



**Oregon Department of Human Services
Superfund Health Investigation and Education Program (SHINE)**

**Health Consultation
Public Comment Release**

**North Morrow Perchlorate Area
Northern Morrow and Northwestern Umatilla Counties, Oregon
December 1st, 2005**

Prepared under a cooperative agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Purpose and Health Issues

The Superfund Health Investigation and Education (SHINE) program evaluates the human health risks Oregonians face from exposures to environmental contaminants. SHINE is a part of the Oregon Department of Human Services (DHS) and was formed in 2001 as a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR).

SHINE has prepared this Public Health Consultation to address the potential health concerns posed by the contamination of perchlorate in groundwater wells throughout northwestern Umatilla and northern Morrow Counties. The area under investigation is known as the North Morrow Perchlorate Area. Perchlorate has been detected by the Oregon Department of Environmental Quality (DEQ) and U.S. Environmental Protection Agency (EPA) in drinking and irrigation groundwater wells at concentrations ranging between 0.5 and 30 parts per billion (ppb). Manufactured perchlorate is commonly used as an oxidizer in rocket fuel, explosives, matches, and fireworks. Perchlorate naturally exists as a constituent in Chilean nitrate fertilizers, and it is formed naturally through atmospheric processes. Perchlorate has also been detected in various U.S. locations in groundwater, food samples, dairy milk, and breast milk.

ATSDR was asked by the U.S. Environmental Protection Agency (EPA) to evaluate the health risks associated with consuming drinking water contaminated with perchlorate in the North Morrow Perchlorate Area. Through the cooperative agreement with ATSDR, SHINE agreed to conduct this Public Health Consultation. Additionally, it was determined that SHINE should evaluate perchlorate exposure from other sources, specifically for produce and milk, and whether exposure to those sources alone or in combination presents a health concern for sensitive populations.

Background

Perchlorate is a contaminant detected in groundwater throughout the United States, with the highest levels found in Arkansas, California, Nevada, Texas, and Utah [1]. Perchlorate was detected in groundwater at a site in California at levels as high as 1,100,000 ppb (not used for drinking water).

Perchlorate is a highly water-soluble anion that is a component of perchlorate salts including ammonium, magnesium, potassium, and magnesium salts [2]. It is a mobile substance that moves easily from surface soils into groundwater, where it rapidly disperses. Perchlorate is stable in the environment and can persist in groundwater for decades [3]. Due to its low vapor pressure, it is not usually found in the vapor form at room temperature.

Ammonium perchlorate and perchloric acid contain chlorine in its highest oxidation state, which makes perchlorate a good oxidizer at elevated concentrations and temperatures. Because of its oxidation capabilities, ammonium perchlorate has been manufactured and

used in solid rocket fuel, explosives, matches, and fireworks [4]. Perchlorate is also used to aid in the inflation of air bags [3]. In the 1950s and 1960s, large doses (400-1000 mg/day) of perchlorate salts were used to treat hyperthyroidism (not to be confused with hypothyroidism, discussed below), until severe health problems related to this treatment were identified, including agranulocytosis and aplastic anemia leading to death (Appendix A) [5]. Natural Chilean nitrate fertilizers contain very small amounts (0.03%) of perchlorate [6]. Small amounts form naturally through atmospheric processes and deposit onto land surfaces.

The Government Accounting Office (GAO) published a report in spring of 2005 about tracking perchlorate contamination in the U.S. They determined 65% of the groundwater perchlorate contamination found throughout the U.S. is linked to defense and aerospace activities, such as rocket motor testing, bomb testing, or explosive disposal. The GAO estimated that 90% of perchlorate is produced for rocket propellant used by the military and NASA [1]. The contaminated wells in the north Morrow area are situated near sites historically used by the Navy and Air Force for bomb testing, by Boeing for engine testing, and the site of the Umatilla Ordnance Depot formerly known as the Weapons Depot. It is unknown whether the military and aerospace activities in this area are the source of perchlorate because the possibility remains that it could come from other sources or that it formed naturally.

Since 1990, the DEQ has been assessing nitrate contamination of groundwater in the area. In 2003, the U.S. Environmental Protection Agency (EPA) assisted DEQ in a broad groundwater sampling effort that analyzed for perchlorate as well as nitrate. Since then, EPA and DEQ have conducted several additional sampling efforts to test for both perchlorate and nitrate. The area where sampling efforts were focused can be seen in Figure 1. This area is referred to as the North Morrow Perchlorate Area. Most of this arid area is sparsely populated with most of the population density located in the towns of Boardman, Echo, Irrigon, Hermiston, Stanfield, and Umatilla.

During a DEQ sampling event in 2003, perchlorate was detected in over half of the one hundred thirty-three domestic, community, monitoring, and irrigation wells tested in the area at concentrations ranging from less than 1 to 24.9 parts per billion (ppb) [7 & 8]. One part per billion in water is equivalent to one microgram (one millionth of a gram) per liter ($\mu\text{g/L}$). Perchlorate was detected in 33 of the 98 domestic drinking water wells tested between 2003 and 2005 with an average concentration of 3.4 ppb (Table 1). The highest detection in a domestic well to date within the North Morrow Perchlorate Area is 13.4 ppb [7]. There was a single detection as high as 29.2 ppb but that was in a monitoring well not available for public use.

Figure 1. North Morrow Perchlorate Area – Demographics.

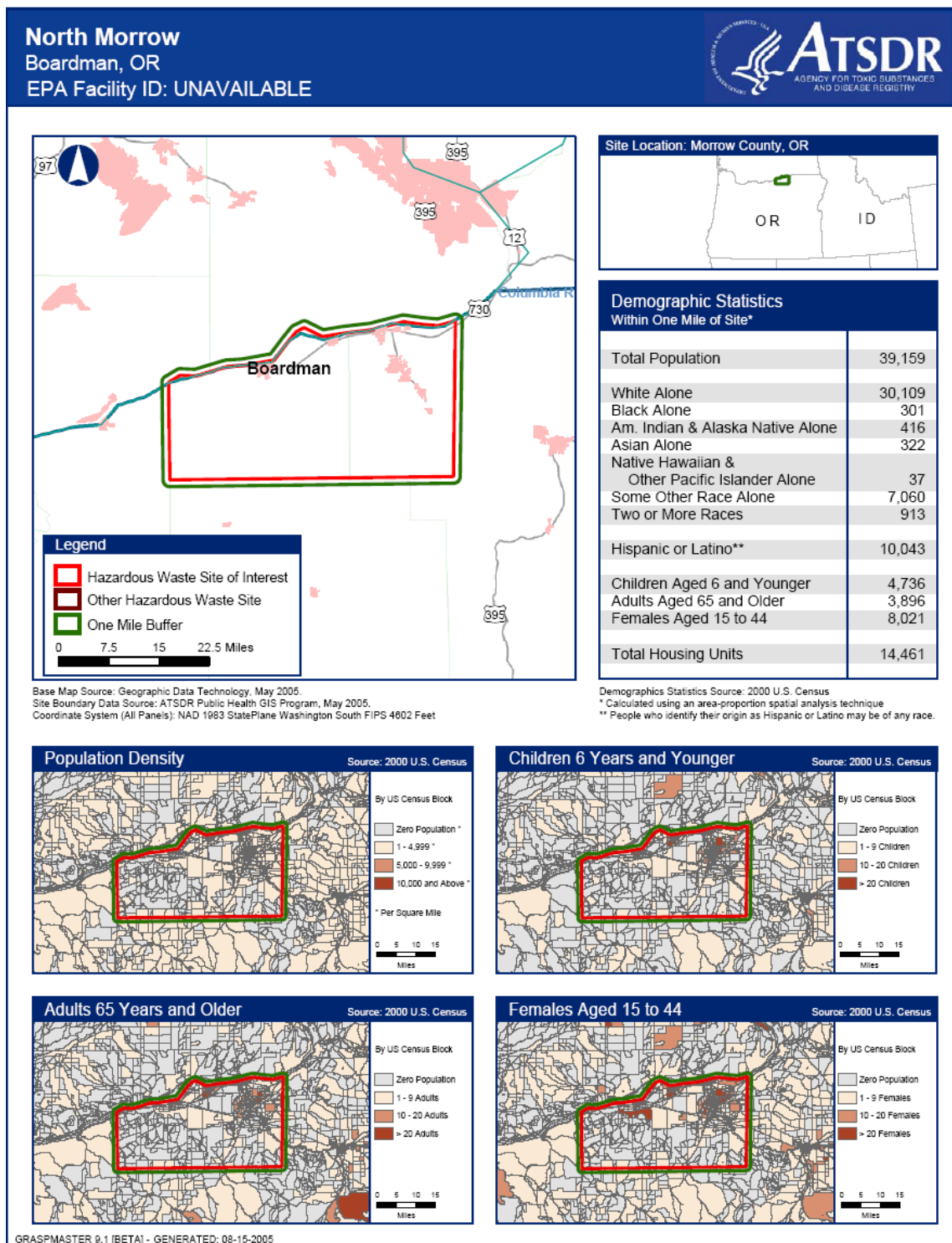


Table 1. Summary of groundwater sampling results in the North Morrow Perchlorate Area – 2003 to 2005.

Type of Well	Total Number of Wells Sampled	Number of Wells With Perchlorate Detections	Percent Of Wells With Detects	Average Concentration [ppb]	Minimum Concentration [ppb]	Maximum Concentration [ppb]
Irrigation – 2003 to 2005	26	11	42%	2.3	< 1	4.23
Domestic/Private – 2003 to 2005	98	33	34%	3.4	0.46	13.4
Community – 2003 to 2005	9	2	22%	2.8	< 1	4.5
Monitoring – 2003 to 2005	106	71	67%	7.5	< 1	29.2

Table 2. Accumulation of perchlorate in food and milk samples tested within the United States.

FOOD ITEMS	Minimum Concentration [ppb]	Average Concentration [ppb]	Maximum Concentration [ppb]	Bioconcentration Factor*	Study
Dairy Milk	0	2	11	-	Kirk et al., 2005
Breast Milk	1.4	10.5	92.2	-	Kirk et al., 2005
Alfalfa	-	-	-	380	Jackson et al., 2005
Tomato Fruit	-	-	-	1.6	Jackson et al., 2005
Cantaloupe Fruit	-	-	-	20	Jackson et al., 2005
Cucumber Fruit	-	-	-	5.7	Jackson et al., 2005
Green Leaf Lettuce	1.0	10.7	27.4	-	FDA, 2004
Iceberg Lettuce	Not Quantifiable	7.76	71.6	-	FDA, 2004
Red Leaf Lettuce	Not Quantifiable	11.6	52	-	FDA, 2004
Romaine Lettuce	Not Quantifiable	11.9	129	-	FDA, 2004

***Bioconcentration Factor** = ratio of plants fresh weight perchlorate concentrations to estimated or measured groundwater perchlorate concentrations

Exposure Assessment and Toxicological Evaluation

The most common route of human exposure to perchlorate is through ingestion of contaminated drinking water, produce, or milk (Table 2). There is evidence that perchlorate bioaccumulates in produce, especially leafy vegetables, when perchlorate contaminated water is used to irrigate crops [9, 10, 11]. Perchlorate has also been

detected in dairy milk and breast milk as a result of perchlorate ingestion by cows and pregnant women [12, 13].

Five elements of an exposure pathway were evaluated to determine whether people are being exposed to perchlorate from the contaminated wells. If all the criteria are met for the five elements, then the exposure pathway is ‘completed’. The five elements for a completed exposure pathway are listed below.

- *A contaminant source or release* – perchlorate was either released from military or other manufactured sources, released as hypochlorite, or formed naturally.
- *A way for the chemical to move through the environment to a place that contains the contaminant* – perchlorate moves easily from the surface, through the soil down into groundwater.
- *Exposure point or area* – contaminated domestic water wells.
- *Route of exposure or a way for the contaminant to reach a population* – consumption of contaminated drinking water alone or possibly in combination with contaminated produce and milk, use of water from a contaminated well for bathing or other household uses.
- *A population that comes in contact with the contaminant* – the residents who have contaminated wells and consume contaminated drinking water.

SHINE determined that there is a completed exposure pathway for ingestion of perchlorate-contaminated drinking water. The exposed population includes residents that have had perchlorate detected in their domestic water wells. A completed exposure pathway also exists for dermal exposure to groundwater through bathing or other household activities, however, it is unlikely that dermal absorption of perchlorate would pose a concern for human health and will not be considered in this consultation. Because perchlorate has a low vapor pressure, it is unlikely that people will breathe in dangerous levels of perchlorate so inhalation of the contaminant is not a completed exposure pathway and is not a concern.

There is also a potential pathway of exposure if milk and produce items available to consumers in Morrow and Umatilla Counties are contaminated with perchlorate. However, at this time there is a lack of data to determine if perchlorate is present in these items. Because of this data gap, SHINE is unable to determine whether there are completed pathways of exposure for other sources. Therefore, we are unable to evaluate the relative risk of exposure from each individual source, beyond drinking water, since the cumulative risk from all sources combined remains to be determined.

A. Perchlorate Health Effects & Toxicity

There are two main concerns surrounding the biological effects of perchlorate exposure: the inhibition of iodide (a form of iodine, I⁻) uptake into the thyroid, and a decline in thyroid hormone production as a result of iodide inhibition. There have been many studies looking at the health effects of low-level perchlorate exposure but few of them have shown a strong, direct association between exposure and adverse health outcomes

[1, 5]. The Government Accounting Office reported that of the 90 perchlorate exposure studies they reviewed, none considered the fetus of a pregnant woman who is “nearly iodine-deficient” [5]. Maternal perchlorate exposure can affect the development of an unborn child or a nursing infant, but there is a lack of information as to what level of exposure could cause harm.

A study conducted in Arizona found that perchlorate contamination was associated with abnormal thyroid function in newborns [15]. However, perchlorate in subject’s drinking water was not measured directly in this study, drawing criticism around the accuracy of the study. A study conducted in Chile evaluated the effect of perchlorate exposure on newborn’s and school-aged children’s thyroid function in an area where perchlorate levels in drinking water were as high as 120 ppb [16]. The thyroid function in those children was compared to thyroid function in Chilean children who consumed drinking water with perchlorate concentrations less than 4 ppb. Perchlorate was not found to adversely affect the thyroid function in the subjects, even those with perchlorate concentrations of 120 ppb in their drinking water. One explanation for this finding was that the Chilean subject’s iodine levels in urine were approximately four times higher than is found on average in the U.S. The high urinary levels indicate that their iodide intake was high and could have counteracted effects from perchlorate exposure [4].

It is unlikely that perchlorate causes thyroid cancer at a dose below that which causes a decline in thyroid hormone production [14]. Animal studies have shown that perchlorate does cause follicular cell tumors in the thyroid at very high doses similar to those that can result in an enlarged thyroid (goiter). Those doses are 1,000,000 times higher than the protective reference dose (the reference dose is defined below). The epidemiological evidence is not strong enough to confirm whether perchlorate causes thyroid cancer in humans at high doses.

B. Inhibition of Iodide

The inhibition of iodide uptake does not necessarily result in any known health effects and can be remedied by increased intake of iodine-rich foods such as seafood, dairy foods, breads or cereals, and iodized salt [17]. An epidemiological study that exposed healthy men and women to various doses of perchlorate determined that radioiodide uptake inhibition occurred at doses above 0.007 mg/kg/day [18]. However, this study has been criticized because the dose was based on an average of the group’s response rather than the actual level where individual subjects experienced zero response following perchlorate exposure [19]. The dose of 0.007 mg/kg/day corresponds to 245 ppb in water for a 70 kg adult who drinks 2 L of water per day if that adult’s only exposure to perchlorate is from ingestion of drinking water.

The thyroid hormones necessary for proper development in fetuses and infants are synthesized from iodide, and unlike adults, infants don’t have an excess store of iodide [4]. Therefore exposure to perchlorate has the potential to reduce iodide below the level required for proper development of fetuses and infants. Perchlorate has been shown to both migrate into breast milk and also cause a decrease of iodide levels in breast milk

[13]. Therefore, a fetus or nursing infant may be exposed to perchlorate from breast milk and simultaneously receive less iodide from the milk because of the presence of perchlorate. Infants and young children that do not nurse would be exposed to perchlorate through ingestion of contaminated water, dairy milk, or produce. They could also be exposed when drinking formula mixed with contaminated groundwater. Growing children may consume large amounts of milk, and this could be a very important source of their exposure.

C. Hypothyroidism

Thyroid hormones are important for metabolism in children and adults. Maintaining iodide and thyroid hormone levels is essential for proper physical and mental development in fetuses, infants, and young children [4, 5, 20, 21].

When iodide inhibition does persist and thyroid hormone levels become too low, a person may develop hypothyroidism. However, the inhibition of iodide uptake does not automatically mean that a healthy adult will develop hypothyroidism. This is because adults have mechanisms in place to help compensate for iodide deficiency to maintain healthy thyroid hormone levels [5].

Hypothyroidism is categorized into subclinical, overt, primary, or central hypothyroidism, which are based on health effects and severity of the condition [5]. Four to 8.5% of adults in the U.S. suffer from sub clinical hypothyroidism but show little or no sign of negative health effects. Subclinical hypothyroidism means that thyroid stimulating hormone (TSH) serum levels are high and serum T4 levels (a thyroid hormone referred to as thyroxine) are normal. Overt hypothyroidism is defined as high TSH serum levels and lowered serum T4 levels.

In adults, symptoms of hypothyroidism can include but are not limited to fatigue, altered metabolism, depression, weight gain, constipation, dry skin, and an enlarged thyroid (goiter). It has also been associated with unhealthy cholesterol levels, elevated blood pressure, impaired heart muscle contraction, and heart failure in people with existing heart disease [22]. Overt hypothyroidism is frequently treated with thyroid hormone medication. Doctors agree that pregnant and nursing women with subclinical hypothyroidism should be treated with thyroid hormone but there is a lack of agreement on how to treat other adults who have subclinical hypothyroidism.

Severe adverse developmental effects can result if fetuses or their mothers experienced significant iodide deficiency or hypothyroidism during pregnancy [5]. About 2.5% of pregnant women are diagnosed with sub clinical hypothyroidism in the U.S. [23]. Subclinical hypothyroidism in pregnant mothers has been linked to adverse effect on neurological development, mental retardation in infants [20], placental abruption, and preterm births [21]. Hypothyroidism in infants and fetuses has been associated with lowered IQ, abnormal cognitive function, an impaired gait, impaired fine motor skills, and abnormal vision, hearing, and speech [15, 24].

D. Safe Exposure Levels

Based on the recommendation from a National Research Council (NRC) report released in 2005, the EPA has revised their perchlorate oral reference dose (RfD) [2]. The RfD is the daily oral perchlorate dose determined to be protective of human health (including sensitive populations) for all routes of exposure. Doses are commonly used to evaluate how much of a substance is harmful to an individual. The current RfD for perchlorate is 0.0007 mg/kg/day (Table 3). Previously, the EPA recommended a provisional RfD range from 0.0001 to 0.0005 mg/kg/day.

An RfD is usually based on a dose that causes no toxic effect. The current perchlorate RfD was derived from the Greer et al. human study where healthy adults ingested various doses of perchlorate to determine the dose that results in no biological effects [18]. A biological effect is different from a health effect. A biological effect may or may not result in a health effect. The National Research Council chose to base the perchlorate RfD on the inhibition of iodide uptake because they said, “it is the event that precedes all thyroid-mediated effects of perchlorate exposure” [5].

The EPA added a safety factor of 10 to the RfD to provide added protection for sensitive populations. This means that the dose at which no effect was observed was divided by 10, which has the effect of reducing the acceptable daily dose to take into account that children may be more sensitive than adults (please see glossary in Appendix A). This information is summarized in Table 3.

Table 3. Summary of how the EPA derived the RfD (Reference Dose).

Safe Perchlorate Dose That Had No Health Effect (Greer et al, 2002)	Safety Factor – To Protect Sensitive Populations	EPA RfD for Perchlorate
0.007 mg/kg/day	10	0.0007 mg/kg/day

Currently, there is no national standard for maximum acceptable perchlorate levels in drinking water. The EPA RfD translates to a concentration of 24.5 ppb in drinking water. However, this calculation assumes that an adult is only exposed to perchlorate from drinking water. 24.5 ppb is slightly lower than the highest concentration of perchlorate detected in a monitoring well (29.2 ppb) tested in Morrow County. Although all of the drinking water concentrations in the limited number of wells tested are below the equivalent RfD in water, there is a strong possibility that residents are exposed to perchlorate from sources other than drinking water.

E. Issues Surrounding the Perchlorate Reference Dose

There has been much debate surrounding the perchlorate RfD of 0.0007 mg/kg/day that was set by the EPA in the spring of 2005. There is concern that the RfD is based on a study of healthy adults and does not adequately address the risks to fetuses, infants, children, and other sensitive populations [19]. The RfD does have a built-in uncertainty or safety factor that is designed to be protective of sensitive populations, but there are people in the scientific community who feel that the factor of 10 does not provide enough

protection. The National Research Council (NRC) defends their recommended RfD saying it is based on iodide inhibition, a biochemical event that is not an adverse health effect [5]. They believe that the recommended dose is protective of human health. Usually an RfD is based on a negative health effect rather than a biochemical event.

The old provisional RfD of 0.0001 – 0.0005 mg/kg/day was based on evidence from many studies that assessed the health effects of perchlorate exposure. The old RfD translated to 4 – 18 ppb in drinking water if a person is only exposed to perchlorate from ingestion of drinking water. So the new RfD is higher than the old one, and some concern has been expressed that it was raised following the NRC recommendation without consideration of normal review processes [4].

Sensitive Populations

Sensitive populations to perchlorate exposure are pregnant and nursing mothers, fetuses, infants, young children, and people who have a severe iodine deficiency or have developed hypothyroidism. Infants and children are often considered a sensitive population for exposure to environmental contaminants. They are at greater risk from exposure to environmental contaminants, including perchlorate, because their organ systems are not fully developed, and they consume more food on a per mass basis as compared with adults.

Other people who may also be sensitive to perchlorate exposure include those with autoimmune thyroiditis (a common thyroid condition), pre-existing iodide deficiency, or who have conditions that result in lower thyroid hormone production. This group would be exposed to perchlorate through similar sources as non-breastfeeding infants and children.

Discussion

At this time, SHINE is unable to evaluate the contribution of sources other than drinking water to residents in North Morrow Perchlorate Area. More data are needed in order to evaluate the population's cumulative risk of exposure in that area and to make a comparison to EPA's RfD of 0.0007 mg/kg/day. Additional data could also be compared to national data for perchlorate in drinking water, milk, and produce. When more data are available, SHINE will evaluate the human health risk on the side of caution in order to protect sensitive populations.

The following items need to be sampled in order to obtain data to evaluate the full risk to human health by perchlorate exposure in the North Morrow Perchlorate Area:

- Produce available to residents in the area, including both commodities potentially irrigated with perchlorate contaminated water grown in the area as well as commodities grown outside the North Morrow Perchlorate Area
- Dairy milk

Community Health Concerns

Perchlorate contamination in drinking water is an emerging issue in northern Morrow and northwestern Umatilla Counties. To bring the issue forward to the community, this public health consultation will be released for public comment. Overall, area residents that SHINE consulted with were unaware of the perchlorate contamination. Some community members have expressed that they feel that a drinking water concentration of 24.5 ppb is protective enough even if they are exposed to perchlorate from sources other than drinking water. An overarching community concern is the impact that perchlorate detections in water could have on agriculture and the local economy.

Community concerns have been documented in Iowa where residents were exposed to perchlorate-contaminated drinking water. Because of the presence of high levels, they were provided with bottled water. Members in the Iowa community expressed that they felt there was no safe level of perchlorate exposure. Others were concerned that their pets would be ingesting an unsafe level of perchlorate.

Conclusions

1. The North Morrow Perchlorate Area poses an *indeterminate public health hazard*. Although perchlorate concentrations in drinking water in the area have not been detected at levels of concern, there is not enough information about exposure contributions from sources other than groundwater. Once data from other sources are available the exposure of sensitive populations that currently have contaminated drinking water can be assessed.
2. The perchlorate anion has been detected in domestic groundwater and irrigation groundwater wells in the North Morrow Perchlorate Area at levels ranging from 0.46 ppb to 13.4 ppb with an average of 3.4 ppb in domestic wells. The highest perchlorate detection in the area was 29.2 ppb and was found in a monitoring well containing water that is not accessed by the public.
3. A completed exposure pathway exists for exposure to perchlorate from ingestion of contaminated drinking water.
4. Fetuses, infants, young children, pregnant and nursing mothers, and people with severe iodine deficiency or hypothyroidism are considered to be populations that are sensitive to perchlorate exposure.

Recommendations

1. SHINE recommends further collaboration with agencies to sample other potential sources of perchlorate exposure for residents in the North Morrow Perchlorate Area to fill the data gap. The data generated from this investigation should be compared to national data.
 - Test milk consumed by sensitive populations in the north Morrow area
 - Test produce available to sensitive populations potentially irrigated with perchlorate contaminated water
2. SHINE recommends that they assess human health risks associated with perchlorate exposure from all sources combined in collaboration with ATSDR. The estimated, cumulative exposure levels for residents in the North Morrow Perchlorate Area should be compared with the RfD.
3. SHINE recommends working with other public health professionals to prepare risk messages for residents in the North Morrow Perchlorate Area. These health messages must correspond to the health risks that sensitive populations in the area face from both individual sources and aggregate perchlorate exposure. If a health risk exists, the messages will include strategies that individuals can use to reduce the effects from exposure.
4. SHINE recommends that the EPA and DEQ continue working together to conduct further groundwater sampling to define the extent of perchlorate contamination in the North Morrow Perchlorate Area.

Public Health Action Plan

The Public Health Action Plan ensures that the public health consultation identifies public health risks along with providing a plan of action designed to reduce and prevent adverse health effects from exposure to hazardous substances in the environment. This plan includes a description of actions that will be taken by SHINE in collaboration with other agencies to pursue the implementation of the recommendations outlined in this document.

A. Past Actions

- SHINE reviewed existing groundwater sampling data collected by the DEQ and EPA in the North Morrow Perchlorate Area.
- SHINE attended the June 9th, 2005, inter-agency technical perchlorate meeting. The agencies and universities represented at the meeting were: ATSDR, EPA, Oregon Department of Agriculture (ODA), Oregon DEQ, Oregon DHS (SHINE program), and Oregon State University (OSU). The inter-agency group agreed that there is a need for the following actions:

- Gather information so the EPA can better assess the relative source contribution that will involve sampling sources of perchlorate exposure such as milk and produce.
 - Possibly prepare an aggregate risk assessment to better characterize the public health implications for the population in the perchlorate area.
 - Determination of the source of perchlorate contamination in the area.
 - Additional sampling to further characterize the perchlorate contamination.
- SHINE collaborated with Oregon DEQ and the EPA to develop a conceptual site model to determine routes of human exposure to perchlorate.

B. Ongoing Actions

- SHINE will continue to be involved with inter-agency activities for the North Morrow Perchlorate Area, primarily bi-weekly check-in calls to discuss sampling results, sample planning, issues surrounding the site, and any other updates.

C. Planned Actions

- SHINE plans to test dairy milk and local produce available to North Morrow Perchlorate Area residents for perchlorate. This will allow SHINE to better characterize the risks from exposure to the contaminant.
- SHINE will develop risk messages and a health education action plan to communicate results of sampling investigations.

Site Team

Oregon Department of Human Services Superfund Health Investigation & Education (SHINE) program team

Author of Report

Kathryn Toepel, MS
Public Health Toxicologist

SHINE Team

Jae Douglas, PhD
Epidemiologist

Julie Early, MS
Health Educator

Amanda Guay, MPH
Program Coordinator

Michael Heumann, MPH, MS
Environmental and Occupational Epidemiology Manager

Agency for Toxic Substances and Disease Registry

Ric Robinson, MPH
Regional Representative
ATSDR

Greg Ulirsch, MS
Senior Health Scientist and Technical Project Officer
ATSDR

Public Comment Release

This is an opportunity for the public to comment on SHINE's findings or proposed activities contained in this draft document. The public comment period for this document is from December 1, 2005, through January 31, 2006. Comments are requested and should be directed to:

SHINE
Oregon Department of Human Services, Health Services
800 NE Oregon #827
Portland, OR 97232

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APPENDIX A. ATSDR glossary of environmental health terms.

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR serves the public by using the best science to take responsive public health actions and provides trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption

For a person or animal, absorption is the process through which a substance enters the body through the eyes, skin, stomach, intestines, or lungs.

Acute

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

Acute exposure

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

Adverse health effect

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

Agranulocytosis

An acute disease marked by high fever and a sharp drop in circulating granular white blood cells.

Aplastic Anemia

A form of anemia in which the capacity of the bone marrow to generate red blood cells is defective and red blood cell production ceases.

Background level

An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biologic uptake

The transfer of substances from the environment to plants, animals, and humans.

Cancer

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

Cancer risk

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

Carcinogen

A substance that causes cancer.

CAS registry number

A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]**Chronic**

Occurring over a long time (more than 1 year) [compare with **acute**].

Chronic exposure

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

Completed exposure pathway [see **exposure pathway**].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

CERCLA, also known as **Superfund**, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

Concentration

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

Contaminant

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

Dermal

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

Dermal contact

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

Detection limit

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

Disease prevention

Measures used to prevent a disease or reduce its severity.

Disease registry

A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD

United States Department of Defense.

Dose (for chemicals that are not radioactive)

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

Dose-response relationship

The relationship between the amount of exposure [**dose**] to a substance and the resulting changes in body function or health (response).

Environmental media

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

Environmental media and transport mechanism

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

EPA

United States Environmental Protection Agency.

Epidemiologic surveillance

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

Epidemiology

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

Exposure

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

Exposure assessment

The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction

A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation

The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway

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

Groundwater

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

Hazard

A source of potential harm from past, current, or future exposures.

Hazardous waste

Potentially harmful substances that have been released or discarded into the environment.

Health consultation

A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health

consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with **public health assessment**].

Health education

Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation

The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to estimate the possible association between the occurrence and exposure to hazardous substances.

Health promotion

The process of enabling people to increase control over, and to improve, their health.

Indeterminate public health hazard

The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence

The number of new cases of disease in a defined population over a specific time period [contrast with **prevalence**].

Ingestion

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

Inhalation

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

Lowest-observed-adverse-effect level (LOAEL)

The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

mg/kg

Milligram per kilogram.

mg/cm²

Milligram per square centimeter (of a surface).

mg/m³

Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration

Moving from one location to another.

No apparent public health hazard

A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)

The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard

A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

Oxidation

The combination of a substance with oxygen or a reaction in which the atoms in an element lose electrons and the valence of the element is correspondingly increased.

Plume

A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure

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

Population

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

ppb

Parts per billion.

ppm

Parts per million.

Prevalence

The number of existing disease cases in a defined population during a specific period [contrast with **incidence**].

Prevalence survey

The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention

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

Public comment period

An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public availability session

An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public health action

A list of steps to protect public health.

Public health advisory

A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)

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

Public health hazard

A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or **radionuclides** that could result in harmful health effects.

Public health hazard categories

Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are **no public health hazard**, **no apparent public health hazard**, **indeterminate public health hazard**, **public health hazard**, and **urgent public health hazard**.

Public health statement

The first chapter of an ATSDR **toxicological profile**. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public meeting

A public forum with community members for communication about a site.

Reference dose (RfD)

An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry

A systematic collection of information on persons exposed to a specific substance or having specific diseases [see **exposure registry** and **disease registry**].

RFA

RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD

See **reference dose**.

Risk

The probability that something will cause injury or harm.

Risk reduction

Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication

The exchange of information to increase understanding of health risks.

Route of exposure

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

Safety factor [see **uncertainty factor]****Sample**

A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see **population**]. An environmental sample (for example, a

small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Source of contamination

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

Special populations

People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Substance

A chemical.

Superfund Amendments and Reauthorization Act (SARA)

In 1986, SARA amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water

Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].

Toxic agent

Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicology

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

Tumor

An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor

Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for

differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a **safety factor**].

Urgent public health hazard

A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)

Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other Glossaries and Dictionaries

Environmental Protection Agency - <http://www.epa.gov/OCEPAt/terms/>

National Center for Environmental Health (CDC) -

<http://www.cdc.gov/nceh/dls/report/glossary.htm>

National Library of Medicine (NIH) -

<http://www.nlm.nih.gov/medlineplus/mplusdictionary.html>