L). The units of ug/L correspond to parts per billion (ppb), and units of mg/L correspond to parts per million (ppm). One ppb equals one drop of water mixed in a competition-size swimming pool One ppm is comparable to one drop of gasoline in a tank full of gas in a full-size car. One ppm is 1000 times higher than one ppb.

If Contamination Is Found In Sampling Results, How Do We Determine If There Is A Health Risk Or Not?

Health based standards and action levels have been established for a number of chemicals that have been found in groundwater. These standards and action levels represent the concentration of a specific contaminant below which adverse health risks are not likely. Results of private well sampling are compared to these standards and action levels to determine if the water is safe to drink.

How Are Action Levels And Standards For Drinking Water Set?

The EPA establishes a standard called a maximum contaminant level (MCL). MCLs are protective of public health. They are set so that the levels will not be harmful ***and*** they have safety margins built in to protect sensitive populations (e.g., children). MCLs are established to regulate contaminants in public water systems but are widely used for evaluation of private well water results. At the request of the CT Department of Environmental Protection (CT DEP), action levels are set by the CT Department of Public Health (CTDPH) for chemicals found in private and public drinking water .

The EPA and the CTDPH use a process called "risk assessment" to set drinking water quality standards, including MCLs and Action Levels. This process estimates levels of chemical exposure that will not cause adverse health effects and then factors in extra margins of safety. These standards usually assume that people drink water from the same source for the entire life span (70 years).

What if My Well is Contaminated Above the Action Level?

If your private well is contaminated above the action level, you may be eligible to receive bottled water and an alternative water supply or a treatment system from the CT DEP (860-424-3705). Exposure to well water at concentrations above the Action Level may not cause health effects because, as noted above, these guidelines have a safety margin built in to them. However, it is prudent for such contamination to be investigated and cleaned up. If you have health questions, contact the Toxic Hazard Assessment Program at the CT DPH (860-509-7742).

A Short Glossary of Water Terms

Action Level: The contaminant level which, if exceeded, triggers further investigation or treatment or other requirements by regulatory agencies. These levels are set by CTDPH for evaluating private and public well water quality.

Acute Health Effect: An immediate (i.e. within hours or days) effect that typically requires exposure at levels that are many times higher than the Maximum Contaminant Level or Action Level.

Aquifer: A natural underground layer, often of sand or gravel, that contains water.

Chronic Health Effect: A health effect that takes long-term (years) exposure to be seen (such as cancer).

Inorganic Contaminants: Mineral-based compounds such as metals and nitrates. These contaminants are naturally-occurring in some water, but can also get into water through farming, chemical manufacturing, and other human activities. EPA has set legal limits on 15 inorganic contaminants.

Leachate: Water that percolates or drains through a landfill carrying pollutants from the waste.

Maximum Contaminant Level (MCL): The highest level of a contaminant that EPA allows in drinking water. MCLs ensure that drinking water does not pose either a short-term or long-term health risk. EPA sets MCLs at levels that are economically and technologically feasible to achieve in public water systems.

Organic Contaminants: Carbon-based chemicals, such as solvents and pesticides, which can get into water through runoff from cropland or discharge from factories. EPA has set legal limits on 56 organic contaminants.

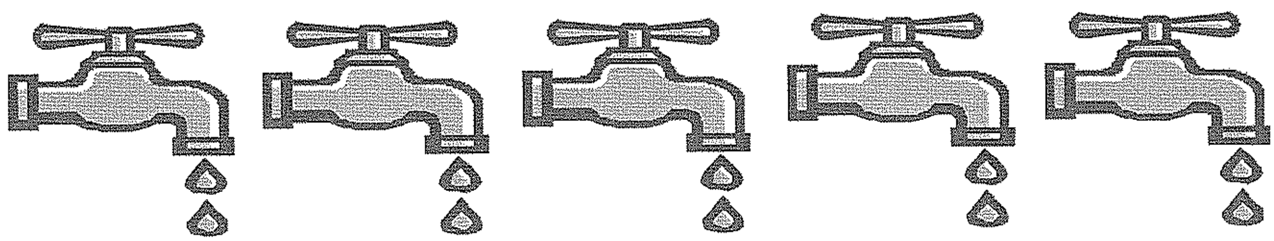
Semi-VOCs: A group of chemicals similar to VOCs (below) which, among other things, do not evaporate so quickly. Examples include petroleum hydrocarbons, such as kerosene and heating oil, and polychlorinated biphenols (PCBs).

Turbidity: The cloudy appearance of water caused by the presence of tiny particles. High levels of turbidity may interfere with proper water treatment and monitoring.

VOCs: Volatile Organic Compounds: Highly evaporative chemicals found in cleaning fluids, paints and petroleum products. Examples include trichloroethylene, benzene, and methyl tert butyl ether (MTBE).

If Multiple Contaminants Are Identified In The Same Well, How Is The Health Risk Evaluated?

MCLs and action levels are set based upon lifetime exposure to a single chemical in water. There are margins of safety built into these levels. Therefore, it is unlikely that if several contaminants are present at their respective MCLs and/or action levels, they will add up to be a health concern. However, CTDPH can review such data on a site-specific basis to ensure that this is the case.



What Does It Mean When A Result Comes Back As "Non-Detect?

If a compound is listed as a "non-detect" (ND), it means that chemists looked for that particular compound but could not measure the concentration. Either the compound is not present at all, or the concentration is too low to be measured (i,e., it is below the detection limit). In almost all cases, the detection limit is much lower than health-based water standards.

What Are Laboratory Contaminants? Why Do They Show Up in Some Samples And Not In Others?

Sometimes water samples can become contaminated in the laboratory. Laboratory contaminants are compounds unintentionally added to the water after it is sampled. Leaching of chemicals from plasticware or laboratory solvents are common causes. It is sometimes important to re-sample if chemists suspect that the compound is a laboratory contaminant.

Is Bathing and Showering A Health Risk?

In some instances, you can be exposed to water contaminants through bathing or showering. The amount of exposure depends on factors specific to each contaminant: the concentration, skin permeability (how easy does the chemical pass through the skin) and the volatility of the contaminant (how readily does it evaporate) . Other factors that effect exposure include water temperature, flow rate of the water, and time spent in the shower. The actual amount of exposure is therefore hard to determine. Connecticut drinking water Action Levels include a safety factor to account for exposures other than drinking. If you have concerns about a particular chemical, please contact the CTDPH at the number below.

Should Drinking Water Be Completely Free of Contaminants?

Advances in the instruments used to measure contaminants allow us to detect minute traces of chemicals in water. Therefore, chemicals can be found in almost all drinking water. Some of these occur naturally in the environment and some of them occur because of human activity. Some contaminants result from the chlorination process or the types of plumbing used in homes and businesses. At low levels, these substances and contaminants do not affect our health.

How Can I Protect My Ground Water Supply?

The best way to protect ground water quality is to handle all chemicals with extreme care. In addition, owners of private wells should:

⇒ Periodically inspect exposed parts of the well for problems such as:
  - cracked, corroded, or damaged well casing
  - broken or missing well cap
  - settling and cracking of surface seals.

⇒ Slope the area around the well to drain surface runoff away from the well.

⇒ Install a well cap or sanitary seal to prevent unauthorized use of, or entry into, the well.

⇒ Have the well tested once a year for coliform bacteria, and every 3 – 5 years for chemical contamination.

⇒ Keep accurate records of any well maintenance, such as disinfection or sediment removal, that may require the use of chemicals in the well.

⇒ Hire a certified well driller for any new well construction, modification, or abandonment and closure.

⇒ Avoid mixing or using pesticides, fertilizers, herbicides, solvents, fuels, and other pollutants near the well.

⇒ Do not spill gasoline from small engines like lawn mowers or from working on cars.

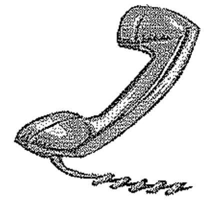
⇒ Do not dispose of wastes in dry wells or in abandoned wells.

⇒ Do not cut off the well casing below the land surface.

⇒ Pump and inspect septic systems as often as recommended by your local health department.

⇒ Never dispose of hazardous materials in a septic system.

Who Can I Call For More Information?



Contact Your Local Health Department and/or these agencies:

CT Dept of Public Health
Environmental & Occupational Health Assessment Program
PO Box 340308, MS # 11CHA
410 Capitol Ave
Hartford, CT 06134-0308
(860) 509-7742

CT Department of Environmental Protection
Water Management Division
79 Elm St
Hartford, CT 06106-5127
(860) 424-3705

Environmental Protection Agency
Region I
1 Congress St (CCT)
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(617) 918-1554

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Appendix C
Risk Calculations

Plymouth Private Well Contamination

ARSENIC

NONCANCER RISK

Ingestion, Max Concentration, child, aged 1-6 years

Ing Rate (L/day)	[Conc] (ug/L)	ED (yr)	$1/BW_c$ (1/kg)	$1/At_{nc}$ (1/yr)	ADD_i (ug/kg/day	RFD (ug/kg/day)	HI
1	71	6	0.058824	0.166667	4.17647058	0.3	13.9215686

CANCER RISK

Ingestion, Max Concentration, child, aged 1-6 years

Ing Rate (L/day)	[Conc] (mg/L)	ED (yr)	$1/BW_c$ (1/kg)	$1/At_c$ (1/yr)	ADD_i (mg/kg/day)	Cancer Slope Factor $(mg/kg/day)^{-1}$	Cancer Risk	Total Cancer $Risk_{Ing+Inh}$
1	0.071	6	0.05882	0.01428571	0.00035798	1.5	0.000537	0.000545

Inhalation, Max Concentration, child, aged 1-6 years

[Conc] (ug/L)	K	Exp Time (hr/day)/ 24 hr day	ED (yr)	$1/At_c$ (1/yr)	Unit Risk (per ug/m_3)	Cancer $Risk_{in}$
71	0.03	0.010416 667	6	0.01428571	0.0043	0.00000818

CADMIUM

NONCANCER RISK

Ingestion, Max Concentration, child, aged 1-6 years

Ing Rate (L/day)	[Conc] (ug/L)	ED (yr)	$1/BW_c$ (1/kg)	$1/At_{nc}$ (1/yr)	ADD_{ing} (ug/kg/day	RFD (ug/kg/day)	HI
1	8	6	0.058824	0.166667	0.470588235	0.5	0.941176

CANCER RISK

Inhalation, Max Concentration, child, aged 1-6 years

[Conc] (ug/L)	K	Exp Time (hr/day)/24 hr day	ED (yr)	$1/At_c$ (1/yr)	Unit Risk (per ug/m_3)	Cancer $Risk_{in}$
8	0.03	0.010417	6	0.01428571	0.0018	3.85714E-07

NICKEL

NONCANCER RISK

Ingestion, Max Concentration Nickel, child, aged 1-6 years

Ing Rate (L/day)	[Conc] (ug/L)	ED (yr)	$1/BW_c$ (1/kg)	$1/At_{nc}$ (1/yr)	ADD_{ing}(ug/kg/day	RFD (ug/kg/day)	HI
1	140	6	0.058824	0.166667	8.235294118	20	0.41176471

CANCER RISK

Inhalation, Max Concentration Nickel, child, aged 1-6 years

[Conc] (ug/L)	K	Exp Time (hr/day)/24 hr day	ED (yr)	$1/At_c$ (1/yr)	Unit Risk (per ug/m_3)	Cancer $Risk_{in}$
130	0.03	0.010416667	6	0.01428571	0.00024	8.35714E-07

Total Cancer Risk with Maximum Concentrations for Arsenic, Cadmium, and Nickel

$Risk_{Ar}$	$Risk_{Cd}$	$Risk_{Ni}$	Total Cancer Risk
0.000545	3.85714E-07	8.35714E-07	0.000546

WHERE:

ADD_{ing}	= Average daily dose from ingestion
AT_{nc}	= Averaging time for noncancer risk: 6 years
AT_c	= Averaging time for cancer risk: 70 years
Bw_c	= Child 50^{th} %tile body weight for age 1-6 yrs; 17 kg (ATSDR 2010);
[Conc]	= Maximum concentration, arsenic: 71 ug/L, cadmium: 8 ug/L, nickel: 140 ug/L
CSF	= Cancer slope factor, arsenic: 1.5 $(mg/kg/day)^{-1}$ (IRIS 1993)
ED	= Exposure duration; 6 years
Exp Time	= 0.25 hr/24 hr day=0.010417
HI	= Hazard index
Ing Rate	= Ingestion rate, child: 1L/day
K	= Constant: 0.03 air concentration (ug/L) = K(water concentration in ug/L) (Anderson et al 2007; Xu and Weisel 2003)
RfD	= EPA reference dose arsenic; 3E-4 mg/kg/day (IRIS 1993), nickel (soluble salts): 20 ug/kg/day (IRIS 1991a), cadmium (in water): 0.5 ug/kg/day (IRIS 1994)
$Risk_{Ar}$	= Cancer risk from inhalation and ingestion exposure to arsenic
$Risk_{Cd}$	= Cancer risk from inhalation exposure to cadmium
$Risk_{Ni}$	= Cancer risk from inhalation exposure to nickel
Unit Risk	= Unit Risk Factor: arsenic: 0.004 per ug/m^3(IRIS 1993), nickel (nickel refinery dust): 0.00024 per ug/m^3 (IRIS 1991b), cadmium: 0.0018 per ug/m^3 (IRIS 1994)