Health Consultation

WARREN TOWNSHIP CISTERN
SAMPLING INVESTIGATION

WASHINGTON COUNTY, OHIO

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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

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HEALTH CONSULTATION

WARREN TOWNSHIP CISTERN SAMPLING INVESTIGATION

WASHINGTON COUNTY, OHIO

Prepared by:

Health Assessment Section
Ohio Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

SUMMARY

The Health Assessment Section (HAS) of the Ohio Department of Health (ODH) produced this Marietta, Warren Township Cistern Sampling Investigation Public Health Consultation to address rain water cistern contamination concerns associated with air releases from the Eramet ferromanganese alloy facility located southwest of the city of Marietta, in Warren Township, Washington County, Ohio.

Residential rain water cistern samples were collected to measure the levels of metals found in these potential drinking water sources. This testing was conducted as a part of the Agency for Toxic Substances and Disease Registry (ATSDR) investigation of air emissions from facilities at the former Union Carbide complex. ATSDR air modeling produced maps of potential metals in air concentrations and their area of deposition. Based upon these modeling results, Marietta-Warren Township residents that used a rain water cistern and lived within three (3) miles of the former Union Carbide complex were asked to participate in the cistern sampling.

A targeted residential rain water cistern sampling investigation sampled a total of nine homes. In all nine cistern samples, laboratory tests measured the water for the following metals: arsenic; aluminum; barium; calcium; chromium; cooper; iron; magnesium; manganese; nickel; potassium; sodium; strontium; zinc and lead. In four of the nine homes sampled, additional testing for *E.coli* and total coliform bacteria were conducted as a part of the lab analysis

Based on the results of the rain water cistern samples collected, the levels of metals detected in the cistern water would not be expected to cause adverse health effects to the residents. In one residence, however, the detection of zinc slightly exceeded the U.S. EPA Lifetime Health Advisory Levels for drinking water. During the cistern recruitment interview, the resident of this home stated that they did not drink the cistern water, but used it for washing clothing only. The rainwater cistern sampling indicated that contamination associated with the air emissions surrounding the former Union Carbide complex currently poses *No Apparent Public Health Hazard*.

HAS did discover that three of the four cisterns sampled for *E.coli* and total coliform had these disease-causing organisms present in their cistern water supply. Although not every home was selected for *E.coli* and total coliform testing, HAS alerted the nine homes sampled and also provided the Marietta City and Washington County health departments the cistern sampling findings that the potential disease-causing organisms of *E.coli* and total coliform bacteria may be present in an untreated cistern water supply.

For those homes that tested positive for *E.coli* and/or total coliform, ODH recommended the cistern water supply not be used for drinking, food preparation and other household purposes without proper treatment. For each of the nine households that had their cistern sampled, ODH enclosed the document “Plans for Developing a Rainwater Cistern or Hauled Water Supply” as a guideline for improving the water quality and safety of these water supplies.

STATEMENT OF ISSUES

On May 22, 2000, the Agency for Toxic Substances and Disease Registry (ATSDR) was petitioned by U.S. Senator Mike DeWine to evaluate the health impacts from air pollution on residents of Marietta, Washington County, Ohio. At that time, no data were available for review to address the petition. In 2001-2002 ambient air monitoring data, supplied by the Ohio Environmental Protection Agency (OEPA), became available to ATSDR in late March, 2003. The Atlanta-based ATSDR Strike Team was asked to evaluate the 2001-2002 ambient air data and determine if exposure to ambient air concentrations of metals are of health concern or warrant additional evaluation. *The Strike Team concluded that there are insufficient data to answer the question of the extent of exposure and that additional data are necessary to answer questions regarding public health impacts from ambient air contaminants.*

Following the release of the ATSDR health consultation, discussions with residents at an ATSDR Public Meeting in Marietta December 9, 2003 identified the use of cisterns as water supplies as a potential exposure pathway to metals released in emissions from the Eramet ferromanganese alloy plant and other facilities making up the former Union Carbide complex.

Following up on these concerns, Ohio Department of Health and the Marietta City and Washington County health departments offered to sample water supply cisterns in the area most likely to be affected by aerial disposition from the industries in the Union Carbide complex.

This health consultation evaluates results of sampling of nine (9) cisterns in the area by ODH staff June 29, 2004.

BACKGROUND

Located several miles southwest of the City of Marietta, Ohio, the former Union Carbide facility complex is currently occupied by four companies including: Eramet (former Elkem Metals Co.); Energizer Battery (battery manufacturer); Solvay (a solvent manufacturer); and Chevron Oil. AMP Ohio, a coal-burning power plant originally built to provide power to Union Carbide, is located across the street from the complex. The complex is located on the flood plain of the Ohio River which flows NE to SW, just south and east of the complex. The complex backs up to a relatively steep bedrock bluff behind the complex to the north. U.S. EPA air modeling suggested the predominant wind direction in the area is to the north. There is a low density rural residential area to the north of the facility, and the City of Marietta is located three miles northeast of the facility (see Figure 1: Manganese Air Concentration Modeling Map).

In March 2002, ATSDR staff met with concerned residents to gather health concerns. Residents focused their concerns on the perceived uncontrolled air emissions created by the industrial complex and the “toxic soup” of contamination they believed was impacting the health of their community. Concerns mainly centered on Eramet due to the high volume of metals it refines annually and due to the fact that the facility is unique and environmental pollution controls are minimal.

Although the complex is primarily on rural land and the facility is located in Warren Township several miles outside the City of Marietta, both local township area and city residents expressed concerns about the impact the facilities have on the air quality and their health. During the March 2002 ATSDR site visit, residents reported symptoms that they associated with exposure to releases from the complex. These symptoms include: headaches, burning eyes, nausea, difficulty breathing, fatigue, muscle aches, tremors, sinus problems, bloody noses, a metallic taste in their mouths, a bitter metallic taste in their throats, an ammonia smell, and sore throats. Residents were also concerned about emissions of hexavalent chromium released through the chromium refining process, emissions from the electro-chromium process, and releases of chlorine and sulfuric acid used in the refining process.

In March 2002, ATSDR staff toured the Eramet facility. The ferroalloy portion of the complex, which Eramet bought in 1999, occupies approximately 350 acres of land. The *ferroalloy operation*, which produces iron alloys for the steel, aluminum, and super-alloys industries, began in 1951. The operation includes several different refining processes. The facility is separated into a north and south side by a set of railroad tracks. To the north of the tracks are the electrolytic and briquetting operations that produce high-quality chromium metal, aluminum hardener briquettes and other specialty products. To the south of the railroad tracks are three submerged arc furnaces that produce a full range of ferromanganese and silicomanganese products for the steel industry. This area includes a “manganese oxygen refining” operation, which produces ferromanganese that contains limited amounts of carbon and silicon. Eramet is the only producer of manganese ferroalloys in the United States, and is one of the largest manufacturers of these products in the world. In the year 2000, the Toxic Release Inventory (TRI) reported that Eramet released 431,600 pounds of manganese to ambient air. Since there are no emission control systems in place for the ferromanganese operation, over half of the manganese emissions were released as uncontrolled “fugitive” emissions.

Based on facility-specific TRI information, U.S. EPA, at the request of ATSDR, modeled the chemicals emitted from the five facilities of the former Union Carbide facility complex that could pose a public health threat. The chemicals modeled include:

- ammonia,
- chlorobenzene,
- chloromethane,
- chromium,
- hydrochloric acid,
- manganese,
- styrene,
- sulfuric acid, and
- toluene

U.S. EPA modeling results indicated manganese was the only chemical in air that posed a potential health threat to residents that live around these facilities. The other chemicals modeled were present in such low concentrations that ATSDR determined they do not pose a health threat to residents at this time.

DISCUSSION OF THE ISSUES

Importance of a Completed Exposure Pathway

Area residents have to come into physical contact or *be exposed* to the environmental pollutants produced by the four companies that operate in former Union Carbide facility complex in order for these toxic chemicals to cause the development of adverse health effects in area residents. In order for the residents to come into contact with these chemicals, there must be a *completed exposure pathway*. A completed exposure pathway consists of *five main parts* that must be present for exposure to occur. These include:

I. A Source of the toxic chemicals of concern; (Eramet)

II. A method of Environmental Transport which allows the chemical to move from the source and bring it into contact with the residents (surface water, groundwater, soils, entrained dust, vapors, soil gas); (air releases of dust and fumes)

III. A Point of Exposure which is the place where a resident comes into direct contact with the chemical (on-site versus off-site); (ambient air; cistern water)

IV. A Route of Exposure which is how the resident comes into contact with the chemical (drinking it, eating it, breathing it, touching it); and (drinking cistern water)

V. A Population at Risk which are the people living near the site who could possibly come into physical contact with site-related chemicals. (people live adjacent to the facility)

Exposure pathways can also be characterized by when the exposure occurred or might occur in the *past*, *present*, or *future*.

Physical contact with a chemical contaminant in and by itself *does not* necessarily result in adverse health effects. A chemical's ability to affect the resident's health is also controlled by a number of other factors including:

I. How much of the chemical a person is exposed to (the *dose*).

II. How long a person is exposed to the chemical (duration of exposure).

III. How often a person is exposed to the chemical (acute versus chronic).

IV. The chemical's toxicity and how it impacts the body.

DISCUSSION

Residential Rain Water Cisterns

During a December, 2003 public availability session in Marietta, residents expressed concerns that there were people that lived in the area that used cisterns as a drinking water source. ATSDR/ODH were concerned the aerial deposition of manganese from the Eramet facility could impact the water supply of residences in the area that have and use rainwater cisterns as potential drinking water sources.

A rainwater cistern is a water system that collects rainwater that flows off a roof, channels through gutters and is sent to a collection tank for storage until used by the household. Cisterns may also be referred to as rainwater catchments or rainwater harvesting systems. The construction of rainwater cisterns and hauled water storage tanks used as private water supplies in Ohio is covered in Ohio Administrative Code (OAC) 3701-28-13 (Appendix A).

A rainwater collection system is highly vulnerable to a variety of pollution sources and water contamination. Because rainwater cisterns are exposed to the elements, sources such as birds, bugs, bacteria, dust, dirt, leaf litter, roofing materials, local industry and land use practices, have the potential to adversely impact the quality of the collected water.

In accordance with OAC Rule 3701-28-07, cisterns in Ohio are required to have continuous disinfection in order to make the water sanitary for potable uses. Current acceptable methods for continuous disinfection are chlorination, iodination, ozonation, and ultraviolet (UV) light systems that meet NSF Standard 55 Class "A". Because cisterns collect rainwater off of the roof in areas where there may be large trees overhanging the roof, it is critical to routinely maintain gutters, downspouts, debris filters, roof washers, and cistern sand and gravel filters.

Residential Rain Water Cistern Sampling

Using the U.S. EPA modeling results as a guide, Marietta-Warren Township residents that used a rain water cistern and lived within three (3) miles of the former Union Carbide complex were chosen to take part of the ODH cistern sampling (Figure 1). By using a targeted mailing to residential addresses identified from the modeling results, ODH announced the cistern sampling event and recruited homeowners that use rain water cisterns.

ODH Private Water Systems staff collected water samples from nine (9) cisterns June 29, 2004. During phone conversations with ODH Health Assessment Section staff, most of the participating Warren Township residents stated they do not drink the cistern water as a primary drinking water source, but use it to wash items such as clothing, cars, animals and watering their plants and gardens. There were however several residents that stated they do drink their cistern water (see Table 2. ODH Cistern Sampling – Water Quality Summary). In all nine cistern samples, laboratory tests measured the water for the following metals: arsenic; aluminum; barium; calcium; chromium; cooper; iron; magnesium; manganese; nickel; potassium; sodium; strontium; zinc and lead (see Table 1. Residential Cistern Sampling Metals Results). In four of the nine homes sampled, additional testing for *E.coli* and total coliform bacteria were conducted as a part of the lab analysis (see Table 2. ODH Cistern Sampling – Water Quality Summary).

TOXICOLOGY OF THE CHEMICALS OF CONCERN

Manganese in water

Manganese is a naturally-occurring metal found in soils, rocks and food. Manganese is an essential nutrient that plays an important role in our health. Everyone comes in contact with small amounts of manganese in air, water, and food. Low levels of manganese are found in living things such as plants and animals.

In nature, manganese occurs as solid-forming mixtures with oxygen, carbon, and silica. These manganese compounds are mined and refined to yield manganese metal primarily for use in the steel industry, but also as dietary supplements and as ingredients in ceramics, fertilizers, and pesticides. Some manganese compounds dissolve in water and manganese is a common trace element in surface and underground waters. Manganese levels in groundwater in Ohio typically are less than 100 ppb. However, certain sandstone aquifers in eastern Ohio can have levels of naturally-occurring manganese up to 2,000 ppb and sand and gravel aquifers along the Ohio River can have manganese levels in excess of 5,000 ppb (Ohio EPA, 2000).

There are no federal health-based standards established for manganese in drinking water. US EPA has established a Secondary Maximum Contaminant Level (SMCL) for manganese in public water supplies of 50 ppb. This is not a health-based drinking water standard, but is based on aesthetic qualities such as odor, taste, color and clarity. Elevated manganese levels can result in a disagreeable odor and a black coloration to the water. The U.S. Food and Drug Administration use the same 50 ppb standard for manganese in bottled drinking water. Various states have established their own water quality standards for manganese in drinking water, ranging from 50 to 840 ppb (ATSDR, 2000).

Using the ATSDR manganese deposition and air concentration modeling results, ODH determined that manganese releases could impact the water quality for those Marietta-Warren Township residents that used a rain water cistern and lived within three (3) miles of the former Union Carbide complex. These air emissions may be an important source for manganese and other metals in cistern water. Manganese particulates wash out in rain events or can be deposited as aerial fallout accumulates in cistern water and sediment.

Health Implications

For nearly all people, food is the main source of manganese. Manganese plays a role in bone mineralization, protein formation, metabolic regulation, and provides cells with protection from free radical species. Diets deficient in manganese can result in serious illness, leading to problems with blood clotting, skin disorders, and metabolic disorders, plus interfering with normal growth, bone formation, and reproduction (ATSDR, 2000). Central nervous system effects (tremors, loss of muscle control) have been associated with ingestion of drinking water with highly elevated levels of manganese (at or in excess of 14,000 ppb) in a study of a human population in Japan and in a second study of elderly individuals in Greece who were drinking water with manganese levels of 1,800 to 2,300 ppb. Other studies in Canada and Israel, however, indicated no correlation between increased incidence of CNS disorders and ingestion of drinking water with similarly high levels of manganese (ATSDR, 2000).

Health problems, especially problems with the brain and central nervous system, occur on a "continuum of dysfunction" that is dose-related. In other words, if you are exposed to normal levels of manganese, you would not expect to see any health problems. If you are exposed to increased lower levels of manganese, very mild or unnoticeable effects may be or may not be seen. Health problems appear to increase in severity as the exposure levels and duration increases (ODH, 2003. Manganese fact sheet. Appendix D).

Zinc in water

One residence had elevated levels of zinc up to 3,190 ppb in their cistern water sample. Zinc, like manganese, is an abundant, naturally-occurring metal found in soils, water and all foods. Zinc also is an important nutrient that is essential for good health. Everyone comes into contact with small amounts of zinc in air, soil, water and food in their daily life. Natural waters in Ohio typically have zinc at levels approximating 20-40 ppb, but can have zinc at levels up 3,600 ppb (Ohio EPA, 2000).

Zinc, like manganese, also typically occurs in nature as mixtures with oxygen (oxides), sulfur (sulfates, sulfides), and chlorine (chlorides). Its main commercial use is to "galvanize" metal, i.e., coat iron or other metals to prevent rust or oxidation. It is also a common ingredient in vitamins, sun blocks, ointments, deodorants, acne and poison ivy treatments and anti-dandruff shampoos.

Zinc is an essential nutrient in small amounts and is present in all foods and most drinking water supplies. Zinc leaves the body in urine and feces. Ingestion of very high levels of zinc (many 1,000s of parts billion) can cause anemia, stomach cramps, nausea and vomiting (ATSDR, 2004). Zinc generally does not function as an acute poison. Not enough zinc in one's diet can cause loss of appetite, decreased sense of taste and smell, decreased immune function, slow healing, cause skin disorders, and retard growth, especially in males.

There are no federal health-based drinking water standards for zinc in public water supplies. A "secondary" drinking water standard of 5,000 ppb zinc in water has been established for zinc in public water supplies based on non-health water quality effects, primarily taste. As indicated above, one water sample from a cistern sampled as part of the investigation detected zinc at a concentration of 3,190 ppb. This level slightly exceeds ATSDR's Chronic Environmental Media Evaluation Guide (EMEG) for Zinc for children (=3,000 ppb) but is below the EMEG value for adults (= 10,000 ppb). Concentrations below ATSDR EMEG values are unlikely to pose a health threat but levels above the EMEG do not necessarily represent a health threat and cannot predict the development of adverse health impacts following exposure. The sample concentration also exceeds U.S. EPA's Lifetime Health Advisory for zinc in water supplies (Lifetime HA = 2,000 ppb). This is defined as the level of a contaminant in drinking water below which no non-cancer adverse health effects are likely to occur during a lifetime of exposure (U.S. EPA, 2004).

A possible source of the zinc could be the weathering of galvanized metals used in construction of the cistern water collection system. Discussions with the resident indicated that no one in the household was using the cistern water as a drinking water source.

Bacteriological Concerns
Three of the four cisterns sampled for *E.coli* and total coliform had these disease-causing organisms present in their cistern water supply. Although not every home was selected for *E.coli* and total coliform testing, HAS alerted the nine homes sampled and also provided the Marietta City and Washington County health departments the cistern sampling findings that the potential disease-causing organisms of *E.coli* and total coliform bacteria may be present in an untreated cistern water supply.

Physical Hazards
No physical hazards were identified in this evaluation.

Children's Health Considerations
Manganese is essential for good health. It plays a role in bone mineralization, protein formation, metabolic regulation, and provides cells with protection from free radical species. ATSDR recognizes that in communities faced with contamination of their air, water, soil, or food, the unique vulnerabilities of infants and children demand special emphasis. ATSDR is committed to evaluating the health impact of environmental contamination on children. Air quality in this area could pose a health concern for children because they could potentially be exposed unhealthy levels of metals in air. More data are needed to assess children's health in this community.

Conclusions

Prompted by concerns that there may be contaminated water in cisterns used as a drinking water sources and by the U.S. EPA aerial deposition modeling of manganese that demonstrated there could be impacted rainwater cistern water supply of residences in the area, ODH conducted a targeted cistern sampling investigation to determine if these potential drinking water sources were contaminated. Based on the results of the rain water cistern samples collected, the levels of metals detected in the cistern water would not be expected to cause adverse health effects to the residents. In one residence however, the detection of zinc slightly exceeded the U.S. EPA Lifetime Health Advisory Levels for drinking water. However, during the cistern recruitment interview, the resident of this home stated that they did not drink the cistern water, but used it for washing clothing only. The rainwater cistern contamination associated with the air emissions surrounding the former Union Carbide complex currently poses *No Apparent Public Health Hazard*.

Recommendations
Although the levels of metals detected in the cistern water would not be expected to cause adverse health effects to the residents, there were homes that tested positive for potential disease-causing organisms that may be present in their untreated cistern water supply. For those homes that tested positive for *E.coli* and/or total coliform, ODH recommended the cistern water supply not be used for drinking, food preparation and other household purposes without proper treatment. In each of the nine households that had their cistern sampled, ODH enclosed the document "Plans for Developing a Rainwater Cistern or Hauled Water Supply" (Appendix A) as a guideline for improving the water quality and safety of these water supplies.

Prepared by
Robert C. Frey, Ph.D., Principal Investigator/Chief of the Health Assessment Section
Greg Stein, Community Involvement/Health Education Consultant

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(OAC) 3701-28-13 (OAC) 3701-28-09 (OAC) 3701-28-07

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Table 1. Residential Cistern Sampling Metals Results

Resident	As	Al	Ba	Ca	Cr	Cu	Fe	Mg	Mn	Ni	K	Na	Sr	Zn	Pb
Res – 1	BDL	BDL	BDL	6	BDL	40	731	1	206	BDL	BDL	BDL	BDL	3190	10.4
Res – 2	BDL	BDL	BDL	14	BDL	102	61	BDL	45	BDL	BDL	BDL	BDL	147	3.7
Res – 3	BDL	BDL	24	26	BDL	BDL	53	8	32	BDL	2	22	66	164	BDL
Res – 4	BDL	BDL	30	28	BDL	60	BDL	1	BDL	BDL	2	BDL	79	81	5.0
Res – 5	BDL	BDL	72	99	BDL	BDL	BDL	19	BDL	BDL	2	36	309	37	BDL
Res – 6	BDL	BDL	73	89	BDL	56	87	19	BDL	BDL	2	19	169	88	2.5
Res – 7	BDL	BDL	BDL	17	BDL	BDL	148	7	18	BDL	2	23	58	45	BDL
Res – 8	BDL	BDL	BDL	16	BDL	BDL	BDL	BDL	28	BDL	2	BDL	43	32	BDL
Res – 9	BDL	BDL	BDL	16	BDL	32	90	2	184	BDL	BDL	BDL	42	17	BDL

Residential metals results measured in ppb (parts per billion)
BDL: Below Detection Limits

Table 2. ODH Cistern Sampling – Water Quality Summary

Homes Tested	Drink Cistern Water	Other Use	Metals Found	E. coli	Total coliform
Res – 1	No	Washing clothing only	Elevated iron, manganese and zinc. Iron, manganese and zinc exceeded the SMCLs. Zinc slightly exceeded the U.S. EPA Lifetime health Advisory levels for drinking water.	NA	NA
Res – 2	"Drink the cistern water all the time and have never been sick from it."		No concentrations of metals in their rain cistern water at levels of public health concern.	No	Yes
Res – 3	One resident stated they do not drink the cistern water but two other household members do use the cistern water as a primary drinking water source.	Washing clothing	No concentrations of metals in their rain cistern water at levels of public health concern.	Yes	Yes
Res – 4	No	Washing cars, watering, cleaning, etc.	No concentrations of metals in their rain cistern water at levels of public health concern.	NA	NA
Res – 5	Stated they do drink the water and have a "treatment system," as the water is filtered through their refrigerator filter.		No concentrations of metals in their rain cistern water at levels of public health concern.	No	No
Res – 6	No	Watering the garden, washing animals, etc.	No concentrations of metals in their rain cistern water at levels of public health concern.	NA	NA
Res – 7	Stopped drinking the cistern water within the last couple of months.	Bathing & cooking and everything else.	No concentrations of metals in their rain cistern water at levels of public health concern.	Yes	Yes
Res – 8	No		No concentrations of metals in their rain cistern water at levels of public health concern.	NA	NA
Res – 9	No		No concentrations of metals in their rain cistern water at levels of public health concern. Did have slightly elevated levels of manganese. But these levels are below the conservative health-based drinking water screening criteria.	NA	NA

NA = Not Applicable

Figure 1:
Manganese Air Concentration Modeling Map

Appendix A
Plans for Developing a Rainwater Cistern or Hauled Water Supply

Appendix B
E.coli fact sheet

Appendix C
Total & Fecal Coliform Bacteria fact sheet

Appendix D
Manganese fact sheet