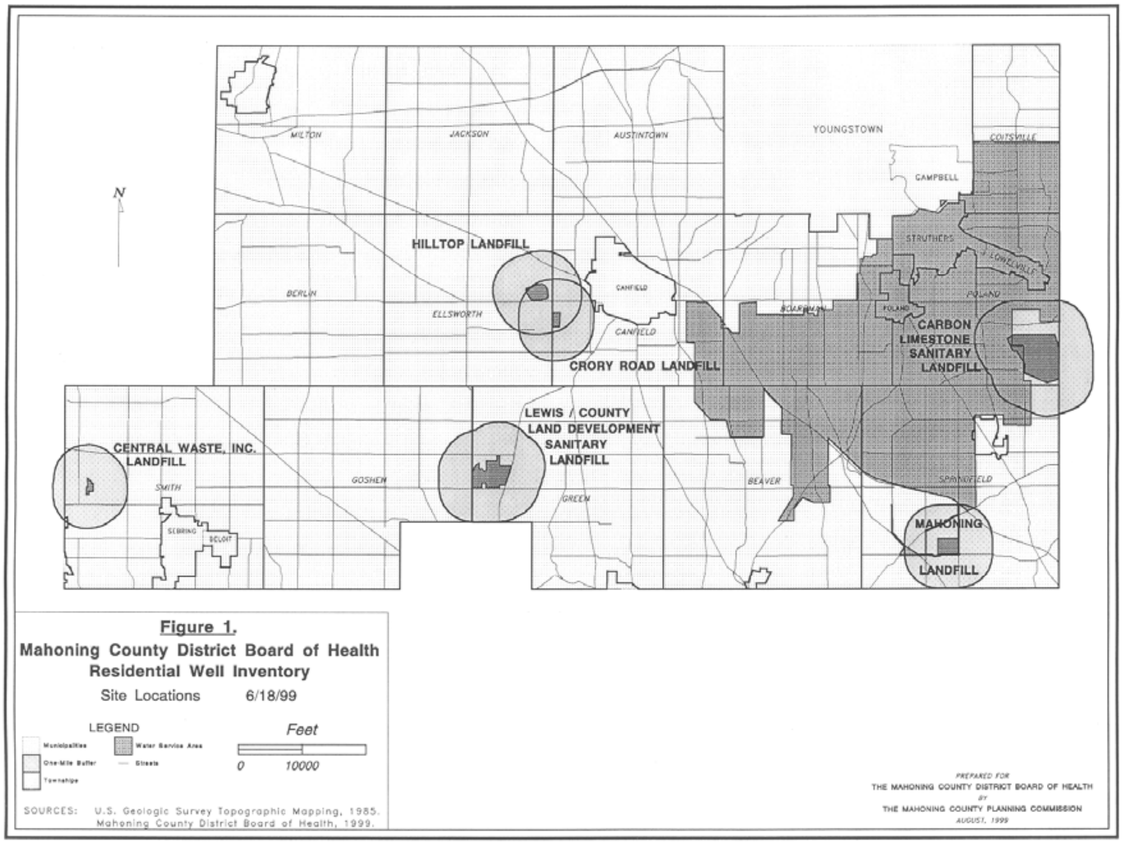
# Groundwater Surveillance
# In the Vicinity of Mahoning County Landfills, 2006-2008

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**A "NACCHO Model Practice"**
**National Association of County and City Health Officials**

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# Executive Summary

## BACKGROUND

- The District Board of Health collects water samples from private wells around the eight open and closed landfills in Mahoning County and analyzes these samples in its drinking water laboratory
- The testing program began at the request of landfill host community residents and has been funded through a consent agreement and contracts between the District Board of Health, Republic Services, Poland Township, and the Mahoning County Solid Waste Management District

## WHO PARTICIPATES

- As of July 2008, 192 homeowners whose wells represent 15% of the 1,315 wells within a one-mile radius of the eight landfills participated in the twice-yearly program.
- The District Board of Health continues to recruit new participants on a yearly basis.

## WHAT WE TEST FOR

- Water samples are analyzed for 28 different chemical and bacteriological constituents, which include heavy metals, volatile organic compounds, bacteria, and other chemicals that affect the taste and smell of drinking water
- Each participant receives a detailed report explaining the test results that enables the homeowner to compare current results with those from the last eight samples taken from the well

## WHAT THE TEST RESULTS MEAN

- The District Board of Health compares test results with water quality standards for public water supplies which have been adopted by regulatory or scientific agencies like the U.S. Environmental Protection Agency and World Health Organization
- Test results are also compared with results from hundreds of wells around the state sampled every year by the Ohio Environmental Protection Agency (EPA)
- Average levels of drinking water constituents in wells sampled during the years 2006-2008 for which comparable constituents are available from wells sampled by the Ohio EPA are similar to levels found in the 2008 statewide sample; iron levels in local wells are usually lower than levels in the statewide sample due to the frequent use of home water treatment devices. Wells sampled by the Ohio EPA are generally deeper than most residential wells and consequently, are more likely to be reduced; iron is more soluble in reduced conditions thus yielding higher levels than most residential wells.
- The increase in positive bacterial samples may be due to cracks in well casings. Cracks can occur with fluctuations in temperature during seasonal weather changes in the winter and spring. Expansion and contraction of the piping can cause cracks to occur in the well casing allowing surface water to enter the well.

## FUTURE IMPROVEMENTS

- Groundwater surveillance efforts will continue to focus on collection of raw water samples.
- The District Board of Health will strive to increase participation in order to perform time series analyses on individual wells with assistance from the Ohio EPA.

## Background

Each year more than a million tons of solid waste and construction and demolition debris are disposed of in Mahoning County landfills. In Ohio, health districts as agents of the state's Environmental Protection Agency are responsible for regulating the operation of these landfills. In addition to licensing and monitoring operations at Mahoning County landfills, the District Board of Health has conducted periodic testing of private water wells in the vicinity of the active and closed landfills since 1993. This groundwater surveillance program began at the request of families living in the vicinity of these landfills and is funded through an agreement between the District Board of Health, Republic Services, Poland Township, and Mahoning County's solid waste management district. In 2009 the Groundwater Monitoring Program earned the distinction of a "NACCHO Model Practice" awarded by the National Association of County and City Health Officials for innovative programs in public health. This report presents a description of this groundwater monitoring program and analysis of water quality data collected from private water wells during a recent three-year period.

## Types and locations of Mahoning County Landfills

Mahoning County is home to a variety of landfill disposal facilities. There are two types of landfill facilities located in the health district:

- solid waste sanitary landfill facilities which dispose of household trash, commercial waste, industrial processing waste, and municipal and industrial sludge and
- construction and demolition debris facilities which dispose of waste from the construction of homes and buildings and/or the destruction of man made structures.

During the 2006-2008 sampling period there were a total of eight landfill facilities: four closed and four active located throughout Mahoning County's fourteen townships (Table 1). In 2009 the County Land Development Construction and Demolition Debris Landfill closed. Therefore, currently there are five close landfills and three active landfills. The construction and demolition debris facility located in Green Township is unique because it is located on top of and adjacent to two closed sanitary landfills. It was permitted as an environmental improvement activity to remediate large scale ponding that had occurred during the post closure care inspection period.

Table 1
**MAHONING COUNTY LANDFILLS 2008**

| **Owner<br>Facility Name** | **Location** | **Operational Status** | **Classification of Waste** |
|---|---|---|---|
| Waste Management of Ohio, Inc.<br>**Mahoning Landfill, Inc.** | Springfield Township | Open | Solid Waste Landfill |
| Transload of America, Inc.<br>**Central Waste, Inc.** | Smith Township | Open | Solid Waste landfill |
| Browning Ferris Industries of Ohio, Inc.<br>**Carbon Limestone** | Poland Township | Open | Solid Waste Landfill |
| Browning Ferris Industries of Ohio, Inc.<br>**County Land Development Landfill** | Green Township | Open | Construction & Demolition Debris Landfill |
| Browning Ferris Industries of Ohio, Inc.<br>**County Land Development Landfill** | Green Township | Closed | Solid Waste Landfill |
| Browning Ferris Industries of Ohio, Inc.<br>**Lewis Landfill** | Green Township | Closed | Solid Waste Landfill |
| Toth & Company, Inc.<br>**Crory Road Landfill** | Canfield Township | Closed | Solid Waste Landfill |
| Toth & Company, Inc.<br>**Hilltop Landfill** | Ellsworth Township | Closed | Solid Waste Landfill |

## Groundwater Monitoring Participants

With funding from contractual agreements between Browning Ferris Industries of Ohio (now Republic Services), the Mahoning County Solid Waste Management District, and Poland Township Trustees, the Board of Health began to implement a groundwater monitoring program in 1993 for any resident who lived within a one mile radius of any landfill facility. Originally, all residents were contacted by mail and invited to voluntarily enter the groundwater testing program.

Today, the Board of Health continues to recruit participants through word of mouth referrals, telephone surveys, and personal contact with constituents. Interested residents are provided an explanation of:

- the history of the sampling program
- a sampling schedule, and
- the type of information they will receive about their drinking water.

Using the Mahoning County geographical information system (GIS) and the resources of the Youngstown State University, Center for Urban and Regional Studies, the Board of Health has mapped all wells serving residences located within the one mile radius. Figure 1 in the Appendix is an example of the maps created using GIS. It depicts the inventory of all wells within a one mile radius of the BFI Carbon Limestone Landfill in Poland Township.

In July 2007, the number of participants in the program stood at 174. One year later, 192 residents were participating in the program (Table 2). Participation has increased by an average of approximately 5% per year since its inception.

Table 2

**Drinking Water Well Inventory, 2008**

| SITE | Number of Wells Within One Mile | Number of Participant Wells Sampled Semi-annually | Percentage of Wells Sampled |
|---|---|---|---|
| Central Waste Inc | 158 | 20 | 13% |
| County Land Development | 208 | 30 | 14% |
| Toth (Hilltop and Crory Road) Landfills | 391 | 36 | 10% |
| Mahoning Landfill | 348 | 47 | 13% |
| Carbon Limestone Sanitary Landfill | 210 | 57 | 27% |
| **TOTALS** | 1315 | 192 | 15% |

## Sampling of Wells

Registered Sanitarians from the Board of Health Solid and Infectious Waste Program collect samples from the residents' homes using Ohio Environmental Protection Agency (EPA) standard sampling procedures. Sanitarians attempt to collect raw water samples from either inside the residence at the well storage tank or from an outside spigot that is not connected to a water treatment system. Testing raw water from a well is ideal since it is most reflective of the ground water quality for that area. Samples collected from treatment systems can give results that are skewed since softening agents add chemicals to the water. For example, home water ion exchange softeners add sodium to remove calcium and magnesium. The drinking water is collected in several water bottles of various sizes, preserved, and placed in ice chests for transportation to the District Board of Health Laboratory Services Division.


*Sanitarian Dave Fetchko collects a water sample from a resident's home*

### Laboratory Testing

The samples are then analyzed by Ohio EPA certified laboratory analysts over a period of approximately five weeks. All tests are performed using approved EPA methods along with testing procedures from *Standard Methods for the Examination of Water and Wastewater, 21st Edition, 2005*.

The water samples are analyzed for 28 different chemical and bacteriological parameters which include: heavy metals, volatile organic compounds, bacteriological coliform organisms, and various other chemicals that may alter the aesthetic quality to the water. These parameters are part of the Ohio EPA primary and secondary drinking water standards. ***Primary*** drinking water standards are those parameters that may affect human health. ***Secondary*** standards are those parameters that may impact the supply from an *aesthetic* point of view. These include taste, color, or odor. Examples of aesthetic effects that can impact use of the water in a home include iron and manganese that causes staining on toilets, sinks, and white clothes. Other non-regulated contaminants such as calcium and magnesium contribute to hardness and increase soap usage; sulfur causes a rotten egg odor.


*Laboratory technician Janine Soubra prepares samples under a fume hood*

**Report to Homeowners**

Homeowners receive several reports once sample analysis is completed and tests results are finalized, that include:

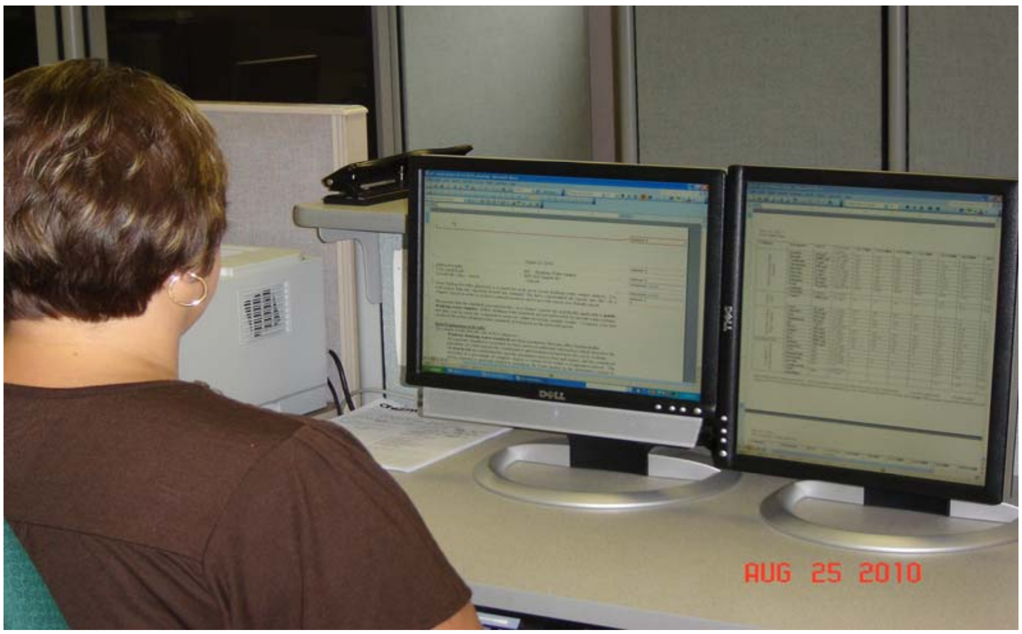
- a brief explanation of the chemical and bacteriological parameters tested
- a letter explaining public drinking water standards and how to compare their test results to those standards
- a table indicating which parameters exceed standards
- "At A Glance" tables that compare the test results over several sampling periods that enables the homeowner to easily identify trends in their individual drinking water quality
- supplemental information about specific parameters and treatment systems

The reports and supplemental information are valuable to homeowners because the material can help the homeowner assess their well quality and determine steps to improve their drinking water. For example, those homeowners whose bacteriological test indicates that total coliform bacteria are present in their well water are given information explaining what total coliform bacteria are, where they are found in nature and the hazards of having coliforms, such as *Escherichia coli*, in their water. Also, instructions on how to disinfect the well are included along with information on how to re-sample the well once disinfection has taken place. Homeowners are encouraged to re-sample after disinfection to assure the chlorination process eliminated the bacteria.

Another example of the importance of providing this information is when chemical parameters such as nitrate exceed primary drinking water standards. This chemical parameter can be very harmful to infants; therefore it is critical that homeowners know the health effects of elevated nitrate levels in their water. The homeowner is given a fact sheet on nitrate and information on “blue baby syndrome” which is caused by elevated nitrate levels. The fact sheets also include possible reasons for the elevated level along with information on treatment systems that are able to reduce nitrate levels.

Treatment system options and fact sheets are provided for all reports that show parameters exceeding primary and secondary standards. Homeowners are encouraged to read the information and to contact the laboratory if they need help in interpreting their test results.  Each year several individuals contact the lab for assistance in improving the quality of their water.

The Appendix includes a sample of a homeowner report.




*Secretary Julie Thompson prepares water test reports for homeowners participating in the groundwater surveillance program*

**Evaluating Test Results**

Since there are no regulations that pertain to existing private drinking water systems in Ohio, the Board of Health uses standards set forth by the Ohio Department of Health (ODH) Private Water System Program and the United States EPA Public Drinking Water Standards as guidelines to evaluate drinking water quality. There are four main guidelines used to assess private drinking water system quality: **Maximum Contaminant Levels (MCL), Secondary Maximum Contaminant Levels (SMCL), Action Levels**, and a series of **Recommended Levels**.

*Maximum Contaminant Levels* are established for chemicals that could potentially pose a serious risk to human health. A MCL is the maximum concentration of a particular chemical that is allowed to be present in a public drinking water system. These levels are established by the federal EPA and are enforceable.  Public drinking water supplies must not exceed the MCLs over the compliance periods. *SMCLs* are not enforceable and are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color and odor. These contaminants are not considered to present a risk to human health at the SMCL concentrations.

*Action Levels* are established for lead and copper and are considered exceeded if more than 10 percent of the tap samples exceed the action level in the compliance period. The action required is generally related to managing the water quality in the distribution system to reduce corrosion of lead solder and copper pipes.

*Recommended levels* are those levels at which a particular agency has determined that levels above this may cause some type of health risk. Recommended levels are only suggested levels and are not enforceable standards. Recommended levels are not always established by the U.S. Environmental Protection Agency. Other organizations such as the American Heart Association and World Health Organization recommend certain limits in order to avoid a potential increase in risk to an individual's health. For example, a limit of 20 mg/L of sodium is recommended for individuals restricted to a total sodium intake of 500 mg/day, whereas the World Health Organization has established a drinking water limit of 200 mg/L for individuals without dietary sodium restrictions.

The standards discussed above only pertain to public drinking water systems. However, the Board of Health considers these standards a good scientific basis upon which to evaluate and interpret test results from individual drinking water systems that are sampled through the groundwater monitoring program. More information concerning private drinking water can be obtained from "Water Tests: What do the Numbers Mean" published by the Pennsylvania State University and included in the Appendix. This booklet provides helpful information as to how to interpret test results and whether elevated levels are of a concern.

*Laboratory assistant Ralph Widger decanting samples prior to analysis*

**Data Analysis**

Once a sampling event is completed the data from all wells in the vicinity of each landfill are compiled and analyzed. The data are aggregated into a table that compares all sample results to Maximum Contaminant Levels, Secondary Maximum Contaminant Levels, Action Levels, or Recommended Levels for public drinking water systems. Using this table the reader is able to determine the percentage of parameters that exceed these concentrations.

Tables 1 through 5 in the Appendix present a comparative analysis of the water samples collected over a three year sampling period and include the average, median, high, and low values for wells sampled around individual landfills. The average values can be compared to values in the adjacent columns for "Average Ambient Ground Water Quality in Ohio." This information indicates the average concentration of a chemical parameter as compared to the type of aquifer and can be used as a benchmark for ground water quality in Ohio. From information obtained from Ohio EPA hydrogeologists, wells in Mahoning County are more likely to draw groundwater from sand and gravel aquifers. If the type of aquifer is known the homeowner can compare averages of chemical parameters from their well to those compiled by the OEPA to determine if water quality in Mahoning County differs from wells throughout the state. Homeowners can search for their well logs, which contain information about their wells, on the Ohio Department of Natural Resources, Division of water web page:

http://www.dnr.state.oh.us/water/maptechs/wellogs/appNEW/

Comparing groundwater quality data between wells can be confusing because groundwater quality is influenced by the unique differences in aquifer material and the geochemical conditions of the groundwater. Consequently, this natural variability results in different water quality in adjacent wells. For example, Tables 3-7 indicate that iron varies from non-detect to highly elevated levels. Reduced wells (wells with low dissolved oxygen) exhibit a geochemical condition in which iron in the aquifer material is easily dissolved into groundwater. Oxidized wells (wells with dissolved oxygen in the water) exhibit geochemical conditions in which the iron in the aquifer material is not readily dissolved into the groundwater. This geochemical difference results in significant water quality differences in dissolved iron concentration, even in wells close to one another. The oxidized well is typically shallower with more recent exchange with rainfall or other recharge events, whereas, the reduced well is generally deeper and isolated from the oxygen rich atmosphere. Elevated arsenic concentrations (greater than 10 ppb) are not uncommon in reduced groundwater since arsenic behaves like iron and is more soluble in reduced groundwater environments.

In addition to the natural variation in ground water quality, surface land use generates contaminants that may migrate to the well adding additional complications to interpreting the variability of groundwater quality. For example, nitrate concentrations above 2 mg/L are usually influenced by human activities such as fertilizer or manure application and septic system discharge to groundwater. Nitrate concentrations detected above the maximum contaminant limit (MCL), 10 mg/L, is a potential health concern.

Overall for the five sampling areas it is the Secondary Maximum Contaminant (SMCL) and Recommended Levels that exceed public drinking water standards by the most significant percentage. After reviewing these data, we suspect that the elevated sodium levels (with low chloride levels) may be a result of water softening systems used in some homes. It is possible that the elevated sulfates are part of naturally occurring minerals in soil or rock or the presence of sulfur reducing bacteria. Ground water interacts with the aquifer material that it flows through, and dissolves stable minerals resulting in increased dissolved solids in the ground water. This process continues over time, so ground water held within the aquifer longer tends to exhibit higher concentrations of total dissolved solids. Thus, it is not uncommon for natural ground water to exhibit elevated total dissolved solids or other relatively soluble parameters. This process can lead to concentrations that exceed the arsenic MCL and SMCLs for total dissolved solids, iron, manganese, and sulfate.

Elevated iron and manganese levels are likely to be related to the fact that many of the sampled wells are producing water from reduced (low dissolved oxygen) aquifers which results in dissolution of naturally occurring iron and manganese minerals within the aquifer system.

It must be noted that the "limits of detection" for the District Board of Health laboratory differ from the Ohio EPA laboratory for a number of chemicals. A limit of detection is how low an instrument can accurately detect a specific chemical. Therefore, when a non-detect (ND) is calculated into an average the actual limit of detection is used as the test result, not a zero. If the Board of Health limit of detection is higher than the EPA limit of detection the averages for that specific parameter can be higher depending on number of samples that are non-detect. This explains why some District Board of Health laboratory chemical parameter averages are higher than those given by the EPA.

## Future Improvements

In order to compare samples taken from participants in the Ground Water Monitoring Program with Ambient Ground Water Quality Data from Ohio EPA it is essential that we obtain raw water samples. Samples taken from wells that contain water softening systems may give results that are not indicative of actual ground water quality. Therefore, we continue to work with our participants to identify sample taps that are not on a water treatment system. We expect levels in certain parameters, such as sodium, to decrease once all samples are taken from raw water sources.

It is our desire to provide the homeowner with test results that will help them to identify any trends or abnormalities in their drinking water. The “At a Glance” report that shows the last eight sampling events along with the chart indicating which parameters exceed standards makes it easier for the homeowner to review their test results and identify any systematic changes or trends in their ground water quality in chronological order (see Appendix). This format allows the determination of obvious trends in individual wells and provides a simpler analysis than comparison of ground water quality data between different wells. We continue to recruit participants in the program and wish to make the program as useful as possible to the homeowner.

We continue to encourage and solicit participation in the program so that as the number of participants increases more data will be obtained. We are striving to gather enough data to perform a time series analysis on each well similar to those performed on the sentinel wells throughout Ohio. This will allow us to monitor changes over time in both individual wells and wells in the entire sampling area.

As a NACCHO Model Practice, the Groundwater Monitoring Program in Mahoning County continues to benefit the community along with those individuals participating in the program. The data collected is being used not only to determine if area landfills are affecting groundwater quality, but also to compare groundwater quality in Mahoning County with water quality throughout the state of Ohio.

## Acknowledgements

*We wish to thank Christopher Kenah, Eric Adams and other staff of the Division of Drinking and Ground Waters at the Ohio Environmental Protection Agency for their assistance in supplying the ambient water quality data and reviewing this report; Board of Health member Len Perry for providing comments on the report; and Republic Services, Inc, and the Mahoning County Solid Waste Management District (Green Team) for providing funding support for the Groundwater Monitoring Program. We also wish to thank Matthew Stefanak, Health Commissioner, General Health District in Mahoning County for his part in developing the groundwater monitoring program.*

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**Appendix**

**Table 1**

## Groundwater Monitoring Results, 2006-2008, in Private Wells around Carbon-Limestone Landfill

214 Sampling Events

| | *# Samples* | *MCL/SMCL** | *%>MCL* | *Average* | *Median* | *Range* *Low* | *Range* *High* | District Board of Health Lab Detection Limit |
|---|---|---|---|---|---|---|---|---|
| Parameters with Maximum Contaminant Levels | | | | | | | | |
| bacteria | 258 | negative | 25.2% | | | | | |
| arsenic | 216 | 10 ug/L | 0.0% | 5.0 | 5.0 | 5.0 | 8.3 | 5.0 ug/L |
| barium | 258 | 2000 ug/L | 0.0% | 130.98 | 100.0 | 100 | 440.7 | 100 ug/L |
| cadmium | 258 | 5 ug/L | *** | 10 | 10 | 10 | 10 | 10 ug/L |
| chromium | 258 | 100 ug/L | 0.0% | 20 | 20 | 20 | 20 | 20 ug/L |
| fluoride | 258 | 4 mg/L | 0.0% | 0.370 | 0.228 | 0.025 | 0.020 | 0.020 mg/L |
| mercury | 258 | 2 ug/L | 0.0% | 0.2 | 0.2 | 0.2 | 0.2 | 0.20 ug/l |
| nitrate | 257 | 10 mg/L | 0.4% | 0.91 | 0.50 | 0.50 | 9.32 | 0.050 mg/L |
| selenium | 216 | 50 ug/L | 0.0% | 2 | 2 | 2 | 2 | 2.0 ug/L |
| Parameters with Secondary Maximum Contaminant Levels | | | | | | | | |
| chloride | 258 | 250 mg/L | 2.3% | 44.9 | 27.0 | 1.0 | 400.0 | 1.0 mg/L |
| dissolved solids | 258 | 500 mg/L | 32.6% | 502 | 434 | 43 | 1736 | 1.0 mg/L |
| iron | 258 | 300 ug/L | 22.5% | 457.4 | 50.0 | 50 | 14436.0 | 50 ug/L |
| manganese | 258 | 50 ug/L | 36.8% | 78.6 | 15.0 | 10 | 547.3 | 10 ug/L |
| pH | 258 | 7.0-10.5 | 0.0% | 7.58 | 7.45 | 6.44 | 9.34 | 0 pH units |
| silver | 258 | 100 ug/L | 0.0% | 10 | 10 | 10 | 10 | 10 ug/L |
| sulfate | 258 | 250 mg/L | 7.4% | 141.99 | 117.86 | 21.81 | 473.34 | 1.0 mg/L |
| zinc | 258 | 5000 ug/L | 0.0% | 29.5 | 10.0 | 10 | 1039.0 | 10 ug/L |
| Parameters with Action Levels | | | | | | | | |
| copper | 258 | 1300 ug/L | 0.0% | 18.7 | 10.0 | 10 | 472.4 | 10 ug/L |
| lead | 216 | 15 ug/L | 0.0% | 5.22 | 5.00 | 5.00 | 9.70 | 5.0 ug/L |
| Parameters with Recommended Levels | | | | | | | | |
| sodium | 258 | 200 mg/L | 4.7% | 71.7 | 35.4 | 4.0 | 411.0 | 0.10 mg/L |
| Parameters without Standards | | | | | | | | |
| alkalinity | 258 | | | 321 | 280 | 280 | 270 | 1 mg/L |
| ammonia | 258 | | | 0.098 | 0.020 | 0.020 | 1.000 | 0.02 mg/L |
| conductivity | 258 | | | 750 | 646 | 64 | 2630 | 1.0 umhos/cm |
| chemical oxygen demand | 258 | | | 10.41 | 10.00 | 10.00 | 43.24 | 10 mg/L |
| magnesium | 258 | | | 11.2 | 10.9 | 0.1 | 40.9 | 0.10 mg/L |
| potassium | 258 | | | 1.6 | 1.4 | 0.1 | 6.2 | 0.10 mg/L |
| turbidity | 258 | | | 3.67 | 0.44 | 0.10 | 234.00 | 0.10 NTU |

***Average Ambient Ground Water Quality in Ohio*****

| | Sand and Gravel Aquifers | Sandstone Aquifers | Ohio EPA Lab Detection Limit |
|---|---|---|---|
| arsenic | 5.69 | 3.06 | 2 ug/L |
| barium | 173 | 162 | 15 ug/L |
| cadmium | 0.21 | 0.23 | 0.2 ug/L |
| chromium | 30.0 | 29.9 | 30 ug/L |
| fluoride | 0.40 | 0.31 | 0.10 mg/L |
| nitrate | 0.75 | 0.36 | 0.10 mg/L |
| selenium | 2.02 | 2 | 2 ug/L |
| chloride | 40.1 | 40.7 | 5 mg/L |
| dissolved solids | 466 | 429 | 10 mg/L |
| iron | 1392 | 1589 | 50 ug/L |
| manganese | 225 | 202 | 10 ug/L |
| pH | 7.31 | 7.26 | ±0.01 S.U. |
| sulfate | 80.1 | 84.3 | 5 mg/L |
| zinc | 32.7 | 31.3 | 10 ug/L |
| copper | 12.5 | 13.7 | 10 ug/L |
| lead | 3.69 | 2.78 | 2 ug/L |
| sodium | 26.1 | 63.4 | 5 mg/L |
| alkalinity | 260 | 216 | 5 mg/L |
| ammonia | 0.24 | 0.37 | 0.05 mg/L |
| conductivity | 662 | 649 | ±1% |
| COD | 11.3 | 10.9 | 10 mg/L |
| magnesium | 28.7 | 19.1 | 1 mg/L |
| potassium | 2.45 | 2.46 | 2 mg/L |

* *Maximum Contaminant Level or Secondary Maximum Contaminant Level*

*mg/L = milligrams per liter or parts per million (ppm); ug/L - micrograms per liter or parts per billion (ppb); 1mg = 1000 ug*

** *comparison data from the Ohio Environmental Protection Agency 2008 305(b) Report on Ohio's Ground Water Quality, http://www.epa.ohio.gov/portals/28/documents/gwqcp/gw_parameters.p*

*** Due to the MCL being lower than MCDBOH detection limits, a percentage >MCL cannot be reported for this parameter.

## Table 2

# Groundwater Monitoring Results, 2006-2008, in Private Wells around Toth Landfills

214 Sampling Events

| | *# Samples* | *MCL/SMCL** | *%>MCL* | *Average* | *Median* | *Range Low* | *Range High* | District Board of Health Lab Detection Limit |
|---|---|---|---|---|---|---|---|---|
| <u>Parameters with Maximum Contaminant Levels</u> | | | | | | | | |
| bacteria | 214 | negative | 18.2% | | | | | |
| arsenic | 148 | 10 ug/L | 0.7% | 5.2 | 5.0 | 5.0 | 25.2 | 5.0 ug/L |
| barium | 214 | 2000 ug/L | 0.0% | 94.9 | 100.0 | 3.8 | 192 | 100 ug/L |
| cadmium | 214 | 5 ug/L | *** | 10 | 10 | 10 | 10 | 10 ug/L |
| chromium | 214 | 100 ug/L | 0.0% | 20.1 | 20.0 | 14.6 | 37.0 | 20 ug/L |
| fluoride | 214 | 4 mg/L | 0.0% | 0.702 | 0.328 | 0.020 | 2.400 | 0.020 mg/L |
| mercury | 214 | 2 ug/L | 0.0% | 0.2 | 0.2 | 0.2 | 0.2 | 0.20 ug/l |
| nitrate | 214 | 10 mg/L | 2.8% | 0.99 | 0.35 | 0.05 | 29.90 | 0.050 mg/L |
| selenium | 148 | 50 ug/L | 0.0% | 2 | 2 | 2 | 2 | 2.0 ug/L |
| <u>Parameters with Secondary Maximum Contaminant Levels</u> | | | | | | | | |
| chloride | 214 | 250 mg/L | 7.5% | 58.4 | 21.5 | 1.5 | 570.0 | 1.0 mg/L |
| dissolved solids | 214 | 500 mg/L | 77.6% | 773 | 680 | 314 | 2300 | 1.0 mg/L |
| iron | 214 | 300 ug/L | 38.3% | 1130.1 | 50.0 | 47.5 | 33495.0 | 50 ug/L |
| manganese | 214 | 50 ug/L | 30.4% | 206.3 | 17.2 | 6.8 | 3313.0 | 10 ug/L |
| pH | 214 | 7.0-10.5 | 15.0% | 7.57 | 7.51 | 6.29 | 8.82 | 0 pH units |
| silver | 214 | 100 ug/L | 0.0% | 10 | 10 | 10 | 10 | 10 ug/L |
| sulfate | 214 | 250 mg/L | 48.6% | 314.76 | 247.78 | 72.85 | 1184.99 | 1.0 mg/L |
| zinc | 214 | 5000 ug/L | 0.0% | 29.8 | 10.0 | 10.0 | 272.6 | 10 ug/L |
| <u>Parameters with Action Levels</u> | | | | | | | | |
| copper | 214 | 1300 ug/L | 0.5% | 292.3 | 10.9 | 2.6 | 45634.0 | 10 ug/L |
| lead | 148 | 15 ug/L | 0.0% | 5.10 | 5.00 | 5 | 11.00 | 5.0 ug/L |
| <u>Parameters with Recommended Levels</u> | | | | | | | | |
| sodium | 214 | 200 mg/L | 18.7% | 119.3 | 86.2 | 7.4 | 660.0 | 0.10 mg/L |
| <u>Parameters without Standards</u> | | | | | | | | |
| alkalinity | 214 | | | 417 | 400 | 110 | 820 | 1 mg/L |
| ammonia | 213 | | | 0.2795 | 0.0328 | 0.0200 | 2.2800 | 0.02 mg/L |
| conductivity | 214 | | | 1145 | 994 | 471 | 3110 | 1.0 umhos/cm |
| chemical oxygen demand | 214 | | | 12.14 | 10.00 | 1.79 | 98.86 | 10 mg/L |
| magnesium | 214 | | | 21.4 | 15.2 | 0.1 | 157.0 | 0.10 mg/L |
| potassium | 214 | | | 3.40 | 3.00 | 0.1 | 12.7 | 0.10 mg/L |
| turbidity | 214 | | | 7.53 | 1.17 | 0.10 | 74.60 | 0.10 NTU |

***Average Ambient Ground Water Quality in Ohio****

| | Sand and Gravel Aquifers | Sandstone Aquifers | Ohio EPA Lab Detection Limit |
|---|---|---|---|
| arsenic | 5.69 | 3.06 | 2 ug/L |
| barium | 173 | 162 | 15 ug/L |
| cadmium | 0.21 | 0.23 | 0.2 ug/L |
| chromium | 30.0 | 29.9 | 30 ug/L |
| fluoride | 0.40 | 0.31 | 0.10 mg/L |
| nitrate | 0.75 | 0.36 | 0.10 mg/L |
| selenium | 2.02 | 2 | 2 ug/L |
| chloride | 40.1 | 40.7 | 5 mg/L |
| dissolved solids | 466 | 429 | 10 mg/L |
| iron | 1392 | 1589 | 50 ug/L |
| manganese | 225 | 202 | 10 ug/L |
| pH | 7.31 | 7.26 | ±0.01 S.U. |
| sulfate | 80.1 | 84.3 | 5 mg/L |
| zinc | 32.7 | 31.3 | 10 ug/L |
| copper | 12.5 | 13.7 | 10 ug/L |
| lead | 3.69 | 2.78 | 2 ug/L |
| sodium | 26.1 | 63.4 | 5 mg/L |
| alkalinity | 260 | 216 | 5 mg/L |
| ammonia | 0.24 | 0.37 | 0.05 mg/L |
| conductivity | 662 | 649 | ±1% |
| COD | 11.3 | 10.9 | 10 mg/L |
| magnesium | 28.7 | 19.1 | 1 mg/L |
| potassium | 2.45 | 2.46 | 2 mg/L |

* *Maximum Contaminant Level or Secondary Maximum Contaminant Level*

*mg/L = milligrams per liter or parts per million (ppm); ug/L - micrograms per liter or parts per billion (ppb); 1mg = 1000 ug*

** *comparison data from the Ohio Environmental Protection Agency 2008 305(b) Report on Ohio's Ground Water Quality, http://www.epa.ohio.gov/portals/28/documents/gwqcp/gw_parameters.pdf*

*** Due to the MCL being lower than MCDBOH detection limits, a percentage >MCL cannot be reported for this parameter.

# Table 3

## Groundwater Monitoring Results, 2006-2008, in Private Wells around Central Waste Landfill

96 Sampling Events

| | *# Samples* | *MCL/SMCL** | *%>MCL* | *Average* | *Median* | *Range* | | District Board of Health Lab |
|---|---|---|---|---|---|---|---|---|
| Parameters with Maximum Contaminant Levels | | | | | | *Low* | *High* | Detection Limit |
| bacteria | 99 | negative | 29.5% | | | | | |
| arsenic | 59 | 10 ug/L | 1.7% | 5.4 | 5.0 | 5.0 | 5.0 | 5.0 ug/L |
| barium | 99 | 2000 ug/L | 0.0% | 151.3 | 100.0 | 100.0 | 1176.0 | 100 ug/L |
| cadmium | 99 | 5 ug/L | *** | 10.00 | 10.00 | 10.00 | 10.00 | 10 ug/L |
| chromium | 99 | 100 ug/L | 0.0% | 20.1 | 20.0 | 20.0 | 30.0 | 20 ug/L |
| fluoride | 98 | 4 mg/L | 0.0% | 0.740 | 0.429 | 0.023 | 2.580 | 0.020 mg/L |
| mercury | 99 | 2 ug/L | 1.0% | 0.20 | 0.20 | 0.20 | 0.21 | 0.20 ug/l |
| nitrate | 97 | 10 mg/L | 0.0% | 0.54 | 0.50 | 0.50 | 2.10 | 0.050 mg/L |
| selenium | 59 | 50 ug/L | 0.0% | 2.00 | 2.00 | 2.00 | 2.00 | 2.0 ug/L |
| Parameters with Secondary Maximum Contaminant Levels | | | | | | | | |
| chloride | 99 | 250 mg/L | 1.0% | 26.1 | 11.0 | 4.0 | 450.0 | 1.0 mg/L |
| dissolved solids | 99 | 500 mg/L | 94.9% | 946 | 879 | 465 | 1504 | 1.0 mg/L |
| iron | 99 | 32.1 | 54.5% | 1234.4 | 420.0 | 50.0 | 7665.0 | 50 ug/L |
| manganese | 99 | 50 ug/L | 17.2% | 45.9 | 17.6 | 10.0 | 64.0 | 10 ug/L |
| pH | 99 | 7.0-10.5 | 6.1% | 7.79 | 7.83 | 6.89 | 8.92 | 0 pH units |
| silver | 99 | 100 ug/L | 0.0% | 10.00 | 10.00 | 10.00 | 10.00 | 10 ug/L |
| sulfate | 99 | 250 mg/L | 83.8% | 456.31 | 412.03 | 147.76 | 1173.47 | 1.0 mg/L |
| zinc | 99 | 5000 ug/L | 0.0% | 23.0 | 10.0 | 10.0 | 94.6 | 10 ug/L |
| Parameters with Action Levels | | | | | | | | |
| copper | 99 | 1300 ug/L | 0.0% | 39.9 | 10.0 | 10.0 | 938.5 | 10 ug/L |
| lead | | 15 ug/L | 0.0% | 5.03 | 5.00 | 5.00 | 7.00 | 5.0 ug/L |
| Parameters with Recommended Levels | | | | | | | | |
| sodium | 99 | 200 mg/L | 43.4% | 193.3 | 184.0 | 22.9 | 525.0 | 0.10 mg/L |
| Parameters without Standards | | | | | | | | |
| alkalinity | 96 | | | 609 | 515 | 270 | 1890 | 1 mg/L |
| ammonia | 96 | | | 0.8484 | 0.7100 | 0.0200 | 3.5600 | 0.02 mg/L |
| conductivity | 99 | | | 1470 | 1316 | 700 | 2850 | 1.0 umhos/cm |
| chemical oxygen demand | 99 | | | 10.70 | 10.00 | 10.00 | 37.90 | 10 mg/L |
| magnesium | 99 | | | 23.1 | 8.6 | 0.1 | 85.0 | 0.10 mg/L |
| potassium | 99 | | | 4.2 | 3.5 | 0.1 | 12.3 | 0.10 mg/L |
| turbidity | 98 | | | 12.92 | 2.53 | 0.11 | 91.20 | 0.10 NTU |

***Average Ambient Ground Water Quality in Ohio****

| | Sand and Gravel Aquifers | Sandstone Aquifers | Ohio EPA Lab Detection Limit |
|---|---|---|---|
| arsenic | 5.69 | 3.06 | 2 ug/L |
| barium | 173 | 162 | 15 ug/L |
| cadmium | 0.21 | 0.23 | 0.2 ug/L |
| chromium | 30.0 | 29.9 | 30 ug/L |
| fluoride | 0.40 | 0.31 | 0.10 mg/L |
| nitrate | 0.75 | 0.36 | 0.10 mg/L |
| selenium | 2.02 | 2 | 2 ug/L |
| chloride | 40.1 | 40.7 | 5 mg/L |
| dissolved solids | 466 | 429 | 10 mg/L |
| iron | 1392 | 1589 | 50 ug/L |
| manganese | 225 | 202 | 10 ug/L |
| pH | 7.31 | 7.26 | ±0.01 S.U. |
| sulfate | 80.1 | 84.3 | 5 mg/L |
| zinc | 32.7 | 31.3 | 10 ug/L |
| copper | 12.5 | 13.7 | 10 ug/L |
| lead | 3.69 | 2.78 | 2 ug/L |
| sodium | 26.1 | 63.4 | 5 mg/L |
| alkalinity | 260 | 216 | 5 mg/L |
| ammonia | 0.24 | 0.37 | 0.05 mg/L |
| conductivity | 662 | 649 | ±1% |
| COD | 11.3 | 10.9 | 10 mg/L |
| magnesium | 28.7 | 19.1 | 1 mg/L |
| potassium | 2.45 | 2.46 | 2 mg/L |

* *Maximum Contaminant Level or Secondary Maximum Contaminant Level*

*mg/L = milligrams per liter or parts per million (ppm); ug/L - micrograms per liter or parts per billion (ppb); 1mg = 1000 ug*

** *comparison data from the Ohio Environmental Protection Agency 2008 305(b) Report on Ohio's Ground Water Quality, http://www.epa.ohio.gov/portals/28/documents/gwqcp/gw_parameters.pdf*

*** Due to the MCL being lower than MCDBOH detection limits, a percentage >MCL cannot be reported for this parameter.

# Table 4

## Groundwater Monitoring Results, 2006-2008, in Private Wells around Mahoning Landfill

224 Sampling Events

| | *# Samples* | *MCL/SMCL** | *%>MCL* | *Average* | *Median* | *Range* | | | *Average Ambient Ground Water Quality in Ohio*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameters with Maximum Contaminant Levels | | | | | | *Low* | *High* | District Board of Health Lab Detection Limit | | Sand and Gravel Aquifers | Sandstone Aquifers | Ohio EPA Lab Detection Limit |
| bacteria | 224 | negative | 33.5% | | | | | | | | | |
| arsenic | 180 | 10 ug/L | 0.6% | 5.7 | 5.0 | 5.0 | 134.3 | 5.0 ug/L | arsenic | 5.69 | 3.06 | 2 ug/L |
| barium | 224 | 2000 ug/L | 0.0% | 191.2 | 115.6 | 100.0 | 1051.0 | 100 ug/L | barium | 173 | 162 | 15 ug/L |
| cadmium | 224 | 5 ug/L | *** | 10.0 | 10 | 10 | 14.4 | 10 ug/L | cadmium | 0.21 | 0.23 | 0.2 ug/L |
| chromium | 224 | 100 ug/L | 0.0% | 20.3 | 20.0 | 20.0 | 20.0 | 20 ug/L | chromium | 30.0 | 29.9 | 30 ug/L |
| fluoride | 223 | 4 mg/L | 0.0% | 0.413 | 0.224 | 0.073 | 3.960 | 0.020 mg/L | fluoride | 0.40 | 0.31 | 0.10 mg/L |
| mercury | 224 | 2 ug/L | 0.0% | 0.2 | 0.2 | 0.2 | 0.2 | 0.20 ug/l | | | | |
| nitrate | 224 | 10 mg/L | 0.0% | 0.76 | 0.50 | 0.50 | 7.15 | 0.050 mg/L | nitrate | 0.75 | 0.36 | 0.10 mg/L |
| selenium | 180 | 50 ug/L | 0.0% | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 ug/L | selenium | 2.02 | 2 | 2 ug/L |
| Parameters with Secondary Maximum Contaminant Levels | | | | | | | | | | | | |
| chloride | 224 | 250 mg/L | 1.3% | 34.8 | 16.0 | 2.0 | 520.0 | 1.0 mg/L | chloride | 40.1 | 40.7 | 5 mg/L |
| dissolved solids | 224 | 500 mg/L | 31.7% | 495 | 398 | 205 | 1479 | 1.0 mg/L | dissolved solids | 466 | 429 | 10 mg/L |
| iron | 224 | 300 ug/L | 14.3% | 231.1 | 50.0 | 50.0 | 3834.0 | 50 ug/L | iron | 1392 | 1589 | 50 ug/L |
| manganese | 224 | 50 ug/L | 32.1% | 74.8 | 11.0 | 10.0 | 698.0 | 10 ug/L | manganese | 225 | 202 | 10 ug/L |
| pH | 224 | 7.0-10.5 | 0.0% | 7.72 | 7.64 | 7.04 | 9.36 | 0 pH units | pH | 7.31 | 7.26 | ±0.01 S.U. |
| silver | 224 | 100 ug/L | 0.0% | 10 | 10 | 10 | 10 | 10 ug/L | | | | |
| sulfate | 224 | 250 mg/L | 7.6% | 126.11 | 104.55 | 16.05 | 695.60 | 1.0 mg/L | sulfate | 80.1 | 84.3 | 5 mg/L |
| zinc | 224 | 5000 ug/L | 0.0% | 30.4 | 10.0 | 570.4 | | 10 ug/L | zinc | 32.7 | 31.3 | 10 ug/L |
| Parameters with Action Levels | | | | | | | | | | | | |
| copper | 224 | 1300 ug/L | 1.3% | 80.2 | 10.0 | 10.0 | 6253.0 | 10 ug/L | copper | 12.5 | 13.7 | 10 ug/L |
| lead | 180 | 15 ug/L | 2.2% | 6.07 | 5.00 | 5.00 | 45.30 | 5.0 ug/L | lead | 3.69 | 2.78 | 2 ug/L |
| Parameters with Recommended Levels | | | | | | | | | | | | |
| sodium | 224 | 200 mg/L | 5.4% | 73.4 | 36.7 | 4.9 | 587.0 | 0.10 mg/L | sodium | 26.1 | 63.4 | 5 mg/L |
| Parameters without Standards | | | | | | | | | | | | |
| alkalinity | 224 | | | 387 | 325 | 70 | 1090 | 1 mg/L | alkalinity | 260 | 216 | 5 mg/L |
| ammonia | 224 | | | 0.1384 | 0.0708 | 0.0200 | 0.9940 | 0.02 mg/L | ammonia | 0.24 | 0.37 | 0.05 mg/L |
| conductivity | 223 | | | 665 | 581 | 307 | 1899 | 1.0 umhos/cm | conductivity | 662 | 649 | ±1% |
| chemical oxygen demand | 224 | | | 10.73 | 10.00 | 60.31 | 14.62 | 10 mg/L | COD | 11.3 | 10.9 | 10 mg/L |
| magnesium | 224 | | | 9.4 | 9.1 | 0.1 | 48.0 | 0.10 mg/L | magnesium | 28.7 | 19.1 | 1 mg/L |
| potassium | 224 | | | 1.3 | 1.1 | 0.1 | 6.2 | 0.10 mg/L | potassium | 2.45 | 2.46 | 2 mg/L |
| turbidity | 224 | | | 2.74 | 0.64 | 0.10 | 43.50 | 0.10 NTU | | | | |

* *Maximum Contaminant Level or Secondary Maximum Contaminant Level*
*mg/L = milligrams per liter or parts per million (ppm); ug/L - micrograms per liter or parts per billion (ppb); 1mg = 1000 ug*
** *comparison data from the Ohio Environmental Protection Agency 2008 305(b) Report on Ohio's Ground Water Quality, http://www.epa.ohio.gov/portals/28/documents/gwqcp/gw_parameters.pdf*
*** Due to the MCL being lower than MCDBOH detection limits, a percentage >MCL cannot be reported for this parameter.

# Table 5

## Groundwater Monitoring Results, 2006-2008, in Private Wells around CLD Landfill

156 Sampling Events

| | *# Samples* | *MCL/SMCL** | *%>MCL* | *Average* | *Median* | *Range* | | District Board of Health Lab Detection Limit | ***Average Ambient Ground Water Quality in Ohio**** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Low* | *High* | | | Sand and Gravel Aquifers | Sandstone Aquifers | Ohio EPA Lab Detection Limit |
| Parameters with Maximum Contaminant Levels | | | | | | | | | | | | |
| bacteria | 155 | negative | 25.2% | | | | | | | | | |
| arsenic | 107 | 10 ug/L | 0.9% | 5.2 | 5.0 | 5.0 | 12.4 | 5.0 ug/L | arsenic | 5.69 | 3.06 | 2 ug/L |
| barium | 156 | 2000 ug/L | 0.0% | 178.7 | 100.0 | 100.0 | 1328.0 | 100 ug/L | barium | 173 | 162 | 15 ug/L |
| cadmium | 158 | 5 ug/L | *** | 10 | 10 | 10.00 | 10.00 | 10 ug/L | cadmium | 0.21 | 0.23 | 0.2 ug/L |
| chromium | 158 | 100 ug/L | 0.0% | 20.1 | 20.0 | 20.0 | 20.0 | 20 ug/L | chromium | 30.0 | 29.9 | 30 ug/L |
| fluoride | 158 | 4 mg/L | 0.0% | 0.531 | 0.351 | 0.078 | 2.660 | 0.020 mg/L | fluoride | 0.40 | 0.31 | 0.10 mg/L |
| mercury | 158 | 2 ug/L | 0.0% | 0.2 | 0.2 | 0.2 | 0.2 | 0.20 ug/l | | | | |
| nitrate | 158 | 10 mg/L | 1.9% | 1.10 | 0.50 | 0.05 | 26.80 | 0.050 mg/L | nitrate | 0.75 | 0.36 | 0.10 mg/L |
| selenium | 107 | 50 ug/L | 0.0% | 2 | 2 | 2 | 2 | 2.0 ug/L | selenium | 2.02 | 2 | 2 ug/L |
| Parameters with Secondary Maximum Contaminant Levels | | | | | | | | | | | | |
| chloride | 158 | 250 mg/L | 9.0% | 151.2 | 35.0 | 2.5 | 2350.0 | 1.0 mg/L | chloride | 40.1 | 40.7 | 5 mg/L |
| dissolved solids | 158 | 500 mg/L | 50.6% | 675 | 511 | 282 | 4390 | 1.0 mg/L | dissolved solids | 466 | 429 | 10 mg/L |
| iron | 158 | 300 ug/L | 30.8% | 640.3 | 50.0 | 50.0 | 7479.0 | 50 ug/L | iron | 1392 | 1589 | 50 ug/L |
| manganese | 158 | 50 ug/L | 25.0% | 56.8 | 12.3 | 10.0 | 556.4 | 10 ug/L | manganese | 225 | 202 | 10 ug/L |
| pH | 158 | 7.0-10.5 | 1.3% | 7.75 | 7.70 | 6.97 | 8.76 | 0 pH units | pH | 7.31 | 7.26 | ±0.01 S.U. |
| silver | 158 | 100 ug/L | 0.0% | 10 | 10 | 10.00 | 10.00 | 10 ug/L | | | | |
| sulfate | 158 | 250 mg/L | 9.0% | 164.38 | 148.80 | 41.57 | 533.02 | 1.0 mg/L | sulfate | 80.1 | 84.3 | 5 mg/L |
| zinc | 158 | 5000 ug/L | 0.0% | 18.2 | 10.0 | 10.0 | 735.6 | 10 ug/L | zinc | 32.7 | 31.3 | 10 ug/L |
| Parameters with Action Levels | | | | | | | | | | | | |
| copper | 158 | 1300 ug/L | 0.6% | 33.6 | 10 | 10 | 2121.0 | 10 ug/L | copper | 12.5 | 13.7 | 10 ug/L |
| lead | 107 | 15 ug/L | 0.9% | 5.30 | 5.00 | 5.00 | 18.50 | 5.0 ug/L | lead | 3.69 | 2.78 | 2 ug/L |
| Parameters with Recommended Levels | | | | | | | | | | | | |
| sodium | 158 | 200 mg/L | 16.0% | 155.2 | 76.1 | 10.2 | 1589.0 | 0.10 mg/L | sodium | 26.1 | 63.4 | 5 mg/L |
| Parameters without Standards | | | | | | | | | | | | |
| alkalinity | 158 | | | 331 | 320 | 135 | 655 | 1 mg/L | alkalinity | 260 | 216 | 5 mg/L |
| ammonia | 158 | | | 0.4246 | 0.1055 | 0.0200 | 7.8000 | 0.02 mg/L | ammonia | 0.24 | 0.37 | 0.05 mg/L |
| conductivity | 158 | | | 1100 | 777 | 423 | 6610 | 1.0 umhos/cm | conductivity | 662 | 649 | ±1% |
| chemical oxygen demand | 158 | | | 51.2 | 10.0 | 10.0 | 6266.0 | 10 mg/L | COD | 11.3 | 10.9 | 10 mg/L |
| magnesium | 158 | | | 10.6 | 10.2 | 0.1 | 45.0 | 0.10 mg/L | magnesium | 28.7 | 19.1 | 1 mg/L |
| potassium | 158 | | | 2.8 | 2.3 | 0.1 | 12.2 | 0.10 mg/L | potassium | 2.45 | 2.46 | 2 mg/L |
| turbidity | 155 | | | 6.50 | 1.43 | 0.10 | 41.70 | 0.10 NTU | | | | |

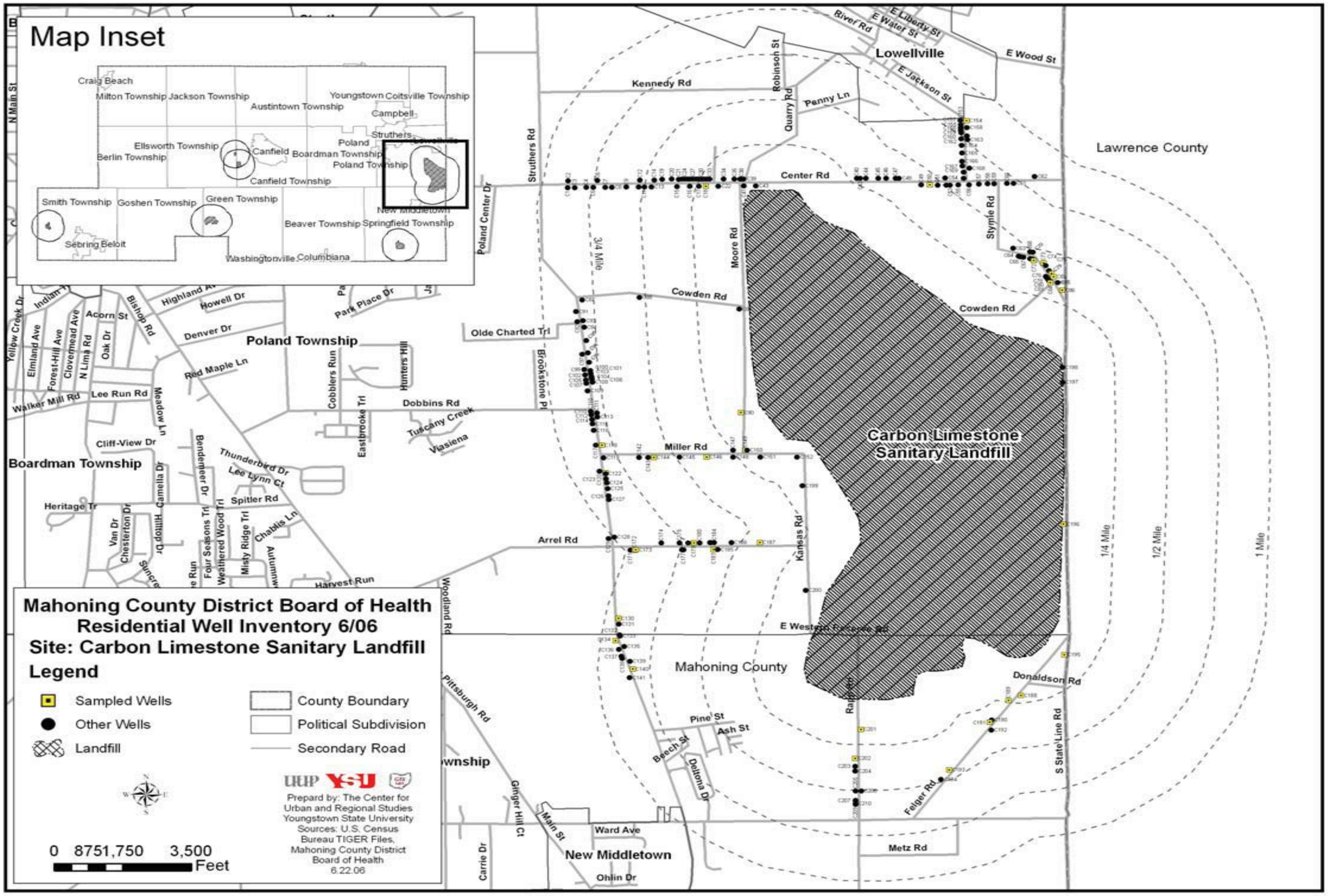
* *Maximum Contaminant Level or Secondary Maximum Contaminant Level*

*mg/L = milligrams per liter or parts per million (ppm); ug/L - micrograms per liter or parts per billion (ppb); 1mg = 1000 ug*

** *comparison data from the Ohio Environmental Protection Agency 2008 305(b) Report on Ohio's Ground Water Quality, http://www.epa.ohio.gov/portals/28/documents/gwqcp/gw_parameters.p*

*** Due to the MCL being lower than MCDBOH detection limits, a percentage >MCL cannot be reported for this parameter.

Figure 1



Map Inset
Craig Beach
Milton Township
Jackson Township
Austintown Township
Youngstown
Coitsville Township
Campbell
Struthers
Ellsworth Township
Berlin Township
Canfield
Boardman Township
Poland
Poland Township
Canfield Township
Smith Township
Goshen Township
Green Township
New Middletown
Beaver Township
Springfield Township
Sebring
Beloit
Washingtonville
Columbiana
Lowellville
E Wood St
Kennedy Rd
Penny Ln
Center Rd
Lawrence County
Struthers Rd
Poland Center Dr
Moore Rd
Stymie Rd
Cowden Rd
Olde Charted Trl
Poland Township
Dobbins Rd
Miller Rd
Carbon Limestone Sanitary Landfill
Boardman Township
Arrel Rd
Kansas Rd
E Western Reserve Rd
Mahoning County
Donaldson Rd
Pine St
Ash St
Beech St
Felger Rd
S State Line Rd
Main St
Ward Ave
New Middletown
Metz Rd
Ohlin Dr
3/4 Mile
1/4 Mile
1/2 Mile
1 Mile
Mahoning County District Board of Health
Residential Well Inventory 6/06
Site: Carbon Limestone Sanitary Landfill
Legend
Sampled Wells
Other Wells
Landfill
County Boundary
Political Subdivision
Secondary Road
Prepard by: The Center for Urban and Regional Studies Youngstown State University
Sources: U.S. Census Bureau TIGER Files, Mahoning County District Board of Health
6.22.06
0 875 1,750 3,500
Feet

**Figure 2**

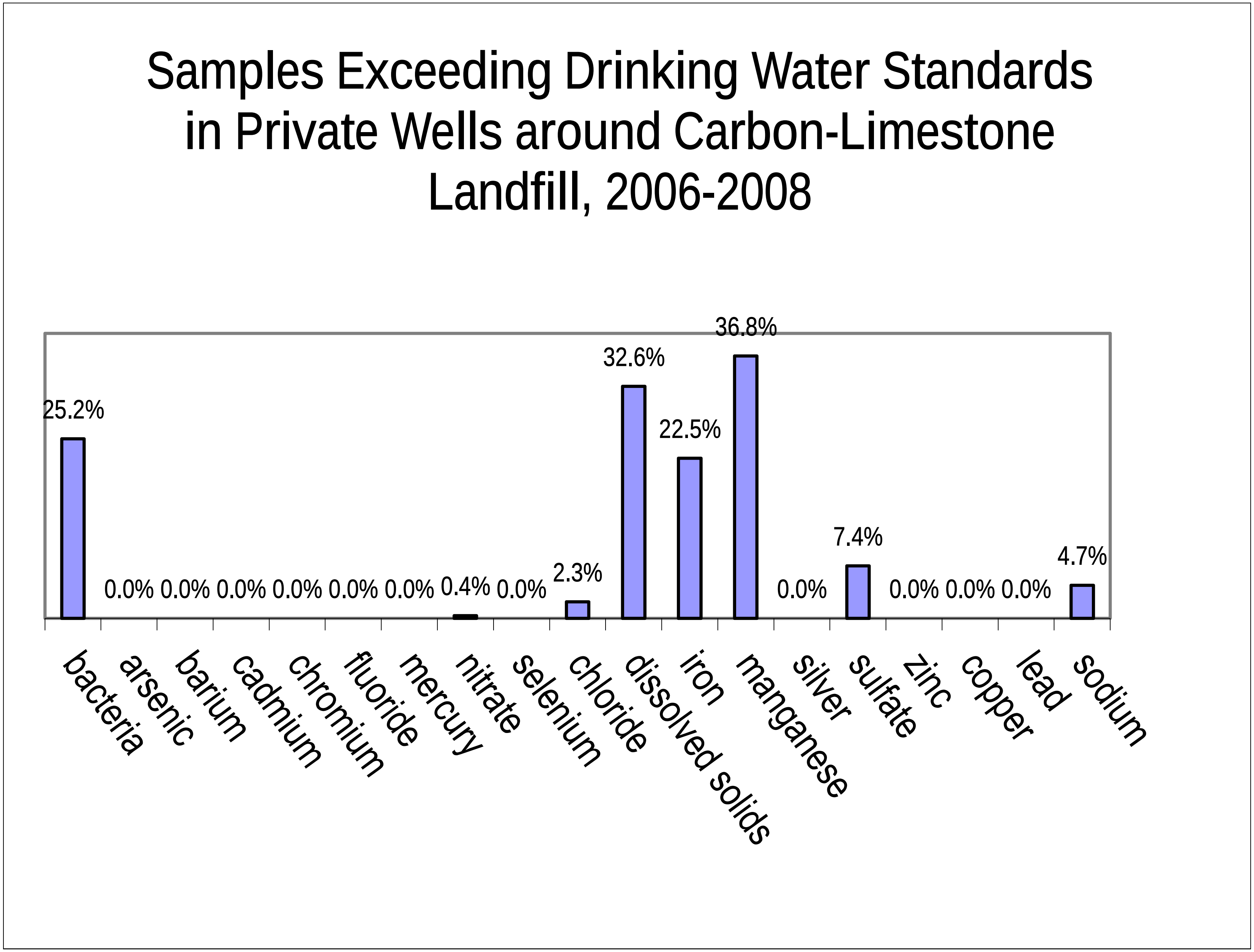
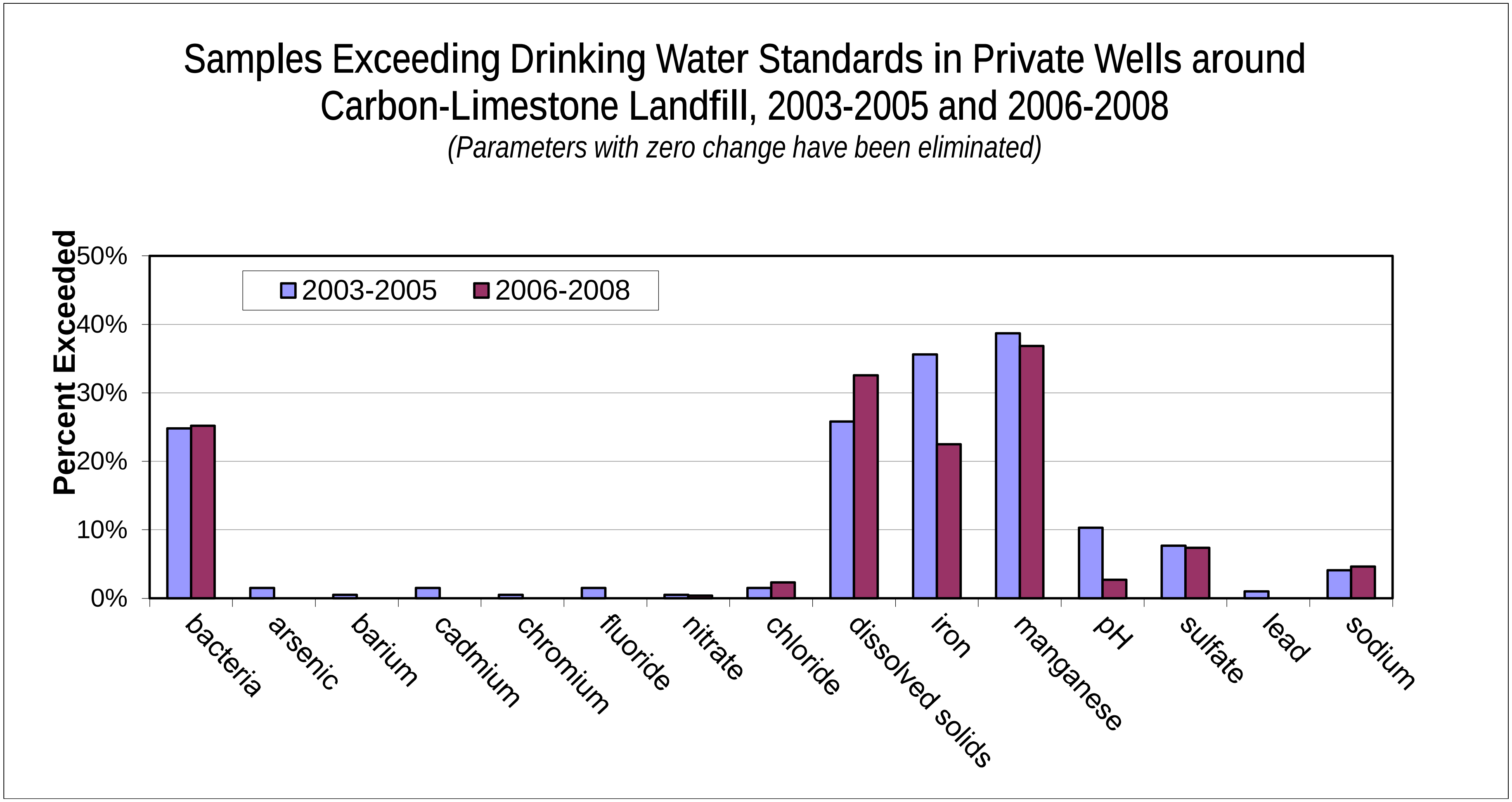
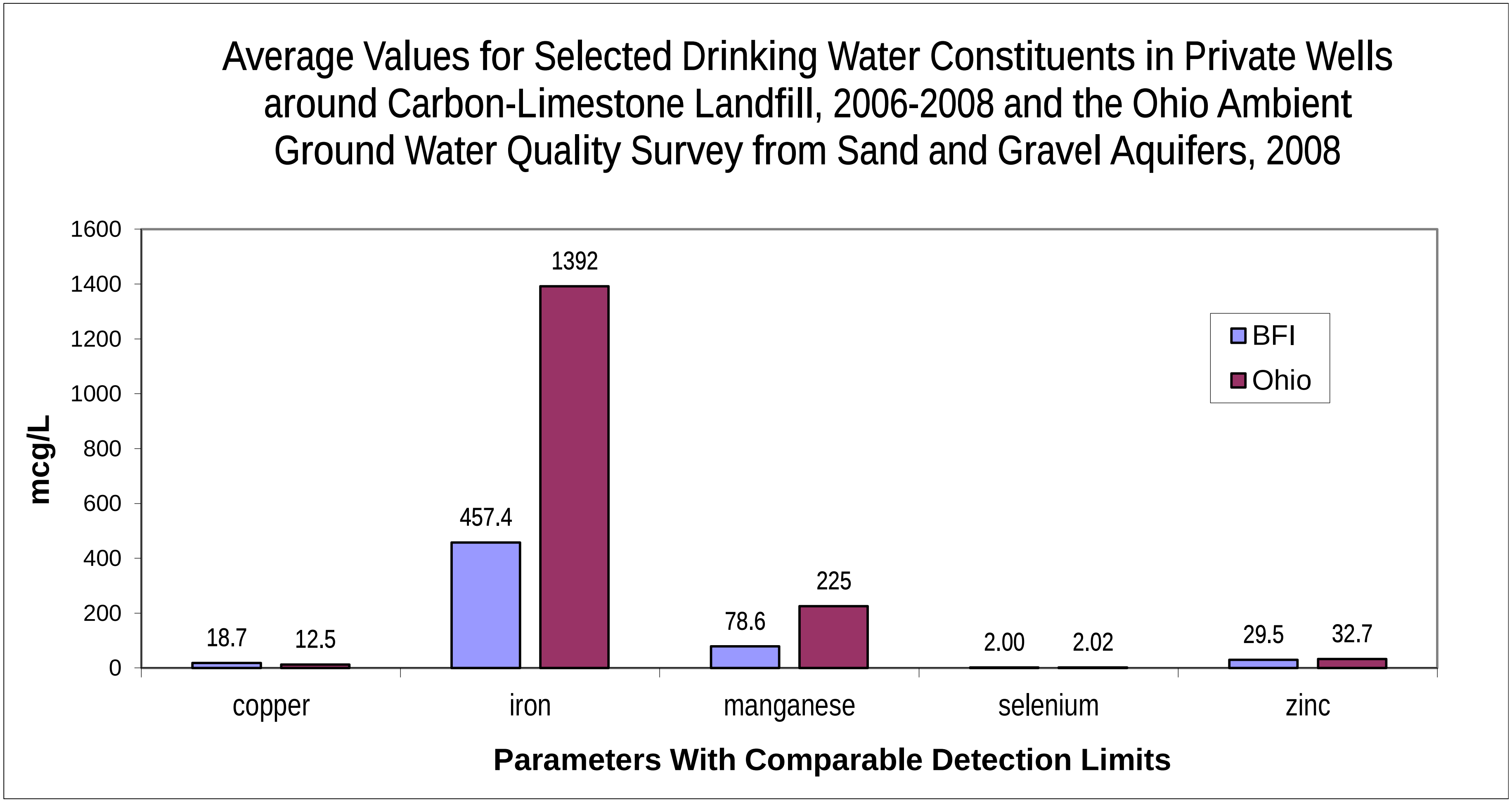

Samples Exceeding Drinking Water Standards in Private Wells around Carbon-Limestone Landfill, 2006-2008
25.2%
0.0%
0.0%
0.0%
0.0%
0.0%
0.0%
0.4%
0.0%
2.3%
32.6%
22.5%
36.8%
0.0%
7.4%
0.0%
0.0%
0.0%
4.7%
bacteria
arsenic
barium
cadmium
chromium
fluoride
mercury
nitrate
selenium
chloride
dissolved solids
iron
manganese
silver
sulfate
zinc
copper
lead
sodium

**Figure 3**



Samples Exceeding Drinking Water Standards in Private Wells around Carbon-Limestone Landfill, 2003-2005 and 2006-2008
(Parameters with zero change have been eliminated)
Percent Exceeded
50%
40%
30%
20%
10%
0%
2003-2005
2006-2008
bacteria
arsenic
barium
cadmium
chromium
fluoride
nitrate
chloride
dissolved solids
iron
manganese
pH
sulfate
lead
sodium

**Figure 4**



Average Values for Selected Drinking Water Constituents in Private Wells around Carbon-Limestone Landfill, 2006-2008 and the Ohio Ambient Ground Water Quality Survey from Sand and Gravel Aquifers, 2008
mcg/L
1600
1400
1200
1000
800
600
400
200
0
18.7
12.5
457.4
1392
78.6
225
2.00
2.02
29.5
32.7
BFI
Ohio
copper
iron
manganese
selenium
zinc
Parameters With Comparable Detection Limits

**Figure 5**

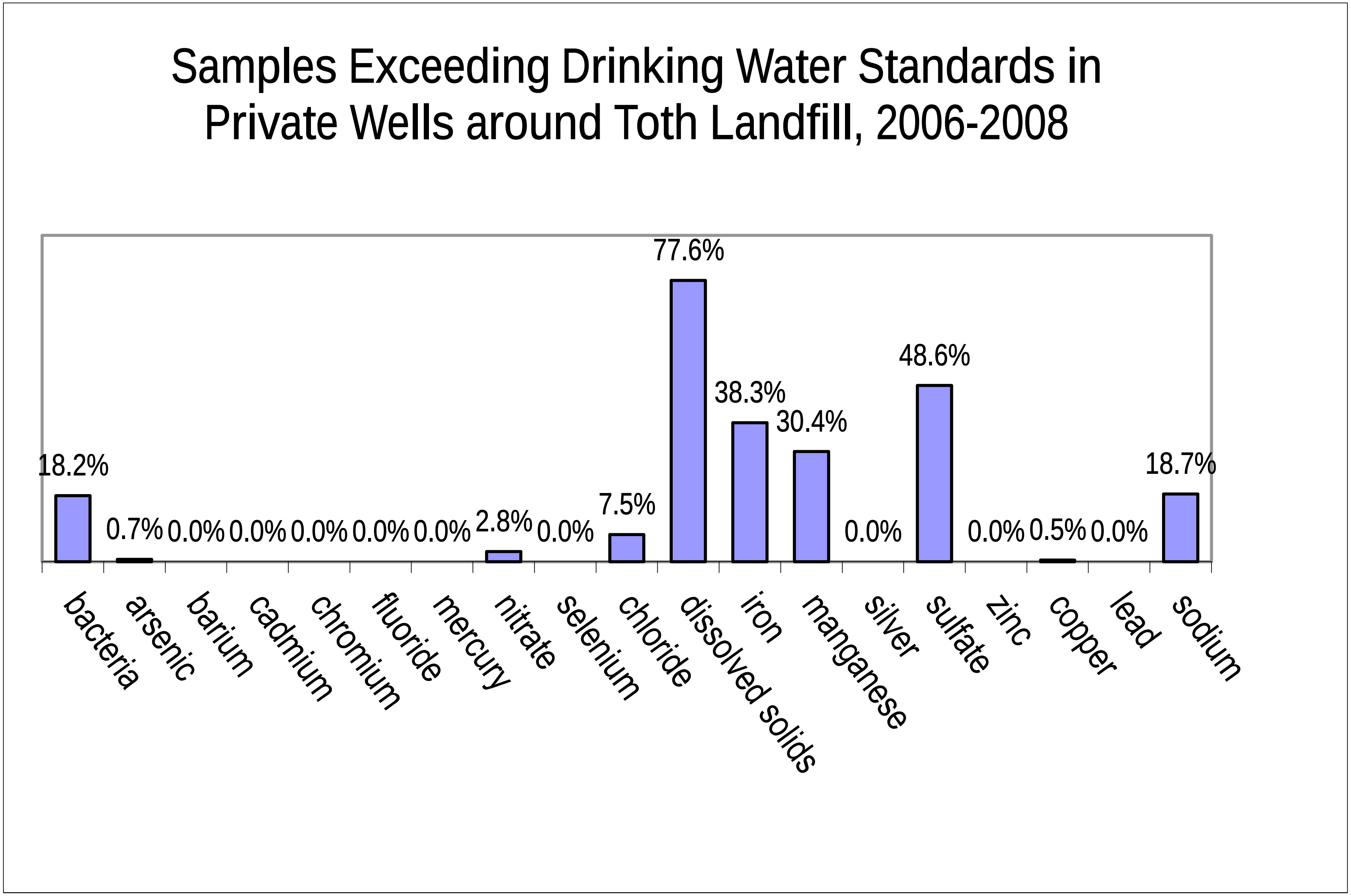

Samples Exceeding Drinking Water Standards in Private Wells around Toth Landfill, 2006-2008
18.2%
0.7%
0.0%
0.0%
0.0%
0.0%
0.0%
2.8%
0.0%
7.5%
77.6%
38.3%
30.4%
0.0%
48.6%
0.0%
0.5%
0.0%
18.7%
bacteria
arsenic
barium
cadmium
chromium
fluoride
mercury
nitrate
selenium
chloride
dissolved solids
iron
manganese
silver
sulfate
zinc
copper
lead
sodium

**Figure 6**

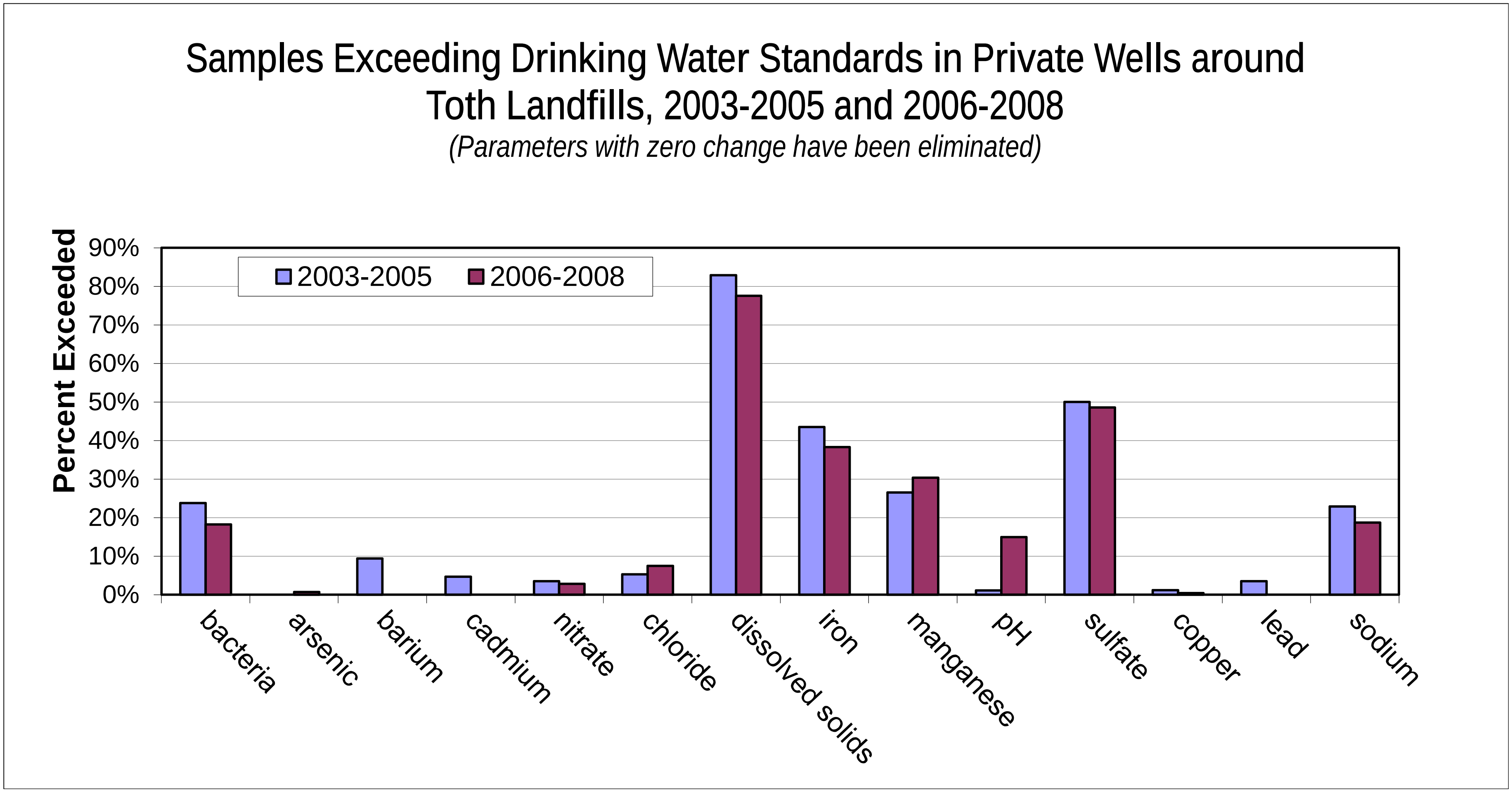

Samples Exceeding Drinking Water Standards in Private Wells around Toth Landfills, 2003-2005 and 2006-2008
(Parameters with zero change have been eliminated)
Percent Exceeded
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2003-2005
2006-2008
bacteria
arsenic
barium
cadmium
nitrate
chloride
dissolved solids
iron
manganese
pH
sulfate
copper
lead
sodium

Figure 7

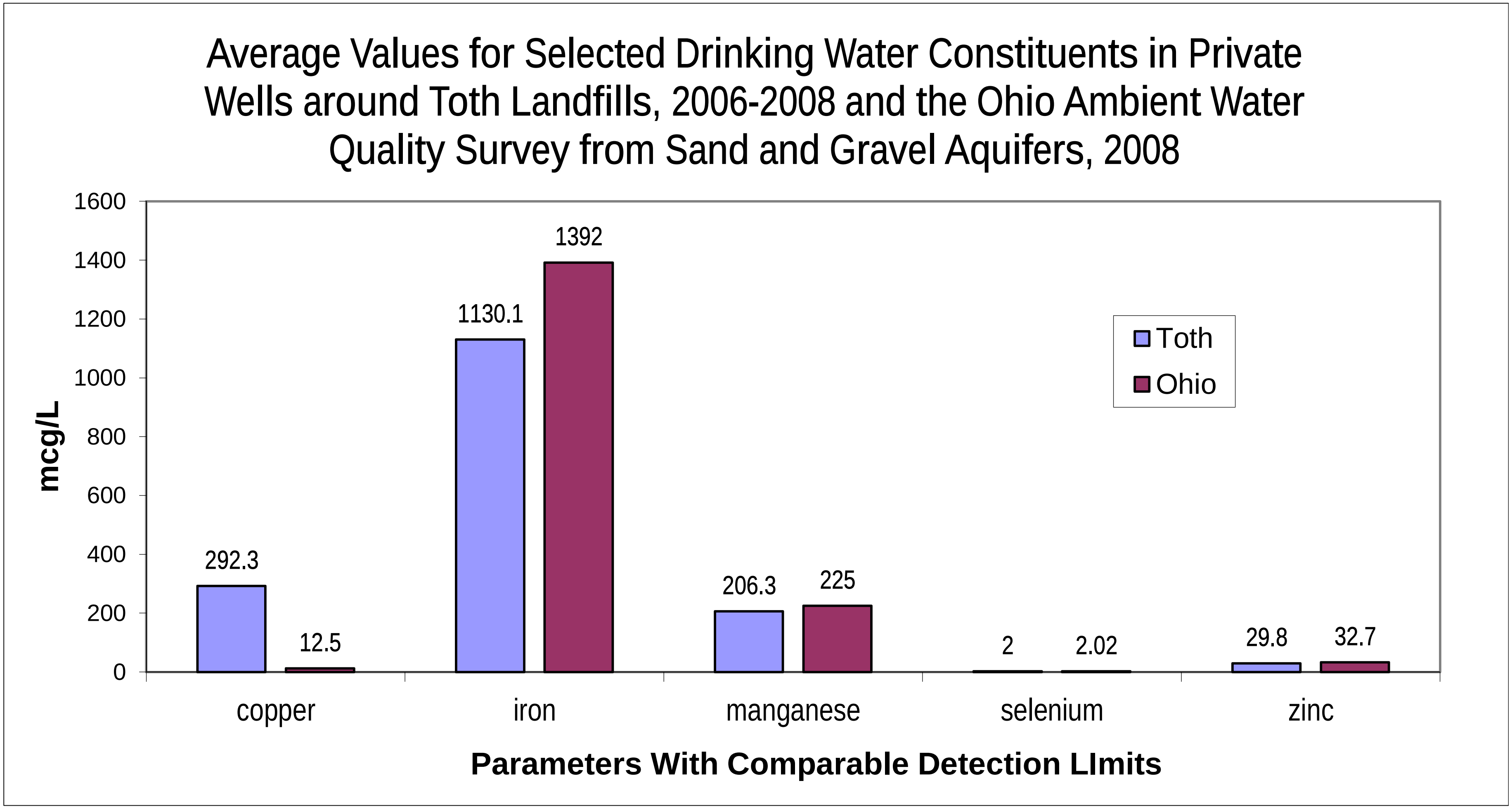
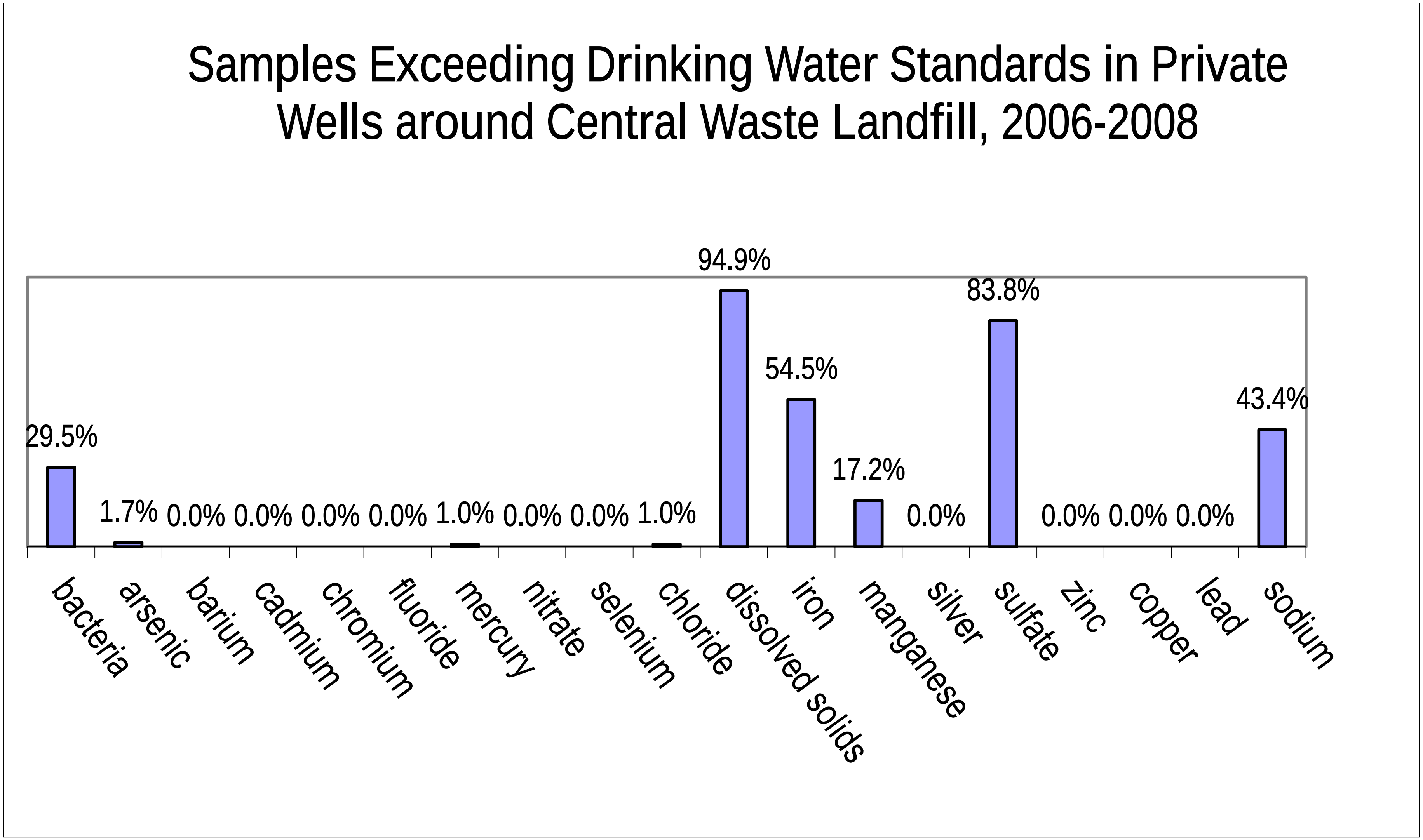

Average Values for Selected Drinking Water Constituents in Private Wells around Toth Landfills, 2006-2008 and the Ohio Ambient Water Quality Survey from Sand and Gravel Aquifers, 2008
mcg/L
1600
1400
1200
1000
800
600
400
200
0
292.3
12.5
1130.1
1392
206.3
225
2
2.02
29.8
32.7
Toth
Ohio
copper
iron
manganese
selenium
zinc
Parameters With Comparable Detection LImits

**Figure 8**



Samples Exceeding Drinking Water Standards in Private Wells around Central Waste Landfill, 2006-2008
29.5%
1.7%
0.0%
0.0%
0.0%
0.0%
1.0%
0.0%
0.0%
1.0%
94.9%
54.5%
17.2%
0.0%
83.8%
0.0%
0.0%
0.0%
43.4%
bacteria
arsenic
barium
cadmium
chromium
fluoride
mercury
nitrate
selenium
chloride
dissolved solids
iron
manganese
silver
sulfate
zinc
copper
lead
sodium

**Figure 9**

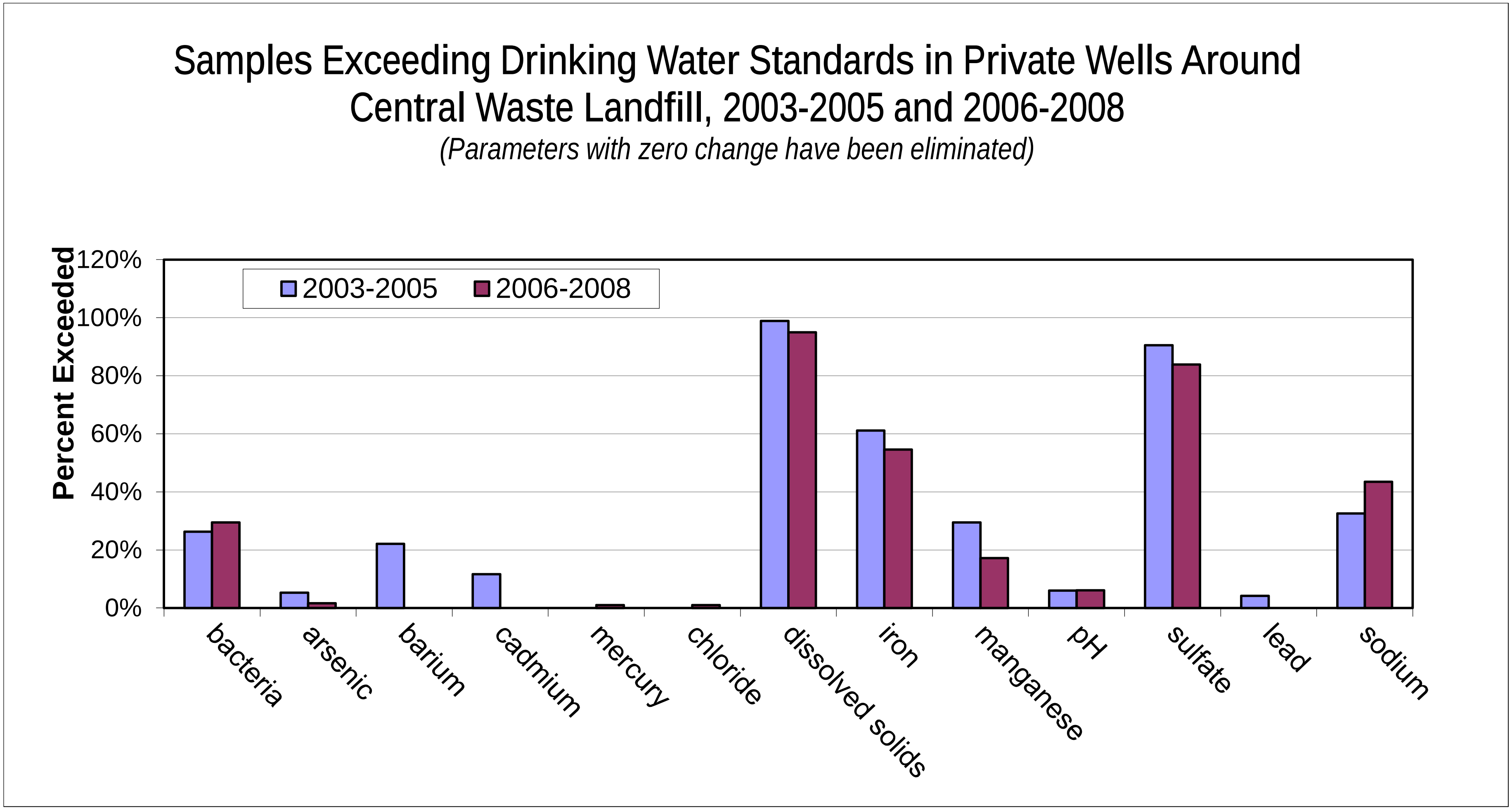

Samples Exceeding Drinking Water Standards in Private Wells Around Central Waste Landfill, 2003-2005 and 2006-2008
(Parameters with zero change have been eliminated)
Percent Exceeded
120%
100%
80%
60%
40%
20%
0%
2003-2005
2006-2008
bacteria
arsenic
barium
cadmium
mercury
chloride
dissolved solids
iron
manganese
pH
sulfate
lead
sodium

**Figure 10**

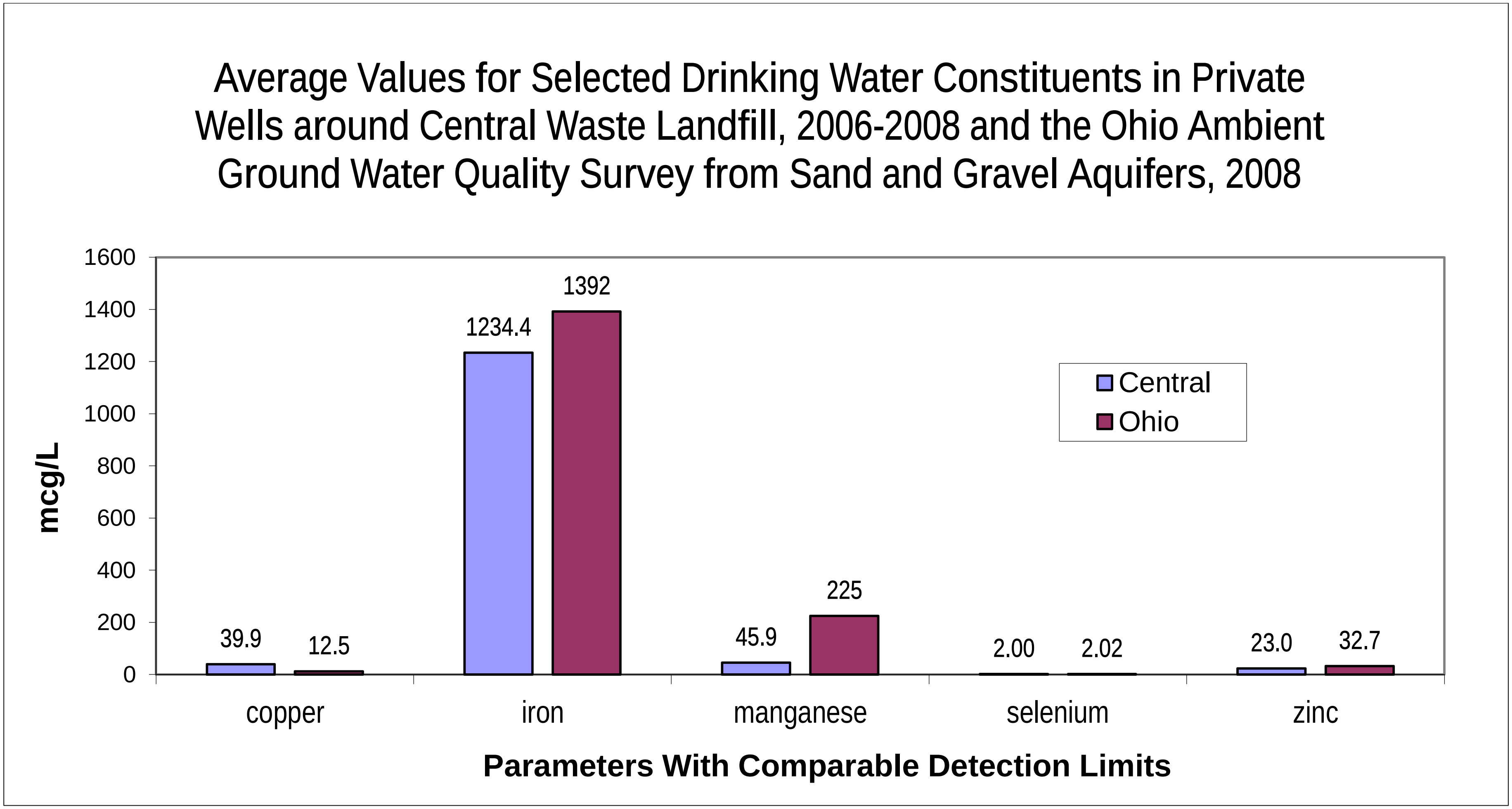

Average Values for Selected Drinking Water Constituents in Private Wells around Central Waste Landfill, 2006-2008 and the Ohio Ambient Ground Water Quality Survey from Sand and Gravel Aquifers, 2008
1600
1400
1200
1000
800
600
400
200
0
mcg/L
1392
1234.4
Central
Ohio
225
39.9
12.5
45.9
2.00
2.02
23.0
32.7
copper
iron
manganese
selenium
zinc
Parameters With Comparable Detection Limits

**Figure 11**

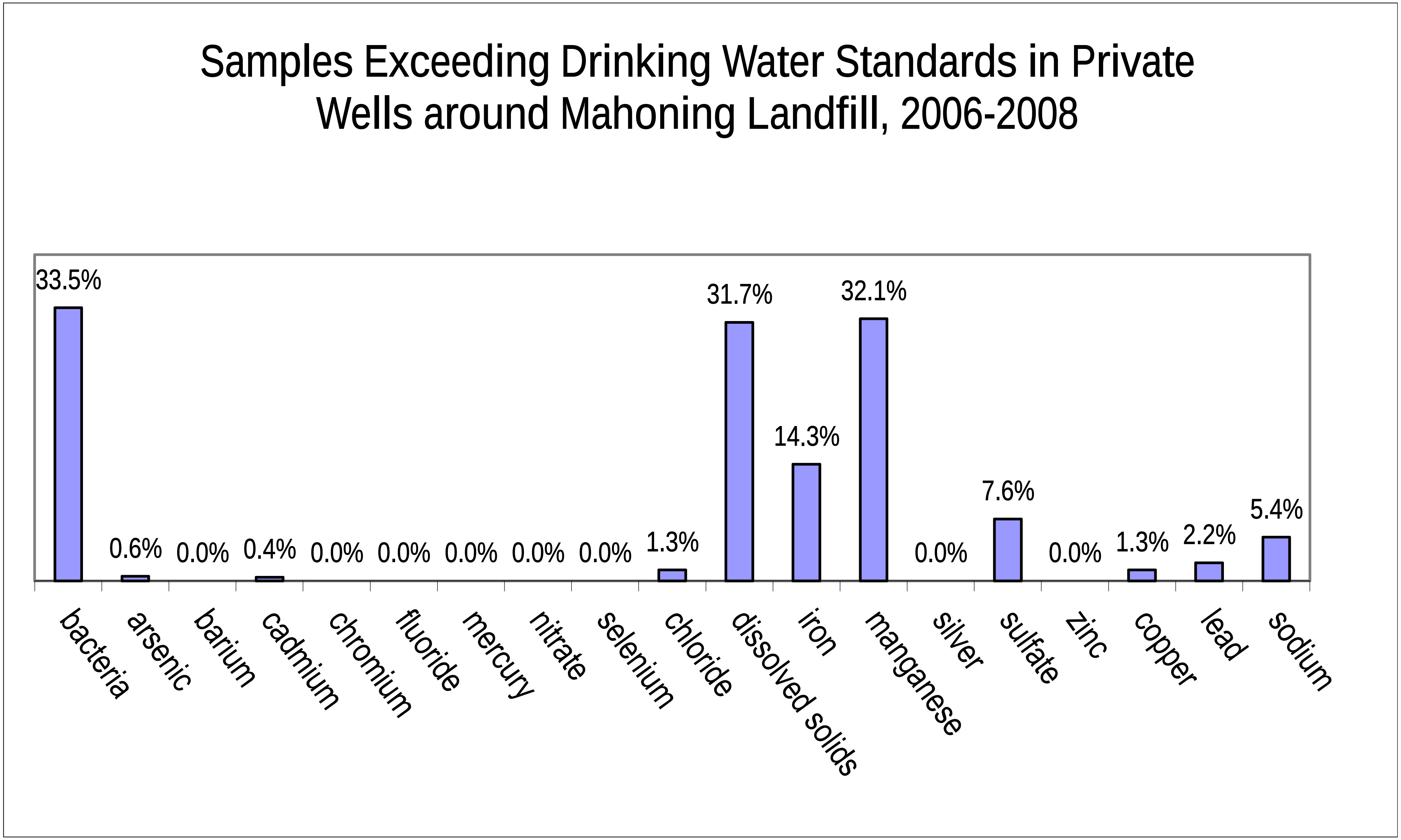

Samples Exceeding Drinking Water Standards in Private Wells around Mahoning Landfill, 2006-2008
33.5%
0.6%
0.0%
0.4%
0.0%
0.0%
0.0%
0.0%
0.0%
1.3%
31.7%
14.3%
32.1%
0.0%
7.6%
0.0%
1.3%
2.2%
5.4%
bacteria
arsenic
barium
cadmium
chromium
fluoride
mercury
nitrate
selenium
chloride
dissolved solids
iron
manganese
silver
sulfate
zinc
copper
lead
sodium

**Figure 12**

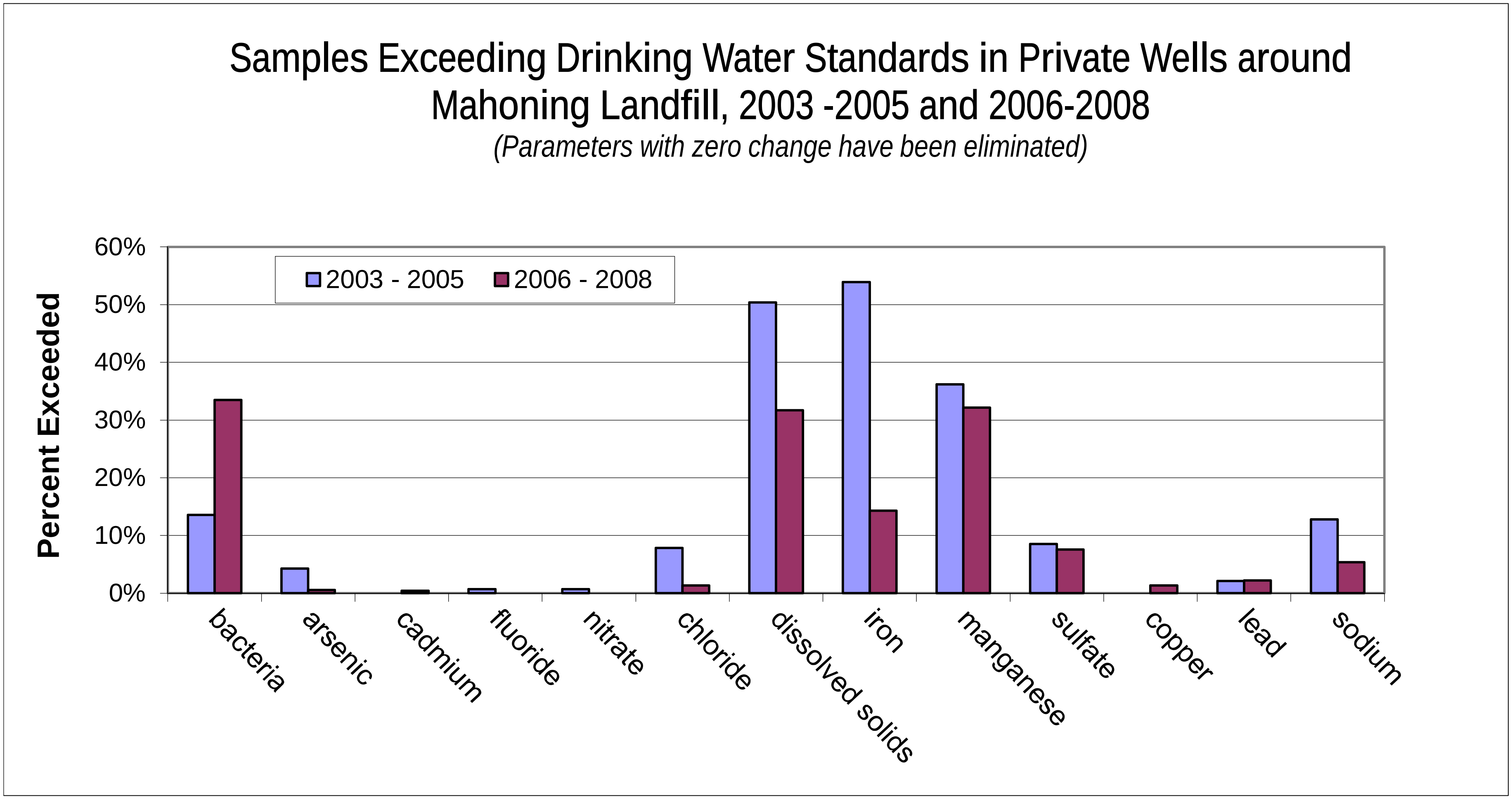
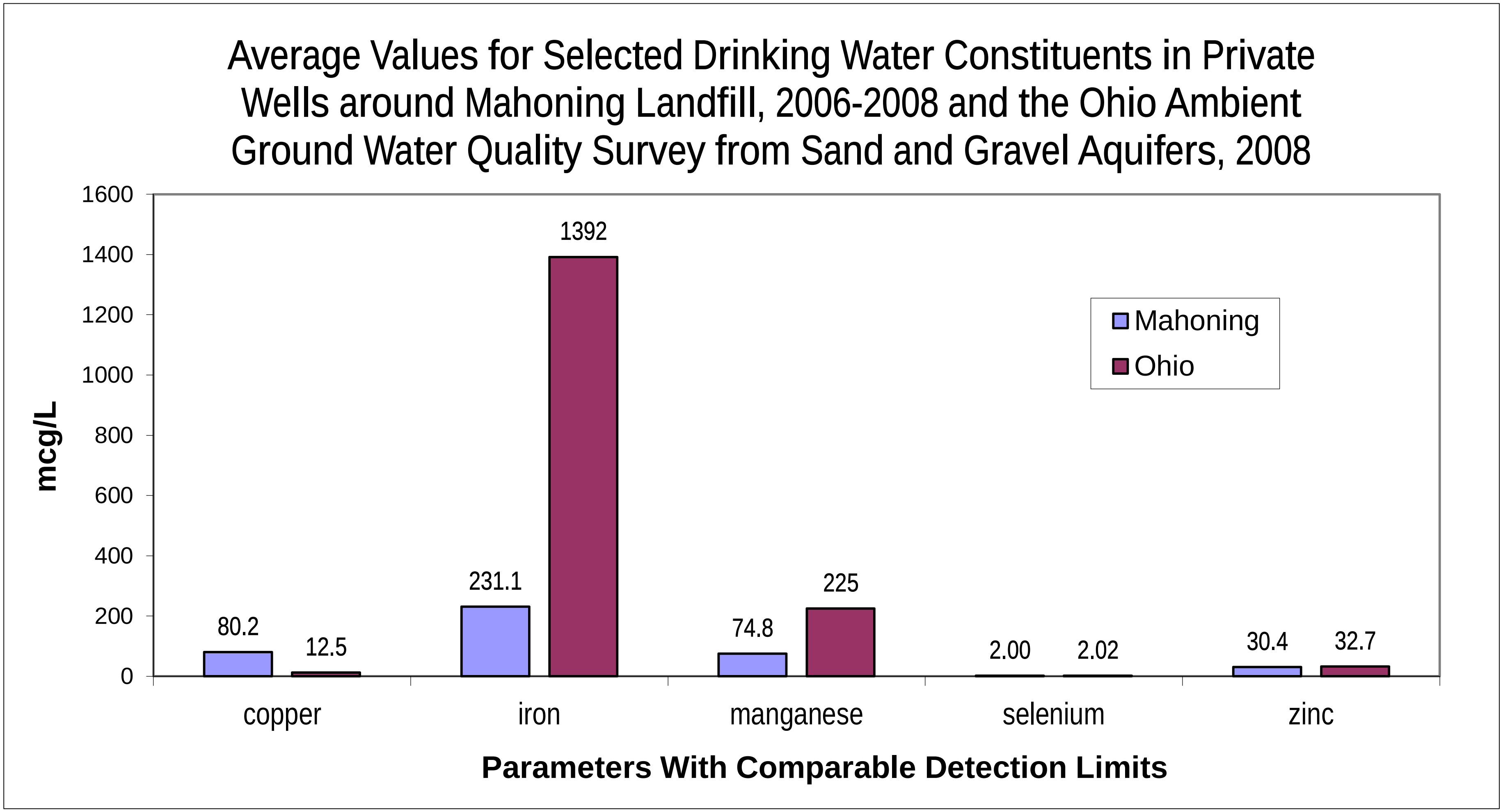

Samples Exceeding Drinking Water Standards in Private Wells around Mahoning Landfill, 2003 -2005 and 2006-2008
(Parameters with zero change have been eliminated)
Percent Exceeded
60%
50%
40%
30%
20%
10%
0%
2003 - 2005
2006 - 2008
bacteria
arsenic
cadmium
fluoride
nitrate
chloride
dissolved solids
iron
manganese
sulfate
copper
lead
sodium

**Figure 13**



Average Values for Selected Drinking Water Constituents in Private Wells around Mahoning Landfill, 2006-2008 and the Ohio Ambient Ground Water Quality Survey from Sand and Gravel Aquifers, 2008
mcg/L
1600
1400
1200
1000
800
600
400
200
0
80.2
12.5
231.1
1392
74.8
225
2.00
2.02
30.4
32.7
Mahoning
Ohio
copper
iron
manganese
selenium
zinc
Parameters With Comparable Detection Limits

**Figure 14**

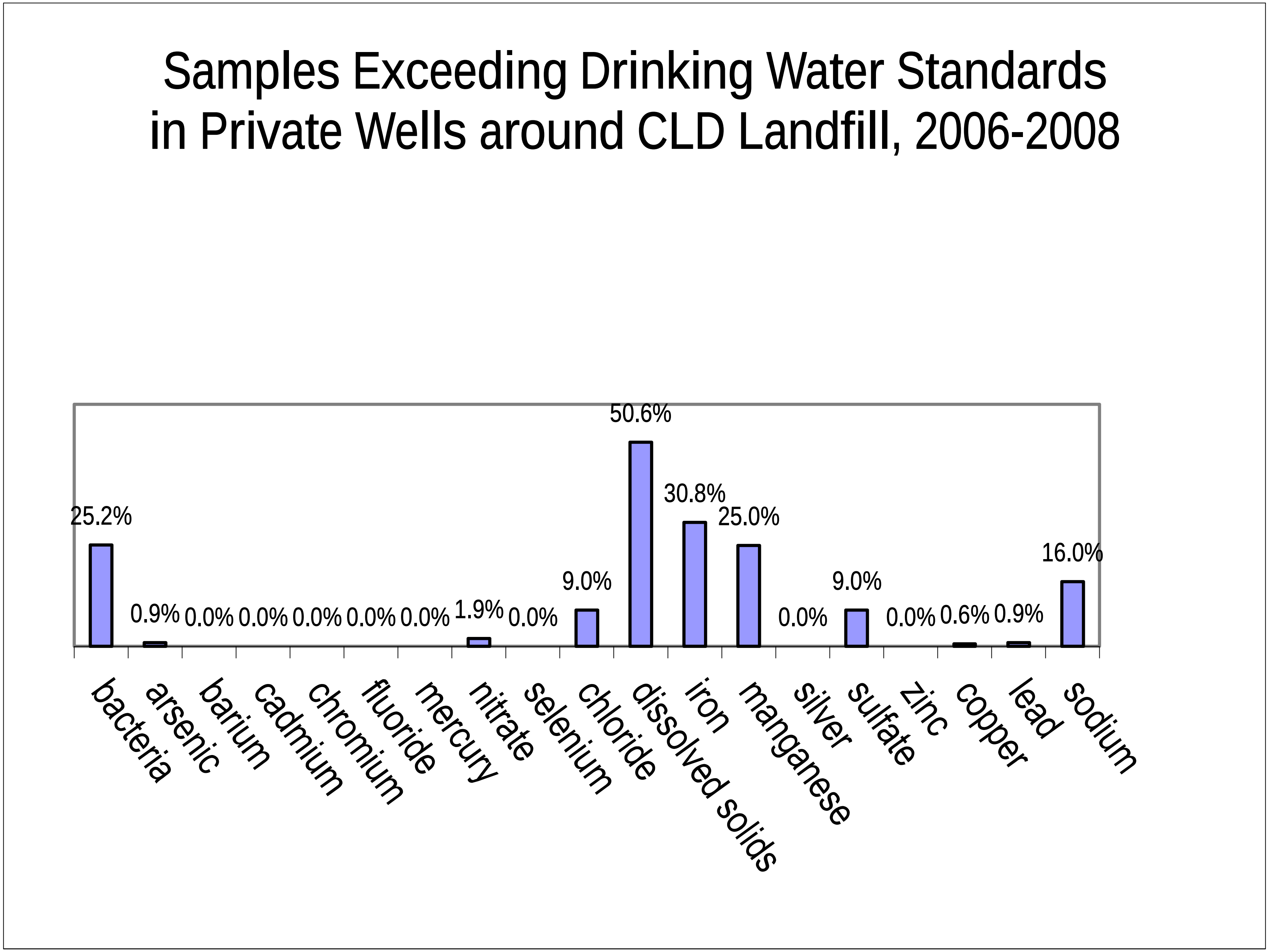
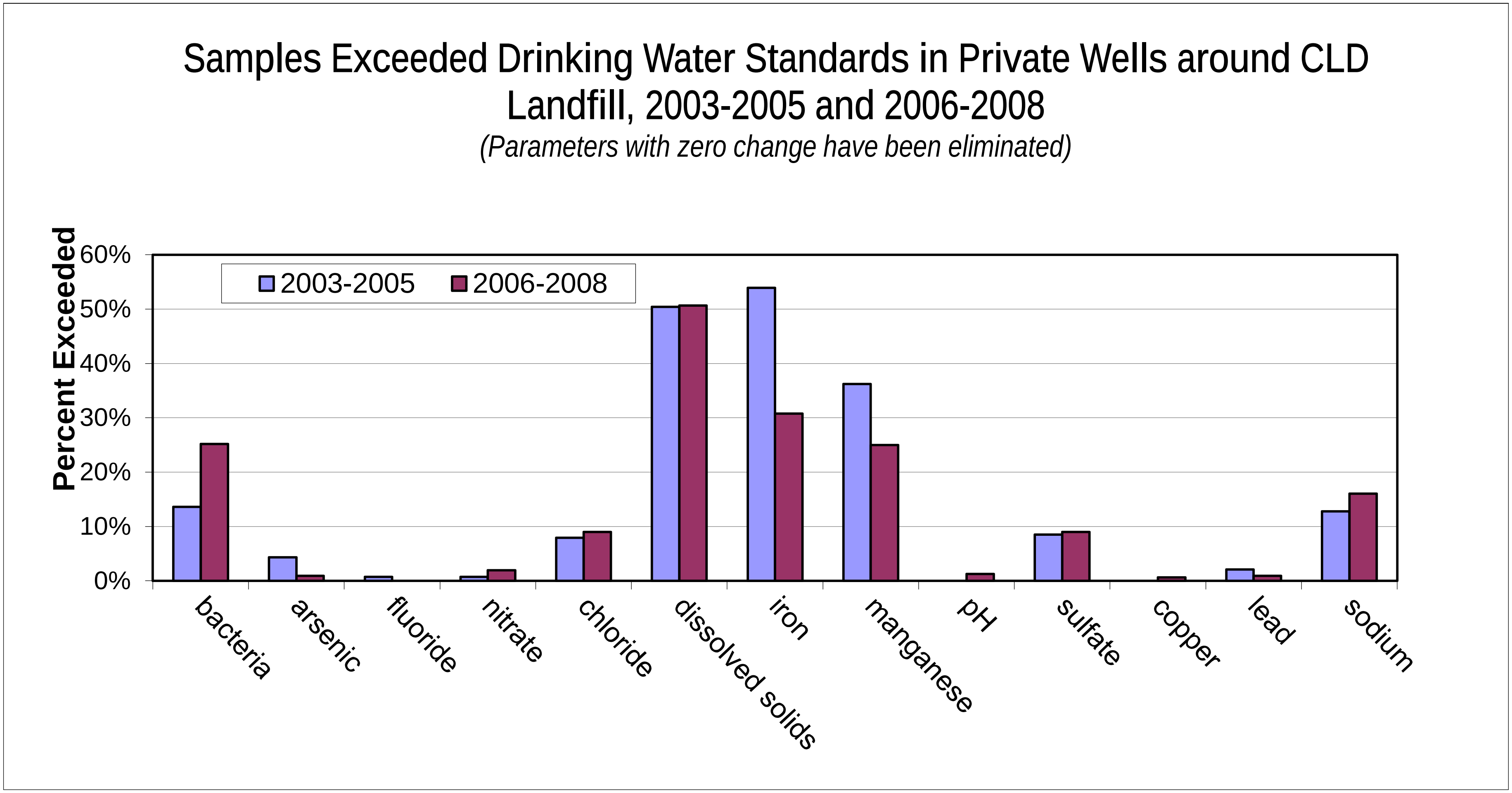
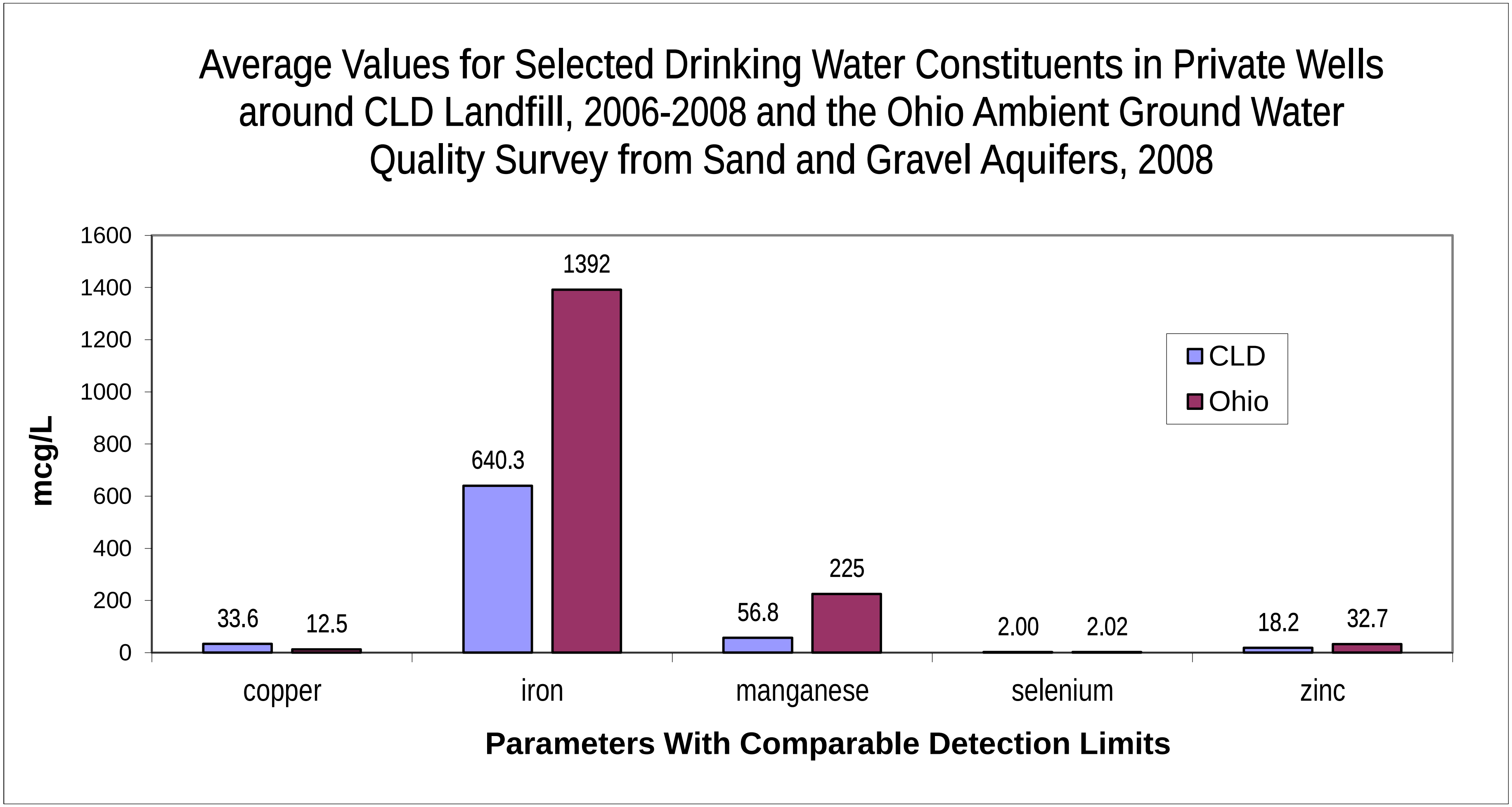

Samples Exceeding Drinking Water Standards
in Private Wells around CLD Landfill, 2006-2008
25.2%
0.9%
0.0%
0.0%
0.0%
0.0%
0.0%
1.9%
0.0%
9.0%
50.6%
30.8%
25.0%
0.0%
9.0%
0.0%
0.6%
0.9%
16.0%
bacteria
arsenic
barium
cadmium
chromium
fluoride
mercury
nitrate
selenium
chloride
dissolved solids
iron
manganese
silver
sulfate
zinc
copper
lead
sodium

**Figure 15**



Samples Exceeded Drinking Water Standards in Private Wells around CLD Landfill, 2003-2005 and 2006-2008
(Parameters with zero change have been eliminated)
Percent Exceeded
60%
50%
40%
30%
20%
10%
0%
2003-2005
2006-2008
bacteria
arsenic
fluoride
nitrate
chloride
dissolved solids
iron
manganese
pH
sulfate
copper
lead
sodium

**Figure 16**


Average Values for Selected Drinking Water Constituents in Private Wells around CLD Landfill, 2006-2008 and the Ohio Ambient Ground Water Quality Survey from Sand and Gravel Aquifers, 2008
mcg/L
1600
1400
1200
1000
800
600
400
200
0
33.6
12.5
640.3
1392
56.8
225
2.00
2.02
18.2
32.7
CLD
Ohio
copper
iron
manganese
selenium
zinc
Parameters With Comparable Detection Limits

Client
Address
City, State Zip Code

RE: Drinking Water Sample
Mahoning, SLF Sample ID: 1011017-003A
Outside

Dear Client,

Enclosed is a report for your most recent drinking water sample analysis. You will notice that our reporting format has changed. We have consolidated all reports into the "At a Glance" layout in order to conserve natural resources and to provide a more user friendly report.

Please note that the standards presented in the "At a Glance" reports are specifically applicable to **public drinking water supplies**. Public drinking water standards are not enforceable for private water systems, but they can be used for comparative purposes when reviewing sample results. Compare your test results to the public drinking water standards in bold print in the enclosed reports.

**Brief Explanation of Results**

The sample results fall into one of five categories:

- **Primary drinking water standards** are those parameters that may affect human health.
  - If a primary standard is exceeded we have enclosed additional information which describes the parameter, possible reasons for contamination and treatment technologies for you to evaluate.
- **Action levels** are established for specific parameters such as lead and copper, and are considered exceeded if a percentage of samples surpass a certain level within a compliance period. The action required is generally related to managing the water quality in the distribution system to reduce corrosion of lead solder in copper pipes.
- **Secondary drinking water standards** are those parameters that may impact the water supply from an aesthetic point of view, i.e. taste, color, odor, or fixture/laundry staining.
- **Recommended levels** are parameters which a non-regulatory agency has set a recommended level; such as with sodium.
- **No standards or recommendations** are those parameters that may be helpful in determining water quality, but do not have a set standard or recommendation.
  - If a secondary drinking water standard, action level or recommended standard is exceeded; it is recommended that you obtain information about the contaminant to determine if treatment would be desirable.

In any of the above cases, the laboratory can be a source of information, or you may wish to search the internet for scholarly sources, or contact a water treatment company for additional information. This will help you determine if a treatment system is desirable for your drinking water source. Below is a table indicating those parameters that exceed any of the above categories.

Mahoning, SLF Sample ID: 1011017-003A

**List of Parameters That Exceed One of the Above Standards/Action levels/Recommendations**

| Parameter | MCL | Your Results |
|---|---|---|
| Sulfate | 250 mg/l | 265.48 mg/l |
| Sodium | 200 mg/l | 269 mg/l |
| TDS | 500 mg/l | 632 mg/l |
| | | |
| | | |
| | | |

The groundwater monitoring program continues to be an expanding and ongoing project. We appreciate your cooperation and participation in the program and hope that the information provided helps you determine your drinking water quality. We will contact you in the future when additional sampling dates have been scheduled. If you have any questions, please feel free to contact the lab at 330-270-2841. Thank you again for your participation in this program.

Sincerely,

Sandy Senedak, Director
Laboratory Services Program

cc: file
enclosures

CLD, CDLF
CLD-1

| Category | Parameter | MCL | Detection Limits | 5/25/2005 | 12/27/2005 | 8/23/2006 | 10/17/2006 | 5/1/2007 | 10/16/2007 | 04/01/08 | 7/15/2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Primary Drinking Water Standard | **Arsenic** | **10 µg/l** | 5.0 µg/l | ND | ND | ND | ND | Not Analyzed | Not Analyzed | <5 | <5 |
| | **Barium** | **2000 µg/l** | 100 µg/l | 1035 | 893 | ND | ND | ND | <100 | <100 | <100 |
| | **Cadmium** | **5 µg/l** | 10 µg/l | ND | ND | ND | ND | ND | <10 | <10 | <10 |
| | **Chromium** | **100 µg/l** | 20 µg/l | 39.4 | ND | ND | ND | ND | <20 | <20 | <20 |
| | **Fluoride** | **4 mg/l** | 0.02 mg/l | 0.17 | 0.406 | 0.213 | 0.211 | .24 | 0.125 | 0.165 | 0.196 |
| | **Mercury** | **2 µg/l** | 0.20 µg/l | ND | ND | ND | ND | ND | <0.20 | <0.20 | <0.20 |
| | **Nitrates** | **10 mg/l** | 0.5 mg/l | ND | ND | ND | ND | ND | <0.05 | 0.237 | 0.311 |
| | **Selenium** | **50 µg/l** | 2.0 µg/l | ND | ND | ND | ND | Not Analyzed | Not Analyzed | <2 | <2 |
| | **Total Coliform** | **Negative** | NEG/POS | NEG | NEG | NEG | NEG | NEG | NEG | NEG | NEG |
| | **Turbidity** | **5 NTU** | 0.1 NTU | 18.10 | 9.92 | 27 | 22.5 | 13 | 12.04 | 7.33 | 15.37 |
| Action Level | **Copper** | **1300 µg/l** | 10 µg/l | 4 | ND | ND | ND | ND | <10 | <10 | 12.4 |
| | **Lead** | **15 µg/l** | 5.0 µg/l | 1.7 | 5.88 | 7.5 | ND | Not Analyzed | Not Analyzed | <5 | <5 |
| Secondary Drinking Water Standard | **Chloride** | **250 mg/l** | 1.0 mg/l | 69 | 80 | 77 | 76 | 60 | 90 | 67 | 70 |
| | **Iron** | **300 µg/l** | 50 µg/l | 2274 | 2108 | 2451 | ND | 1800 | 945.2 | 2072 | 2144 |
| | **Manganese** | **50 µg/l** | 10 µg/l | 524.6 | 441.7 | 430.2 | 249 | 530 | 441.2 | 471.2 | 454.4 |
| | **pH** | **7-10.5** | 0 pH units | 7.24 | 7.28 | 8.24 | 7.29 | 7.17 | 7.15 | 7.02 | 7.17 |
| | **Silver** | **100 µg/l** | 10 µg/l | ND | ND | ND | ND | ND | <10 | <10 | <10 |
| | **Sulfate** | **250 mg/l** | 1.0 mg/l | 139.53 | 139.12 | 132.12 | 135.83 | 200 | 191.81 | 169.99 | 164.23 |
| | **TDS** | **500 mg/l** | 1.0 mg/l | 601 | 582 | 612 | 613 | 600 | 593 | 634 | 598 |
| | **Zinc** | **5000 µg/l** | 10 µg/l | 241.7 | 182.4 | 64.7 | ND | ND | 16.4 | <10 | <10 |
| Recommended | **Sodium** | **200 mg/l** | 0.10 mg/l | 23 | 23.1 | 29 | 29.7 | 21 | 23 | 27.3 | 29.2 |
| No standards or recommended levels | **Ammonia** | **NA** | 0.02 mg/l | 9.30 | ND | ND | 0.0213 | .14 | <0.02 | <0.02 | <0.02 |
| | **COD** | **NA** | 10 mg/l | ND | ND | ND | 12.353 | ND | <10 | <10 | <10 |
| | **Magnesium** | **NA** | 0.10 mg/l | 27.20 | 38.5 | 15.6 | 19.8 | 21 | 18.1 | 29 | 26.8 |
| | **Potassium** | **NA** | 0.10 mg/l | 1.954 | 2.107 | 1.1 | 1 | 1.2 | 1.2 | 2.4 | 1.8 |
| | **Specific Conductivity** | **NA** | 1.0 µmhos/cm | 898 | 869 | 916 | 917 | 900 | 890 | 952 | 900 |
| | **Total Alkalinity** | **NA** | 1.0 mg/l | 440 | 580 | 300 | 275 | 480 | 330 | 360 | 280 |

MCL=Maximum contaminate level ND= Non-detect (Below the detection limit of the instrument) NA=Not applicable POS=Positive NEG=Negative
Action Level= Action levels are established for select parameters and are considered exceeded if a certain percentage of the samples exceed the action level within a compliance period.

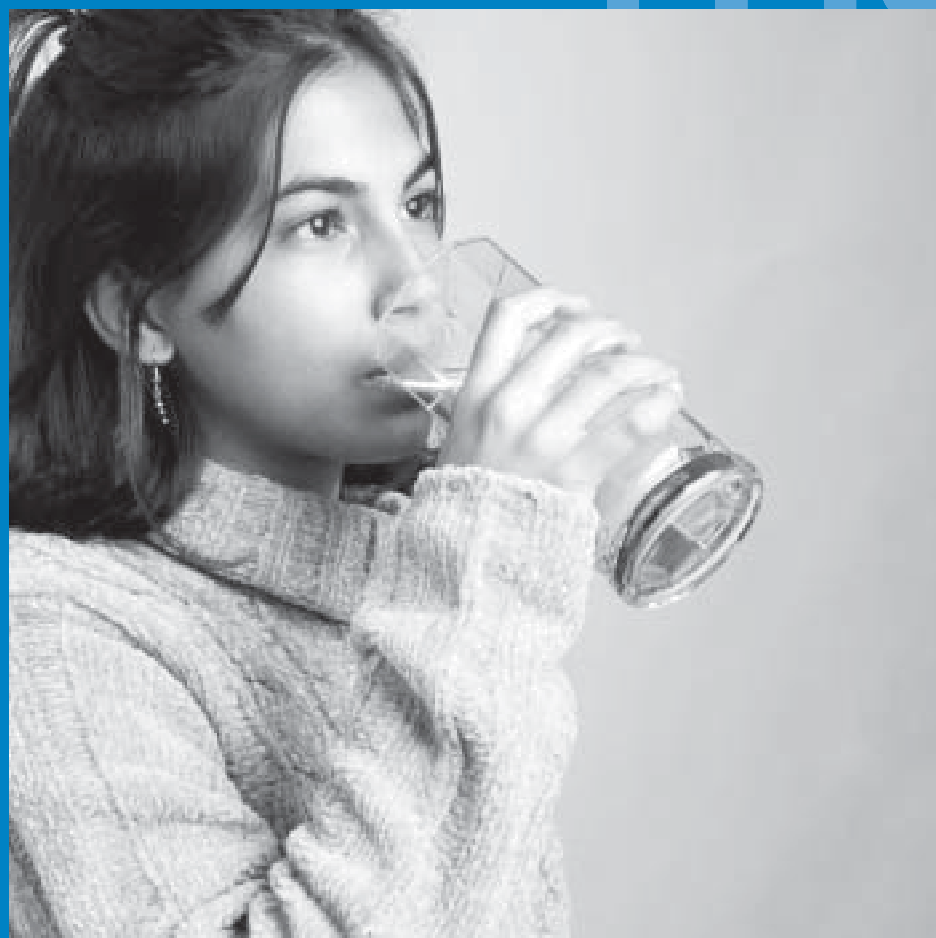
$SO_4$

# Water Tests:

## What Do the Numbers Mean?

Fe

mg



Cl

µg

$H_2S$

PENNSTATE

1855

College of Agricultural Sciences
Agricultural Research and Cooperative Extension

# Table of Contents

## About This Publication

Congratulations! If you are interested in this publication, you must have had your water tested. That's a big step toward ensuring that your water supply is safe to drink. But are you able to understand and interpret what your water test report really means? Water test reports sometimes seem as though they are written in another language. That's where this publication fits in—it will help you translate your water test report into more understandable terms.

If water tests are completely new to you, you might want to read the first few pages, which give a description of a sample water test report and provide specific explanations of drinking water standards and measurement units. If you're more experienced with water tests, you might want to go straight to the detailed discussions of 40 common water quality problems in Pennsylvania or consult the quick reference guide that summarizes these 40 contaminants in one table. References to more detailed written and Web-based publications can be found in many of the topics and near the end of the publication. You can even get some tips on what to do if your water test report indicates a water quality problem. In the Appendices, you'll find a detailed listing of up-to-date drinking water standards and a glossary that defines some of those confusing water quality terms. Finally, you can use the last two pages to compile a record of information essential to the operation of your water supply. The pocket provided inside the back cover is a handy place to store water test reports and other important information (well logs, treatment equipment manuals, etc.).

That water test report may look confusing, but with a little help you can make sense out of it in no time! If you're ready, let's start learning about your report and what it tells you about the safety of your drinking water.

## Why Test Your Water?

If you've had your water tested, you probably did so to find out if it is safe to use as a drinking water supply. Even if your water tastes, smells, and looks fine, water testing is necessary because many contaminants have no obvious odors or tastes. In other cases, where a water quality problem is obvious, testing can determine the exact concentration of the pollutant to assist in determining the best solution to the problem.

Water testing is especially necessary if your house is served by a private water system, because many of these systems have water quality problems. Private water systems include drilled wells, dug wells, springs, or cisterns that serve an individual home. There are no regulations or laws that require water testing, system maintenance, or water treatment on these water supplies. Rather, owners must voluntarily arrange for water testing and must voluntarily correct any problems to provide safe drinking water. Regardless of whether your water supply is private or public, the information in this publication will help you interpret water test results.

If you live in a community that is served by a public water supply (i.e., one source of water for multiple customers), then the water company already does water testing for you. Public water suppliers are required by law to routinely test their water and treat it to meet water quality standards. They are also required to issue water test reports to their customers on a regular basis. This publication may be helpful in interpreting these reports also.

Although drinking water standards are applicable to all types of water supplies, they are not legally binding for private water supplies. It is recommended, however, that private water supply owners maintain their water quality to the same standards required by law for public water supplies.

## Use a Certified Laboratory

Always have your water tested by a certified water testing laboratory. The Pennsylvania Department of Environmental Protection (DEP) certifies water testing laboratories in Pennsylvania to ensure they are using analytical procedures designed to give accurate test results. Be sure to ask if the lab is certified every time you have your water tested. Laboratories are re-evaluated periodically, and their certification status may change. You can obtain a list of certified labs from your local Penn State Cooperative Extension Office or from your local DEP office. Also, your local DEP office can arrange for bacteria testing through their state laboratory.

Be cautious of water test results from uncertified labs. In addition, be cautious of water test results from salespeople and others who say they have their own laboratories or who try to test water at your residence. Always have these tests confirmed by a certified laboratory and, if possible, interpreted by a knowledgeable and neutral third party before taking corrective action.

Once you have received your water test report from the laboratory, you're ready to interpret exactly what it means. The example water test report on the next page will get you started by familiarizing you with the information presented in the report.

**For More Information on Having Your Water Tested**

Testing your water is like a trip to the doctor. If you have no idea what is wrong, the doctor will have to run every known test to pin down the problem, and the cost could be enormous. Fact sheet #F-104, *Water Testing*, is available from your local extension office to help you determine which water tests are most appropriate for your water supply.

## Water Analysis Report

| | |
|---|---|
| Client: John Doe | |
| 12 University Street | |
| Anytown, PA 10000 | |

| | |
|---|---|
| Sample Number: | 1000034 |
| Sample Description: | Well water at kitchen tap |
| Sampled By: | Client |
| Date/Time Sampled: | 3/22/00 10:00 AM |
| Date/Time Sample Received: | 3/22/00 1:00 PM |

| Analysis | Result | Unit | Standard |
|---|---|---|---|
| Total Coliform Bacteria | 20 | per 100 ml | 0 per 100 ml |
| Fecal Coliform Bacteria | ND | per 100 ml | 0 per 100 ml |
| pH | 7.2 | pH units | 6.5 to 8.5 |
| Hardness | 7.3 | gpg | no standard |
| Total Dissolved Solids | 260 | mg/L | < 500 mg/L |
| Iron | 0.4 | mg/L | < 0.3 mg/L |
| Nitrate | 4.23 | mg/L | < 45 mg/L |
| Lead | 11 | µg/L | < 15 µg/L |

**Comments:**

Sample does not meet safe drinking water standards. Total coliform bacteria are present. Iron concentration is above recommended level. Water should be disinfected to remove bacteria. Treatment of iron may be necessary if staining or taste are objectionable.

Submitted by:

Laboratory Director

**ANYLAB LABORATORIES INC.**

# The Components of a Typical Water Test Report

Pennsylvania has dozens of water testing laboratories, each with its own way of presenting results. Your water test may not look exactly like the one shown here, but it probably contains the same basic components. Read about each water test component below and try to find it on your own water test report.

Remember that these are only the most common components of a typical water test report. Some laboratories will include additional information such as the method used for each test (usually an EPA number), the initials of the person that completed each test, and the date each test was completed. This information is generally unimportant to the client.

### 1. Client and Sample Information

Basic information at the top of most water test reports identifies the person who submitted the water sample, where the sample came from, who received it at the laboratory, etc. This is called the chain-of-custody information and could be very important if the results were to be used in any type of legal action.

### 2. Analysis

All water test reports will list the water quality parameters that were tested. The list will include only those that you asked the laboratory to analyze or those that the lab recommended for your water sample. The number of parameters can vary from just a few to dozens of tests. Consult other sections of this publication for a description of each of these tests.

### 3. Results

The most important information on your water test report are the actual results that the laboratory found for your water sample. The numbers indicate the concentration of each water quality parameter in your water sample. In some cases, the unit of measure for each test will be shown next to the result. In others, the units will be shown in a separate column (as in the example test report). The result for each test should be compared to the drinking water standard for that parameter. Sometimes, a water test result will be reported as “ND” (Not Detected), which means that the lab was unable to detect any of that pollutant with its equipment. Similarly, some results may have a less-than sign (<) in front of a number. This result means the sample contained less than the detection level for that test. Detection levels are often set at the permissible drinking water concentration for a particular pollutant. If the less-than symbol (<) appears before a number and the number is equal to the drinking water standard, the water is likely safe to drink for that particular contaminant.

### 4. Units

Concentrations of pollutants are usually measured in water by a unit of weight such as milligrams per liter (mg/L), or by number such as number of bacteria per 100 milliliters of water (#/100 ml). You might see several different measurement units on your water test report. Refer to the section “Understanding Units” on page 6 to learn more about these.

### 5. Standards

Many laboratories include the specific drinking water standards on the report next to each test result. This allows for an easy comparison of your result with the safe or recommended level for each test parameter. A complete list of up-to-date drinking water standards can be found in Appendix I in this publication.

### 6. Comments

Some water testing laboratories will include a brief explanation of your water test results. Specifically, they often will list those pollutants that did not meet the drinking water standard. Occasionally, these comments will also describe the potential harmful effects of pollutants that exceeded the standard and how these pollutants may be removed from the water.

## What Are Drinking Water Standards?

Drinking water standards give the level of a pollutant that is acceptable in water. These standards are set by the U.S. Environmental Protection Agency (EPA) using available research data. The EPA sets standards for contaminants that are known to occur in water, are detectable in water, and cause a health or aesthetic problem in water. EPA sets these standards, but it is up to the Pennsylvania Department of Environmental Protection to enforce the standards when and where they apply.

Two types of drinking water standards are used: primary and secondary. Primary standards are set for contaminants that cause some health effect such as illness, disease, cancer, or another health problem. Adherence to these standards is mandatory for public water systems, but on private water systems these standards are voluntary. Primary standards are also known as Maximum Contaminant Levels or MCLs.

Secondary standards are created for water contaminants that cause aesthetic problems such as bad taste, discoloration, or odor. In the past, these standards were always voluntary and were used mainly as guides. Recently, however, some community water systems have been required to meet some of these secondary standards. Secondary standards are also known as Secondary Maximum Contaminant Levels (SMCLs) or Recommended Maximum Contaminant Levels (RMCLs).

## Understanding Units

All drinking water test results and standards have a unit associated with them. These units give the amount of the pollutant per unit of water. The most common unit is the milligram per liter (mg/L), which expresses the milligrams of a pollutant in every liter of water. Some laboratories prefer to use parts per million (ppm), which is identical to milligrams per liter. Some contaminants that can be measured in very small quantities are reported in micrograms per liter (µg/L), which is identical to a part per billion (ppb). Keep in mind that concentrations expressed in mg/L (or ppm) can be converted to µg/L (or ppb) by multiplying by 1,000, and that µg/L (or ppb) can be converted to mg/L (or ppm) by dividing by 1,000.

**The Most Common Water Test Units**

milligrams per liter (mg/L) = parts per million (ppm)

micrograms per liter (µg/L) = parts per billion

Most pollutants occur in water in very small concentrations. The units shown above are designed to express these small concentrations. The following examples illustrate just how small these units really are.

- One milligram per liter (mg/L) or part per million (ppm) corresponds to one minute in two years or a single penny in $10,000.
- One microgram per liter (µg/L) or part per billion (ppb) corresponds to one minute in 2,000 years or a single penny in $10,000,000.

Although most water quality measurements are expressed in these units, some tests such as bacteria, corrosivity, turbidity, and radon use different units. To learn more about these other units, refer to the discussions on individual parameters in the following section.

## Descriptions of Common Pollutants (by category)

Hundreds of pollutants can occur in drinking water in Pennsylvania. They can be grouped into four basic categories: microbial, inorganic, organic, and radiological. Although over 100 pollutants have drinking water standards (see Appendix I for a complete list), many of these pollutants are very rare in Pennsylvania. The following sections briefly discuss 40 of the most common pollutants in Pennsylvania drinking water. These pollutants are listed alphabetically within the four categories.

## Microbial Pollutants

Microbial pollutants include bacteria, viruses, and protozoans. These are living organisms that are visible in water only with the help of a high-powered microscope. Many different kinds of bacteria, some disease-causing but many not, may be present in a water supply. The tests discussed below are specific bacteria tests that are used to determine whether disease-causing bacteria may be present in the water. Protozoans are less common in water than bacteria, but a few can be problems. Viruses will not be discussed because they rarely occur in Pennsylvania drinking water; however, viruses such as hepatitis are carried by water and can cause serious illness.

### Coliform Bacteria

Coliform bacteria are a large group of bacteria that occur throughout the environment. They are used as an indicator organism to indicate the potential for disease-causing bacteria to be present in water. In other words, if coliform bacteria are present, it is presumed that a contamination pathway exists between the bacteria source and the water supply and that disease-causing bacteria may use this pathway to enter the water supply. Coliform bacteria occur frequently in private water systems, usually from contamination by surface runoff or from human or animal wastes.

Most coliform bacteria do not cause disease, but the greater their number the greater the likelihood that disease-causing bacteria may be present. Since coliforms persist in water longer than most disease-causing organisms, the absence of coliform bacteria leads to the assumption that the water supply is microbiologically safe to drink. Consuming water with coliform bacteria present may cause gastrointestinal illnesses, fever, and other flu-like symptoms. Therefore, the drinking water standard requires that no coliform bacteria be present in public drinking water supplies.

Results from coliform bacteria tests are normally expressed as the number of bacteria colonies present per 100 milliliters (ml) of water. Some laboratories may simply express coliform bacteria results as "Present" (P), or "Absent" (A). In this case, "Present" indicates only that at least one bacterium was present in each 100 ml of water. Occasionally, bacteria results will be expressed as "MPN," which stands for Most Probable Number. This simply means that a statistical relationship was used to estimate the number of bacteria in your sample. Finally, bacteria results also may be reported as "TNTC," or "Too Numerous To Count," meaning the bacteria concentration was too high to quantify.

### Fecal Coliform Bacteria

Fecal coliform bacteria are a smaller group of bacteria within the coliform bacteria group. Water may be tested for fecal coliform bacteria if the total coliform test is positive. Fecal coliform bacteria are specific to the intestinal tracts of warm-blooded animals and are thus a more specific test for sewage or animal waste contamination. The ratio of fecal coliform bacteria to fecal streptococcus bacteria is often used to estimate the source of bacterial contamination (see discussion below). Fecal coliform bacteria levels are expressed as the number of colonies per 100 ml of water. No fecal coliform bacteria are permitted in public drinking water supplies.

### Fecal Streptococcus Bacteria

Fecal streptococcus bacteria are another smaller group of bacteria within the coliform bacteria group that are especially numerous in animal waste (as opposed to human waste). The ratio of fecal coliform to fecal streptococcus bacteria is usually much higher in humans than it is in animals. As a rule of thumb, a fecal coliform to fecal streptococcus ratio greater than 4.0 is indicative of a human source of bacteria such as a septic system. A ratio less than 1.0 is indicative of an animal source of bacteria such as runoff from a feedlot. Ratios between 1.0 and 4.0 are inconclusive about the source of the bacteria. Fecal streptococcus bacteria are expressed as the number of colonies per 100 ml of water. No fecal streptococcus bacteria are permitted in drinking water.

### *E. Coli*

An even more specific bacteria test is the test for *E. coli* (short for *Escherichia coli)*. This is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. A positive *E. coli* result is a strong indication that human sewage or animal waste has contaminated the water.

Hundreds of strains of *E. coli* exist. Although most are harmless and live in the intestines of healthy humans and animals, a few can produce a powerful toxin that causes severe illness and even death. Infection often causes severe bloody diarrhea and abdominal cramps; sometimes the infection causes non-bloody diarrhea. Frequently, no fever is present. It should be noted that these symptoms are common to a variety of diseases and may be caused by sources other than contaminated drinking water.

*E. coli* tests are reported as the number of bacteria per 100 ml of water. The presence of any *E. coli* in a water sample is unacceptable; thus, the primary drinking water standard for *E. coli* is 0 per 100 ml of water.

### Standard Plate Count (Heterotrophic Plate Count)

The Standard Plate Count (SPC) or Heterotrophic Plate Count (HPC) is a more general indicator of bacterial contamination. On some test reports, this also may be referred to as the "Total Bacteria Count." It measures all of the bacteria, including coliform and many other groups, in a water sample. The SPC is usually reported as the number of bacteria per milliliter of sample. There are no drinking water standards for SPC, but if more than 500 bacteria are counted in one milliliter of sample, further testing for total coliform or fecal coliform bacteria is suggested.

### Iron Bacteria

Iron bacteria are a type of bacteria that feed on small amounts of iron in water. Iron bacteria do not constitute a health threat, but they are a nuisance in private water systems because they form gelatinous strands, masses, or thin films that plug pipes, toilets, and plumbing fixtures and reduce flow from wells. Their appearance can vary from orange or brown to clear. Iron bacteria can colonize an entire water system from the well itself through the plumbing, or they may be present only in parts of the plumbing system.

There are no drinking water standards for iron bacteria. Rather, their presence is normally aesthetically degrading enough to require treatment. Water testing is rarely available to determine if iron bacteria are present. Confirmation is usually based upon the visual symptoms in the water.

**For More Information on Bacteria in Water**

Contact your local Penn State Cooperative Extension office and ask for Extension Circular #345, *Safeguarding Wells and Springs from Bacterial Contamination.*

### *Giardia* and *Cryptosporidium*

*Giardia lamblia* and *Cryptosporidium parvum* are small microscopic animals known as protozoa. They both can live in the intestinal tract of mammals, including humans. While there, they multiply by producing oocysts. Infected animals and humans can excrete the oocysts, which can then contaminate water sources. Once ingested, the organism emerges from the protective oocyst and infects the lining of the intestine. Both giardiasis and cryptosporidiosis cause severe diarrhea, nausea, fever, headache, vomiting, and loss of appetite. Both illnesses can be life-threatening to people with depressed immune systems.

Many private water system owners are familiar with *Giardia* and *Cryptosporidium* as a result of publicity following outbreaks of illnesses in public water supplies. Most of these outbreaks have occurred in communities that use surface water supplies (streams, rivers, lakes) where the oocysts can commonly be found. *Giardia* and *Cryptosporidium* are rarely a concern for private water systems using deeper groundwater sources, because the oocysts are efficiently filtered as water passes through soil and rock. Shallow springs or poorly constructed wells that become contaminated with surface water would be most likely to contain *Giardia* and *Cryptosporidium* oocysts. This is one reason that roadside springs are not a good alternative source of drinking water.

Both *Giardia* and *Cryptosporidium* are measured in water by filtering large volumes of the water through a small filter and examining the filter under a microscope for oocysts. Oocysts should be totally absent from water for it to be safe to drink.

**For more information on *Giardia* and *Cryptosporidium*:**

Contact your local extension office and ask for Penn State Agricultural and Biological Engineering Fact Sheet F-134, *Removing Giardia Cysts from Drinking Water.*

Consult the following Pennsylvania Department of Environmental Protection fact sheet: www.dep.state.pa.us/dep/deputate/watermgt/wsm/wsm_dwm/complian/cryto-giardia.htm

## Inorganic Chemicals (IOCs)

The second category of water pollutants includes inorganic chemicals. These are usually substances of mineral origin. Salt, metals, and minerals are examples of inorganic chemicals. The chemicals discussed alphabetically below are the most common inorganic pollutants in Pennsylvania water supplies, or they are of the greatest health concern. Unless otherwise stated, these inorganic chemicals are usually reported in mg/L or ppm units.

### Alkalinity

Alkalinity is a commonly measured water characteristic that has little meaning or importance to the typical homeowner. It is a measure of the ability of water to neutralize acids. Calcium is a major component of alkalinity, as it is with hardness. Thus, if your water has a high alkalinity, it is probably hard also. There is no drinking water standard for alkalinity.

### Arsenic (As)

Arsenic occurs in groundwater from both natural sources and human activities. In drinking water, it is odorless and tasteless. It is relatively rare in Pennsylvania water supplies, compared to those of the western United States.

In Pennsylvania, arsenic can originate natually from certain types of rock, or it may be traced to deep-water brines produced from gas and oil well drilling or from industrial activity. Arsenic has a primary drinking water standard because it can cause skin lesions, circulatory problems, and nervous system disorders. Prolonged exposure also can cause various forms of cancer. The present arsenic drinking water standard is 10 μg/L (0.010 mg/L). A recent survey by the U.S. Geological Survey (USGS) found that arsenic exceeded 10 μg/L in 2% of wells in Pennsylvania.

### Barium (Ba)

Like arsenic, barium occurs naturally in small concentrations in many groundwater supplies. Barium contamination is not common in private water systems in Pennsylvania, but it may occur sporadically in western and northern Pennsylvania near active and abandoned gas and oil wells.

Barium has a primary drinking water standard of 2.0 mg/L because it causes nervous and circulatory system problems, especially high blood pressure. Standard water softeners are effective in removing barium.

### Chloride (Cl)

Chloride is common in Pennsylvania water supplies, but it rarely reaches levels of concern. It occurs naturally in most groundwater but may become elevated due to leaching from salt storage areas around highways or from brines produced during gas well drilling. Other possible sources of chloride are sewage effluent, animal manure, and industrial waste.

Chloride has a secondary drinking water standard of 250 mg/L because it may cause a salty taste in the water. Groundwater in Pennsylvania usually contains less than 25 mg/L of chloride.

### Copper (Cu)

Copper usually originates from corrosion of copper plumbing in the home (see “Corrosivity,” below). Copper has a secondary drinking water standard of 1.0 mg/L because it causes a bitter, metallic taste in water and a blue-green stain in sinks and bathtubs. Copper levels above 1.3 mg/L are a health concern because they may cause severe stomach cramps and intestinal illnesses. Copper can be reduced in water using the corrosion control strategies outlined below.

## Corrosivity

Corrosive water is a term used to describe aggressive water that can dissolve materials with which it comes in contact. It is a problem because many homes have copper or galvanized pipes, lead solder joints, and brass plumbing fixtures. Thus, corrosive water may cause increases in copper and lead concentrations in drinking water. In rare cases, corrosive water may dissolve even PVC plastic plumbing, causing vinyl chloride contamination of the water. This generally occurs only when inferior plastic pipe that was not approved for drinking water systems has been used. Approved plastic pipe is directly stamped with "NSF" (National Sanitation Foundation) and "Drinking Water" on the side.

Symptoms of corrosive water problems include metallic taste, bluish-green stains in sinks and bathtubs, and, in severe cases, small leaks in the plumbing system. Because corrosive water is not a health concern by itself, there is only a secondary or recommended standard that water be noncorrosive.

Water that is soft and acidic ($pH < 7.0$) tends to be more corrosive, but the only true measure of water corrosivity is a stability or saturation index. These indices use chemical characteristics of the water such as hardness and pH to estimate its corrosiveness. A stability index greater than about 6.5 indicates water that is probably corrosive, with higher values being increasingly corrosive. A negative saturation index value likewise indicates a corrosive water supply. The most common saturation index in use is the Langelier Saturation Index (LSI).

Past surveys of private water supplies in Pennsylvania have indicated that corrosive water is a common water quality problem, present in over 60% of the groundwater wells and springs tested. It tends to be most common in northern and western Pennsylvania where more acidic groundwater is prevalent, although areas underlain by Triassic shales in southeastern Pennsylvania also produce corrosive water. It is least common in the agricultural valleys underlain by limestone where groundwater typically has a higher pH and hardness. Cistern water can be quite corrosive.

If your water test indicates that your water is corrosive, you should test your water for copper and lead. Corrosive water problems can be corrected using an acid neutralizing filter or by replacing metal plumbing with NSF-approved plastic components.

## Hardness

Hardness is a general term used to refer to the $CaCO_3$ (calcium carbonate) content of water. Hardness does not pose a health threat, but it does cause aesthetic problems. It can ruin hot water heater elements, reduce soap lathering, and make laundry difficult to clean. Moderate levels of hardness are beneficial because they inhibit plumbing system corrosion. Removal of hardness using a water softener is necessary only if the water is causing aesthetic problems. Use of water softeners may result in undesirable levels of sodium in drinking water and may increase plumbing system corrosion.

Hardness may be reported in milligrams per liter (mg/L) or in a special unit called grains per gallon (gpg). One grain per gallon is equal to about 17 mg/L or parts per million (ppm). Since the level of hardness or calcium carbonate means little to consumers, a chart of water hardness classifications has been developed and appears on the next page. A water hardness of about 90 to 100 mg/L provides excellent corrosion control and is usually acceptable aesthetically, but there are no drinking water standards for hardness.

**For More Information on Water Softening**

Contact your local Penn State Cooperative Extension office and ask for Agricultural and Biological Engineering Fact Sheet F-141, *Water Softening*.

| Classification | Hardness (mg/L or ppm) | Hardness (gpg) |
|---|---|---|
| Soft | Less than 17 | Less than 1.0 |
| Slightly hard | 17 to 60 | 1.0 to 3.5 |
| Moderately hard | 60 to 120 | 3.5 to 7.0 |
| Hard | 120 to 180 | 7.0 to 10.5 |
| Very hard | More than 180 | More than 10.5 |

### Hydrogen Sulfide ($H_2S$)

Hydrogen sulfide ($H_2S$) is a noxious gas that imparts a disagreeable rotten egg odor when dissolved in water. It is a naturally occurring gas that is common in groundwater in parts of Pennsylvania. Very small concentrations of hydrogen sulfide in water are offensive to most individuals. Although hydrogen sulfide is a highly toxic gas, only under the most unusual conditions would it reach levels toxic to humans as a result of its occurrence in drinking water. More often, it is simply an aesthetic odor problem that can be removed using several treatment processes.

### Iron (Fe)

Iron is a common natural problem in groundwater in Pennsylvania that may be worsened by mining activities. It occurs throughout Pennsylvania but is most problematic in the western region of the state. Iron does not occur in drinking water in concentrations of health concern to humans. The secondary drinking water standard for iron is 0.3 mg/L because it causes a metallic taste and orange-brown stains that make water unsuitable for drinking and clothes washing.

### Lead (Pb)

If lead is detected in your drinking water, it probably originated from corrosion of your plumbing system. Lead was a common component of solders used in plumbing systems until it was banned in 1991. In homes built in the early 1900s, lead pipe also may be present. Thus, if your home was built before 1991 and has a metal plumbing system, it is likely that some lead is present. If your water supply is corrosive (see discussion above), then any lead present in the plumbing system may be dissolved into your drinking water. Lead concentrations are usually highest in the first water out of the tap (known as "first-draw" water), since this water has been in contact with the plumbing for a longer time. Lead concentrations typically decrease as water is flushed through the plumbing system.

A survey in 1989 found that about 20% of the private water supplies in Pennsylvania contained lead concentrations above the MCL of 0.015 mg/L (15 μg/L). Lead poses a serious health threat to the safety of drinking water. It is colorless, odorless, and tasteless. Long-term exposure to lead concentrations in excess of the drinking water standard has been linked to many health effects in adults including cancer, stroke, and high blood pressure. At even greater risk are the fetus and infants up to four years of age, whose rapidly growing bodies absorb lead more quickly and efficiently. Lead can cause premature birth, reduced birth weight, seizures, behavioral disorders, brain damage, and lowered IQ in children. The U.S. Environmental Protection Agency considers lead to be the most serious environmental health hazard for children in the United States.

It should be noted that in rare cases, the source of lead in drinking water might be from groundwater pollution rather than corrosion of the plumbing system. Such pollution may be the result of industrial or landfill contamination of an aquifer. The source of the lead usually can be determined by comparing water test results from a first-draw sample versus a sample collected after the water runs for several minutes. If the lead concentration is high in both samples, then the source of the lead is likely from groundwater contamination.

**For More Information on Lead**

Contact your local Extension office and ask for Extension Circular #416, *Lead in Drinking Water.*

This publication is also available online at pubs.cas.psu.edu/FreePubs/ec416.html

### Manganese (Mn)

Like iron, manganese is a naturally occurring metal that can be worsened by mining activities. Manganese at concentrations normally found in drinking water does not constitute a health hazard; however, even small amounts of manganese may impart objectionable tastes or blackish stains to water. For this reason, manganese has a recommended drinking water standard of 0.05 mg/L.

### Nitrate ($NO_3$) or Nitrate Nitrogen ($NO_3$-N)

Nitrate in drinking water usually originates from fertilizers or from animal or human wastes. Nitrate concentrations in water tend to be highest in areas of intensive agriculture or where there is a high density of septic systems. In Pennsylvania, nitrate concentrations tend to be highest in the southeastern and southcentral counties where agriculture is most prevalent.

Nitrate has a primary drinking water standard that was established to protect the most sensitive individuals in the population (infants under 6 months of age and a small component of the adult population with abnormal stomach enzymes). These segments of the population are prone to methemoglobinemia (blue baby disease) when consuming water with high nitrates. The need for a nitrate MCL has been questioned lately because blue-baby disease occurs very rarely in the United States.

Nitrate may be reported on your water test report as either nitrate ($NO_3$) or nitrate-nitrogen ($NO_3$-N). Look carefully at your report to determine which form of nitrate is being reported. The primary drinking water standard or MCL is 10 mg/L as nitrate-nitrogen ($NO_3$-N), but it is 45 mg/L as nitrate ($NO_3$).

**For More Information on Nitrates**

Contact your local Penn State Cooperative Extension office and ask for Agricultural and Biological Engineering Fact Sheet F-136, *Nitrates in Drinking Water.*

### pH

The pH of water is a measure of how acidic or basic the water is. It is measured on the pH scale (from 0 to 14) in pH units. If the pH of water is less than 7.0, it is acidic, and if it is greater than 7.0, it is basic. Water with a pH of exactly 7.0 is considered neutral. If pH values deviate very far from neutral, other water quality problems may be indicated. These would include the presence of toxic metals such as lead (at low pH) and high salt contents (at high pH).

It is recommended that the pH of your water be between 6.5 and 8.5 to minimize other potential water quality problems. Acidic water with a pH less than 6.5 is much more common in Pennsylvania than high-pH water, especially in the northern and western regions of the state. In general, pH is an indicator of other potential water quality problems and is very rarely a problem by itself.

### Sulfate ($SO_4$)

Sulfates normally are present at some level in all private water systems. Sulfates occur naturally as a result of leaching from sulfur deposits in the earth. Private water systems with excessive sulfate in Pennsylvania are generally confined to the western portion of the state or other coal mining regions. Even in these areas, surveys indicate less than 10% of the water supplies have excessive sulfate. Other less common sources are industrial waste and sewage effluent.

Sulfate has a secondary drinking water standard of 250 mg/L because it may impart a bitter taste to the water at this level. A proposal also exists to make sulfate a primary contaminant with an MCL of 500 mg/L, because it may have a laxative effect and cause other gastrointestinal upset above this concentration.

### Total Dissolved Solids (TDS)

The total amount of substances dissolved in water is referred to as the total dissolved solids (TDS) content of water. Waters high in TDS often contain objectionable levels of dissolved salts such as sodium chloride. Thus, high TDS may indicate the presence of other water quality problems. The recommended drinking water standard of 500 mg/L for TDS exists because high-quality waters generally have lower TDS levels.

### Turbidity

Drinking water should be sparkling clear for health and aesthetic reasons. Turbidity refers to fine particles of clay, silt, sand, organic matter, or other material that might reduce the clarity of water. Turbidity makes water unappealing to drink because of its muddy appearance. Particles also might act to shield disease-causing bacteria from chlorine or ultraviolet light treatment and provide nutrients for bacteria and viruses to flourish.

Turbidity usually indicates direct pollution from surface runoff often during or shortly after heavy rainfall. Turbidity might increase in wells because of borehole cave-ins; it also might increase when water levels in the well are low such as during a drought, because the submersible pump may disturb sediments near the bottom of the well.

Turbidity is usually measured in a special unit known as an NTU or Nephelometric Turbidity Unit. Drinking water should not exceed 1 NTU, for both health and aesthetic reasons. Water with less than 1 NTU of turbidity is essentially clear to the naked eye. Water with more than 1 NTU of turbidity makes disinfection to kill bacteria difficult and is the primary reason for the 1 NTU standard.

## Organic Chemicals

Organic chemicals are a large group of over 100 mostly man-made chemicals. They can occur in drinking water sources from industrial activity, landfills, gas stations, pesticide use, or air deposition. Organic chemicals vary in their ability to pollute groundwater and their toxicity. Many organic chemicals are carcinogenic (cancer causing), so they often have very low drinking water standards, usually measured in µg/L. Remember that µg/L are the same as ppb (parts per billion).

Generally speaking, organic chemicals can be grouped into two major categories: volatile organic chemicals (VOCs) and nonvolatile or synthetic organic chemicals (SOCs). The discussion below introduces these general groups of organic chemicals and describes in detail the most common examples in each group. Specific drinking water standards for all organic chemicals are given in Appendix I in the back of this publication. More detailed information on organic pollutants can be found at the following locations.

**For More Information on Organic Chemicals**

Agency for Toxic Substances and Disease Registry (ATSDR)
1-888-422-8737 (toll free)
or online at
www.atsdr.cdc.gov/toxfaq.html

U.S. Environmental Protection Agency Fact Sheets on Common Organic Pollutants
www.epa.gov/safewater/hfacts.html

### Volatile Organic Chemicals (VOCs)

VOCs are man-made compounds that volatilize from water into air. They present a health risk not only from drinking contaminated water, but also from inhaling VOCs that escape from the water as it is used during showering or other home uses. VOCs also are absorbed directly through the skin during bathing and showering. They are commonly used as solvents, fuels, paints, or degreasers. Virtually all VOCs produce an odor in water, although it may not be obvious before the drinking water standard is exceeded. Nearly all VOCs have primary drinking water standards, because they are carcinogenic (cancer-causing) or cause damage to the liver, kidneys, nervous system, or circulatory system.

VOCs are not common in private water systems in Pennsylvania, but they are becoming a more important concern as industrial activities, landfills, gas stations, and other sources of these pollutants encroach on rural areas. The U.S. Geological Survey conducted a recent survey of 118 wells in southern and eastern Pennsylvania. The survey analyzed well water for 60 different VOCs and detected at least one VOC in 27% of the samples. (Although the VOCs were commonly detected, none of the samples exceeded drinking water standards.) VOC contamination of wells was much more common in urban areas than agricultural areas.

Dozens of VOCs are regulated in public water supplies, but the most common are described below. Consult Appendix I for a complete list of drinking water standards for all regulated VOCs.

### Benzene

Benzene is a clear, colorless liquid that is used primarily as an industrial solvent and chemical intermediate. It is lighter than water, migrates easily in groundwater, and is slow to decay. It is also present as a gasoline additive. Because it is a known human carcinogen, benzene has a primary drinking water standard of 0.005 mg/L (5 µg/L).

### Carbon Tetrachloride

Carbon tetrachloride is a colorless liquid that is heavier than water but migrates easily in groundwater. It has been used mostly for the production of chlorofluorocarbons and in the dry-cleaning industry. Carbon tetrachloride has a primary drinking water standard of 0.005 mg/L (5 µg/L) because it is a probable human carcinogen with other acute effects on the gastrointestinal and nervous systems.

### Chloroform

Chloroform is a colorless liquid that is used primarily to make other chemicals. It also can be found in small amounts when chlorine is added to water. Chloroform travels easily in groundwater and does not easily degrade. Chloroform is believed to be a carcinogen. It has been one of the most commonly reported organic chemicals in Pennsylvania groundwater.

Chloroform is one of a group of organics known as trihalomethanes or THMs. No specific drinking water standard exists for chloroform, but the primary standard for THMs is 0.08 mg/L (80 µg/L).

### MTBE (Methyl Tert-Butyl Ether)

MTBE is the most common organic chemical found in Pennsylvania groundwater. It has been used extensively as a gasoline additive in some parts of the United States to reduce air pollution emissions from automobiles. It smells like turpentine and can often be detected in water at low concentrations. Most MTBE originates from gasoline spills or leaking underground storage tanks. It is more water-soluble than other components of gasoline, so it contaminates groundwater more easily. Once in groundwater, MTBE is slow to decay. MTBE is a possible human carcinogen, but little information is available on other health effects. Pennsylvania presently has no drinking water standard, but numerous other states have set standards in the 0.02 to 0.2 mg/L range (20 to 200 µg/L). More information on MTBE is available online at the U.S. Environmental Protection Agency and U.S. Geological Survey Web sites listed at the end of this publication.

### Tetrachloroethylene (PCE) and Trichloroethylene (TCE)

Tetrachloroethylene (commonly known as PCE) and Trichloroethylene (commonly known as TCE) are similar chemicals that have been found in Pennsylvania around industrial sites and landfills. Most of the groundwater contamination from these chemicals has occurred due to improper disposal of industrial wastes. Both chemicals are used as industrial solvents for metal degreasing, but PCE is used primarily in the dry-cleaning industry. Both are heavier than water and move freely through soil and groundwater, but TCE is much more water-soluble than PCE. PCE is a possible carcinogen that causes liver, kidney, and nervous system damage. TCE is a probable carcinogen that also causes acute effects to the liver, kidneys, and central nervous system. Both PCE and TCE have primary drinking water standards of 0.005 mg/L (5 µg/L).

### Xylenes

Xylenes are a component of gasoline. They also are used in the manufacturing of some chemicals, and therefore appear commonly in industrial wastes. Xylenes cause liver, kidney, and nervous system damage. Xylenes biodegrade and move slowly in groundwater. Xylene has been reported in much higher concentrations than most other VOCs in Pennsylvania, but the drinking water standard for xylenes is also much higher (10 mg/L or 10,000 µg/L).

**For More Information on Volatile Organic Chemicals (VOCs)**

U.S. Geological Survey, Water Resources Investigations Report 96-4141
*Occurrence and Concentrations of Volatile Organic Compounds in Shallow Ground Water in the Lower Susquehanna River Basin, Pennsylvania and Maryland*
pa.water.usgs.gov/reports/wrir_96-4141/report.html

*Pennsylvania Department of Environmental Protection*
*Citizen's Guide to Volatile Synthetic Organic Chemicals in Drinking Water*
www.dep.state.pa.us/dep/deputate/watermgt/WSM/Facts/BK0208_TOC.htm (Also available from your local DEP office.)

## Nonvolatile or Synthetic Organic Chemicals (SOCs)

Nonvolatile organic chemicals are also known as Synthetic Organic Chemicals or SOCs. Nearly all SOCs are pesticides, with a few notable exceptions (PCBs and dioxin). They differ from VOCs because they do not escape readily into the air from water.

Dozens of pesticides, including herbicides, insecticides, and fungicides, are used throughout Pennsylvania on crops, golf courses, and lawns. The risk to private water supplies from pesticide applications depends on many factors including the amount, mobility, and toxicity of the pesticide, the proximity of the application to the water supply, and the depth and construction of the water source.

Pesticides are not common in private water supplies, but they are often detected in agricultural areas of the state. A 1993 study by Penn State scientists found detectable residues of at least one pesticide in 27% of the rural wells surveyed in corn-producing regions of Pennsylvania. (Although the pesticides were commonly detected, none of these wells contained a concentration above the drinking water standard.) Pesticide concentrations are generally higher in wells located in limestone, which includes most of the prime agricultural regions of Pennsylvania.

Detailed descriptions are given below for some of the pesticides most often found in Pennsylvania groundwater. For more information on these and other less common pesticides, consult the following:

**For More Information on Pesticides**

U.S. Environmental Protection Agency
www.epa.gov/pesticides/

Penn State Pesticide Education Program
www.cas.psu.edu/docs/casdept/pested/index.html

Publication NRAES-34, *Pesticides and Groundwater*, can be ordered for $5.00 from NRAES, www.nraes.org.

### Atrazine

Atrazine is the most commonly used herbicide in Pennsylvania. It is applied to nearly 90% of the corn crop in the state. It is water-soluble, moves easily into groundwater and surface water after application, and is by far the most common pesticide reported in private water supplies in Pennsylvania. In a 1993 study, Atrazine was detected in 22% of private water supplies in corn-producing regions of Pennsylvania. Because it is classified as a possible human carcinogen that also damages the liver, kidney, and heart, Atrazine has a primary drinking water standard of 0.003 mg/L (3 µg/L).

### 2,4-Dichlorophenoxyacetic Acid (2,4-D)

2,4-D is widely used to kill broadleaf weeds in farm fields and pastures and on lawns and golf courses. It also is used to kill algae and aquatic plants in ponds and lakes. 2,4-D damages the liver, circulatory, and nervous systems. Like atrazine, it is one of the most commonly used pesticides in Pennsylvania and also one of the most commonly found in groundwater in agricultural areas of the state. 2,4-D has a primary drinking water standard of 0.07 mg/L (70 µg/L).

### Chlorpyrifos

Chlorpyrifos, also known as Dursban, is one of the most commonly used insecticides on corn crops in Pennsylvania. It is also used to control pests on cattle, and it is widely used around the home for control of cockroaches, fleas, and termites. Chlorpyrifos does not mix well with water and sticks tightly to soil particles. It was detected in trace amounts in a small percentage of private water systems in a 1993 study. Chlorpyrifos is presently considered a possible human carcinogen. No drinking water standard exists for chlorpyrifos, but the U.S. Environmental Protection Agency recommends that children not drink water containing levels greater than 0.03 mg/L. The U.S. EPA recently announced a ban on the production of chlorpyrifos, starting in June 2000.

### Glyphosate

Glyphosate is one of the most widely used pesticides in the United States. It is a herbicide used mostly for control of broadleaf weeds and grasses in pastures, corn, soybeans, and lawns. It is a component of the often-used herbicide Roundup. Glyphosate has a primary drinking water standard of 0.7 mg/L (700 µg/L) because it causes kidney damage and reproductive effects after long-term exposure. Glyphosate is strongly adsorbed to soil and does not readily move to or in groundwater.

### Metolachlor

Metolachlor is the second most commonly used herbicide on corn in Pennsylvania. It is slightly less mobile than atrazine but still moves easily through soil to groundwater. A 1993 survey of private water systems in Pennsylvania found metolachlor to be the third most commonly detected pesticide in the state.

There are no reported short-term effects from exposure to metolachlor in water, but it is listed as a possible carcinogen with prolonged exposure. No drinking water standard exists, but further testing is being done by the U.S. Environmental Protection Agency. In the interim, the EPA has issued a health advisory for metolachlor of 0.07 mg/L (70 µg/L).

### Simazine

Simazine is commonly used for control of broad-leaved and grassy weeds on crops, orchards, and Christmas tree farms. It is also used to control plants and algae in ponds and lakes. Simazine has a primary drinking water standard of 0.004 mg/L (4 µg/L) because it is a probable carcinogen that also can cause damage to the testes, kidneys, liver, and thyroid after long exposure. Simazine travels easily through soils to groundwater and persists in groundwater for long periods of time.

## Other Synthetic Organic Chemicals

### Dioxin (2,3,7,8-TCDD)

Dioxin (also known as 2,3,7,8-Tetrachlorodibenzo-1,4-dioxin or 2,3,7,8-TCDD) is a contaminant formed in the production of some chlorinated organic compounds, including a few herbicides. It may also be formed when some chlorinated organic chemicals are burned. Dioxin has been linked to a variety of health effects including liver damage, reproductive effects, birth defects, and cancer. Most dioxin in water comes from improper disposal of industrial wastes. It is not very water-soluble, and most dioxin is found adhering to sediment or organic particles. It does not move easily into groundwater because it is usually trapped in soil. It has the lowest drinking water standard of any regulated substance (0.00000003 mg/L or 0.00003 µg/L).

### Polychlorinated Biphenyls (PCBs)

PCBs are a group of manufactured organic chemicals that are odorless and tasteless in water. They have been used widely as insulating materials, coolants, and lubricants in electrical equipment. The manufacture of PCBs stopped in the United States in 1977 because of health effects, but products containing PCBs are still prevalent. Most PCBs in groundwater originate from improper waste disposal. In water, a small amount of PCBs may remain dissolved, but a larger amount sticks to organic particles and sediments. PCBs have been shown to cause numerous health effects including liver, kidney, and nervous system damage. They are also considered probable carcinogens. As a result, a primary drinking water standard of 0.0005 mg/L (0.5 µg/L) exists for PCBs.

## Radiological Pollutants

Radioactivity usually occurs in water from radium, uranium, or radon. These materials emit radioactivity as alpha, beta, or gamma radiation. Each form of radiation affects the human body differently, yet all can lead to cancer. Radioactivity in water is normally measured in picocuries per liter (pCi/L). Although several drinking water standards exist for radioactivity (see Appendix I), radon is likely to be the most common problem in Pennsylvania.

### Radon

Radon is a naturally occurring radioactive gas formed underground by the decay of uranium or radium deposits. Radon can enter groundwater as it escapes from surrounding rocks. The gas is then released during household uses of the water such as showering, dishwashing, or laundering. Radon has been shown to cause lung cancer upon inhalation, but ingestion of radon in water is not thought to be a major health concern. Thus, the most serious threat from radon in water is the inhalation of escaping gas during showering or bathing. For this reason, the U.S. Environmental Protection Agency has proposed a primary drinking water standard for radon in water of 300 pCi/L.

Recent surveys by the Pennsylvania Department of Environmental Protection and the U.S. Geological Survey indicate that over 60% of the private water supplies in Pennsylvania contain more than 300 pCi/L of radon. The problem is most severe in southeastern counties, but it is present throughout the state.

**For More Information on Radon in Water**

Pennsylvania Department of Environmental Protection
Radon Hotline: 1-800-237-2366

Penn State College of Agricultural and Biological Engineering Fact Sheet F-135, *Reducing Radon in Drinking Water*, is available from your local extension office.

U.S. EPA Fact Sheet
www.epa.gov/safewater/radon/qa1.html

## Need More Information?

Do you still have questions? There are numerous sources of both written and online information related to drinking water and interpreting water test results. In addition to the specific references listed throughout this circular, the following general locations may be helpful for finding more information on interpreting water test information.

### Your Local Penn State Cooperative Extension Office

Penn State Cooperative Extension has many agents and university specialists trained in water resources who can help solve your water supply problems. Numerous publications also are available on many water issues.

Water publications online
pubs.cas.psu.edu/Water.html
www.sfr.cas.psu.edu/water

### U.S. Environmental Protection Agency

Safe Drinking Water Hotline
1-800-426-4791

Office of Groundwater and Drinking Water
www.epa.gov/ogwdw/

U.S. EPA Drinking Water and Health
www.epa.gov/safewater/dwhealth.html

### U.S. Department of Agriculture—National Extension Water Quality Program

www.usawaterquality.org/themes/health/default.html

### Pennsylvania Department of Environmental Protection

Bureau of Water Supply Management
www.dep.state.pa.us/dep/deputate/watermgt/WSM/WSM.HTM

### U.S. Geological Survey

www.usgs.gov/
water.usgs.gov/pandp.html

## What's Your Next Step?

If your water test has indicated a problem with your water, you're probably wondering what you should do about it. You have a number of options.

### More Water Testing?

In some cases, further water testing may be a good idea. If your first water test was not done by a certified laboratory, then you should arrange to have your water retested by a certified lab to confirm the results. Even if a certified lab was used for the first test, you may want to have them retest for parameters that were shown to be a problem, before you invest in water supply improvements.

### Maintenance

Some simple maintenance on your water supply may take care of some problems. For example, making sure that the ground slopes away from your well and that it has a good sanitary seal may help prevent surface water contamination of your well and thereby reduce coliform bacteria contamination.

### Pollution Prevention

If the source of your water quality problem is obvious, you may be able to take some action to reduce or remove the source. For example, if your water contains excessive amounts of copper and/or lead, you can probably eliminate this problem by removing your metal plumbing and replacing it with approved PVC plastic pipes.

### New Source

In some cases, it may be easier and less expensive to develop a new source of water. This might include drilling a new well at a different location away from a source of pollution, developing a more shallow or deeper well or spring to avoid contaminated groundwater, or building a rainwater cistern to avoid contaminated groundwater altogether.

### Water Treatment

Water treatment processes are available that remove many contaminants from water to make it drinkable. The other options listed above should be considered and compared to the cost of treatment equipment and maintenance.

Specific publications on treatment and removal of some pollutants have been referenced throughout this circular. In addition, you might want to consult the following publications before purchasing water treatment equipment.

**For More Information on Water Treatment**

Contact your local Penn State Cooperative Extension office and ask for publication NRAES-48, *Home Water Treatment* (available for $15.00), or Agricultural and Biological Engineering Fact Sheet F-131, *Home Water Treatment in Perspective*.

NSF—National Sanitation Foundation
www.nsf.org
An independent organization that tests and certifies water treatment equipment.

# Appendix I—Drinking Water Standards as of April 2000

| Parameter | Standard | Unit | Page Number |
|---|---|---|---|
| **Microbial (all are primary standards)** | | | |
| Total Coliform Bacteria | 0 | bacteria per 100 ml | 7 |
| Fecal Coliform Bacteria | 0 | bacteria per 100 ml | 7 |
| *E. Coli* | 0 | bacteria per 100 ml | 8 |
| *Giardia Lamblia* | 0 | oocysts | 8 |
| *Cryptosporidium Parvum* | 0 | oocysts | 8 |
| **Inorganic Chemicals with Primary Standards** | | | |
| Antimony (Sb) | 0.006 | mg/L | |
| Arsenic (As) | 0.010 | mg/L | 9 |
| Asbestos | 7 million | fibers/L | |
| Barium (Ba) | 2 | mg/L | 9 |
| Beryllium (Be) | 0.004 | mg/L | |
| Bromate | 0.01 | mg/L | |
| Cadmium (Cd) | 0.005 | mg/L | |
| Chlorite | 1.0 | mg/L | |
| Chromium (Cr) | 0.1 | mg/L | |
| Copper (Cu) | 1.3 | mg/L | 9 |
| Cyanide | 0.2 | mg/L | |
| Fluoride (Fl) | 4 | mg/L | |
| Lead (Pb) | 0.015 | mg/L | 11 |
| Mercury (Hg) | 0.002 | mg/L | |
| Nitrate (as Nitrogen) ($NO_3$-N) | 10 | mg/L | 12 |
| Nitrite (as Nitrogen) ($NO_2$-N) | 1 | mg/L | |
| Nitrate + Nitrite (as Nitrogen) | 10 | mg/L | |

**Note:** Standards in mg/L can be converted to µg/L units by multiplying by 1,000.

| Parameter | Standard | Unit | Page number |
|---|---|---|---|
| Selenium (Se) | 0.05 | mg/L | |
| Sulfate ($SO_4$) (proposed) | 500 | mg/L | 12 |
| Thallium (Tl) | 0.002 | mg/L | |
| **Volatile Organic Chemicals (all are primary standards)** | | | |
| Benzene | 0.005 | mg/L | 14 |
| Carbon Tetrachloride | 0.005 | mg/L | 14 |
| Chlorobenzene | 0.1 | mg/L | |
| o-Dichlorobenzene | 0.6 | mg/L | |
| p-Dichlorobenzene | 0.075 | mg/L | |
| 1,2-Dichloroethane | 0.005 | mg/L | |
| 1,1-Dichloroethylene | 0.007 | mg/L | |
| cis-1,2-Dichloroethylene | 0.07 | mg/L | |
| trans-1,2-Dichloroethylene | 0.1 | mg/L | |
| Dichloromethane | 0.005 | mg/L | |
| 1,2-Dichloropropane | 0.005 | mg/L | |
| Ethylbenzene | 0.7 | mg/L | |
| Monochlorobenzene | 0.1 | mg/L | |
| Styrene | 0.1 | mg/L | |
| Tetrachloroethylene (PCE) | 0.005 | mg/L | 14 |
| Toluene | 1 | mg/L | |
| 1,2,4-Trichlorobenzene | 0.07 | mg/L | |
| 1,1,1-Trichloroethane | 0.2 | mg/L | |
| 1,1,2-Trichloroethane | 0.005 | mg/L | |
| Trichloroethylene (TCE) | 0.005 | mg/L | 14 |
| Total Trihalomethanes | 0.08 | mg/L | |
| Vinyl Chloride | 0.002 | mg/L | |
| Xylenes (Total) | 10 | mg/L | 14 |

| Parameter | Standard | Unit | Page Number |
|---|---|---|---|
| **Synthetic Organic Chemicals (all are primary standards)** | | | |
| Alachlor | 0.002 | mg/L | |
| Atrazine | 0.003 | mg/L | 15 |
| Benzo(a)pyrene | 0.0002 | mg/L | |
| Carbofuran | 0.04 | mg/L | |
| Chlordane | 0.002 | mg/L | |
| 2,4-D | 0.07 | mg/L | 15 |
| Dalapon | 0.2 | mg/L | |
| Dibromochloropropane (DBCP) | 0.0002 | mg/L | |
| Di(2-Ethylhexyl) Adipate | 0.4 | mg/L | |
| Di(2-Ethylhexyl) Phthalate | 0.006 | mg/L | |
| Dinoseb | 0.007 | mg/L | |
| Diquat | 0.02 | mg/L | |
| Endothall | 0.1 | mg/L | |
| Endrin | 0.002 | mg/L | |
| Ethylene Dibromide (EDB) | 0.00005 | mg/L | |
| Glyphosate | 0.7 | mg/L | 15 |
| Heptachlor | 0.0004 | mg/L | |
| Heptachlor Epoxide | 0.0002 | mg/L | |
| Hexachlorobenzene | 0.001 | mg/L | |
| Hexachlorocyclopentadiene | 0.05 | mg/L | |
| Lindane | 0.0002 | mg/L | |
| Methoxychlor | 0.04 | mg/L | |
| Oxamyl (Vydate) | 0.2 | mg/L | |
| PCBs | 0.0005 | mg/L | 16 |
| Pentachlorophenol | 0.001 | mg/L | |
| Picloram | 0.5 | mg/L | |
| Simazine | 0.004 | mg/L | 16 |
| 2,3,7,8-TCDD (Dioxin) | 0.00003 | µg/L | 16 |
| Toxaphene | 0.003 | mg/L | |
| 2,4,5-TP (Silvex) | 0.05 | mg/L | |

| Parameter | Standard | Unit | Page Number |
|---|---|---|---|
| **Radionuclides (all are primary standards)** | | | |
| Alpha emitters | 15 | pCi/L | |
| Radium 226 + 228 | 5 | pCi/L | |
| Radium 226 | 20 | pCi/L | |
| Radium 228 | 20 | pCi/L | |
| Beta-particle & photon emitters | 4 | mrem | |
| Radon (proposed) | 300 | pCi/L | 16 |
| Uranium | 30 | µg/L | |
| **Inorganic Chemicals with Secondary Drinking Water Standards** | | | |
| Aluminum (Al) | 0.05-0.2 | mg/L | |
| Chloride (Cl) | 250 | mg/L | 9 |
| Color | 15 | color units | |
| Copper (Cu) | 1.0 | mg/L | 9 |
| Corrosivity | Noncorrosive | | 10 |
| Fluoride | 2 | mg/L | |
| Foaming Agents | 0.5 | mg/L | |
| Iron (Fe) | 0.3 | mg/L | 11 |
| Manganese (Mn) | 0.05 | mg/L | 12 |
| Odor | 3 | T.O.N. | |
| pH | 6.5-8.5 | pH units | 12 |
| Silver (Ag) | 0.1 | mg/L | |
| Sulfate ($SO_4$) | 250 | mg/L | 12 |
| Total Dissolved Solids (TDS) | 500 | mg/L | 12 |
| Zinc (Zn) | 5 | mg/L | |

# Appendix II—Glossary of Common Terms and Abbreviations

**Acid Mine Drainage**
Drainage of water from areas that have been mined for coal or other mineral ores; the water has low pH, sometimes less than 2.0 because of its contact with sulfur-bearing minerals, and often contains metals in concentrations toxic to aquatic life.

**Acidic**
The condition of water or soil containing a sufficient amount of acid substances to lower the pH below 7.0.

**Action Level**
The level of lead or copper which, if exceeded, triggers treatment or other requirements that a public water system must follow.

**Acute Health Effect**
An immediate effect that may result from exposure to certain drinking water contaminants.

**Alkaline**
The condition of water or soil containing a sufficient amount of alkali substances to raise the pH above 7.0.

**Background Level**
The average presence of a substance in the environment or occurring naturally.

**Bacteria**
Microscopic living organisms usually consisting of a single cell. Some bacteria in soil, water, or air may cause human, animal, and plant health problems.

**Calcium Carbonate ($CaCO_3$) Equivalent**
An expression of the concentration of specified constituents in water, in terms of their equivalent value to calcium carbonate. For example, the hardness in water caused by calcium, magnesium, and other ions is usually described as calcium carbonate equivalent.

**Carcinogen**
Any substance that produces cancer in an organism.

**Central Nervous System (CNS)**
Portion of the nervous system consisting of the brain and spinal cord.

**Chronic Health Effect**
The possible result of exposure over many years to a drinking water contaminant at levels above its MCL.

**Cistern**
A storage facility used to store water for a home or farm. Often used to store rain water.

**Coliform**
A group of bacteria found in the intestines of warm-blooded animals (including humans) and in plants, soil, air, and water. Fecal coliforms are a specific class of bacteria that inhabit only the intestines of warm-blooded animals. The presence of coliform is an indication that the water is polluted and may contain disease-causing organisms.

**Conductivity**
A measure of the ability of water to carry an electric current. Related to the total dissolved solids (TDS) in the water.

**Contaminant**
Any physical, chemical, biological, or radiological substance or matter that has an adverse effect on air, water, or soil.

**Corrosivity**
An indication of the corrosiveness of a water sample, as described by the water pH, alkalinity, hardness, temperature, total dissolved solids, and dissolved oxygen concentration. The Langelier Index combines several of these features and is the commonly accepted measure of corrosivity.

***Cryptosporidium Parvum***
Flagellate protozoan that is shed during its oocyst stage with the feces of man and animals. When water containing these oocysts is ingested, the protozoan causes a severe gastrointestinal disease.

**Exposure**
Contact with a chemical or physical agent.

**Fecal Coliform Bacteria**
Bacteria found in the intestinal tracts of animals. Their presence in water is an indicator of pollution and possible contamination by pathogens.

**Filtration**
A process for removing particulate matter from water by passage through porous media.

**First Draw**
The water that immediately comes out when a faucet is first opened. This water is likely to have the highest levels of lead and copper contamination from plumbing materials.

**Gallons Per Minute (gpm)**
A common unit used to express the flow of water over time.

**Gastroenteritis**
An inflammation of the stomach and intestine resulting in diarrhea, with vomiting and cramps when irritation is excessive. When caused by an infectious agent, it is often associated with fever.

***Giardia Lamblia***
Flagellate protozoan that is shed during its oocyst stage with the feces of man and animals. When water containing these oocysts is ingested, the protozoan causes a severe gastrointestinal disease called giardiasis.

**Grain Per Gallon (gpg)**
A unit of measure for hardness, equal to 17.1 mg/L.

**Gram (g)**
A unit of mass (weight) equivalent to one milliliter of water at 4 degrees Celsius. 1/454 of a pound.

**Granular Activated Carbon (GAC)**
Material used in water treatment devices to remove organic chemicals, radon, and other pollutants.

**Gross Alpha Particle Activity**
The total radioactivity due to alpha particle emission, as inferred from measurements on a dry sample. Alpha particles do not penetrate solid materials.

**Gross Beta Particle Activity**
The total radioactivity due to beta particle emission, as inferred from measurements on a dry sample. Beta particles penetrate solid materials and are more hazardous.

**Groundwater**
The supply of fresh water found beneath the Earth's surface. Usually in aquifers, which are often used for supplying wells and springs. Because groundwater is a major source of drinking water, there is growing concern over areas where leaching agricultural or industrial pollutants or substances from leaking underground storage tanks are contaminating groundwater.

**Hard Water**
Alkaline water containing dissolved salts that interfere with some industrial processes and prevent soap from lathering. Some textbooks define hard water as water with a hardness of more than 100 mg/L (as calcium carbonate).

**Hardness**
A characteristic of water caused mainly by the salts of calcium and magnesium such as bicarbonate, calcium sulfate, chloride, and nitrate. Excessive hardness in water is undesirable because it causes the formation of soap curds, increased use of soap, deposition of scale in boilers, damage in some industrial processes, and sometimes objectionable tastes in drinking water.

**Heavy Metals**
Metallic elements with high atomic weights; e.g., mercury, chromium, cadmium, arsenic, and lead. They can damage living things at low concentrations and tend to accumulate in the food chain.

**Heterotrophic Plate Count (HPC)**
A measure of the total number of bacteria in a sample. Also known as the Standard Plate Count (SPC).

**Inorganic Chemicals (IOCs)**
Chemicals of mineral origin.

**Maximum Contaminant Level (MCL)**
The maximum level of a health-related contaminant permitted in a public water system. Also known as a primary drinking water standard.

**Maximum Contaminant Level Goal (MCLG)**
The maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and which allows an adequate margin of safety. Maximum contaminant level goals are nonenforceable health goals.

**Microgram (µg)**
One-millionth of a gram.

**Micrograms Per Liter (µg/L)**
One microgram of a substance dissolved in each liter of water. This unit is equal to parts per billion (ppb).

**Microorganisms**
Living organisms that can be seen individually only with the aid of a microscope.

**Milligram (mg)**
One-thousandth of a gram.

**Milligrams Per Liter (mg/L)**
A measure of concentration of a dissolved substance. A concentration of one mg/L means that one milligram of a substance is dissolved in each liter of water. For practical purposes, this unit is equal to parts per million (ppm).

**Most Probable Number (MPN)**
MPN is the Most Probable Number of coliform group organisms per unit volume of sample water as determined by a statistical relationship. Expressed as the number of organisms per 100 ml of sample water.

**ND**
Abbreviation for "Not Detected." Laboratory expression for a concentration of a substance in water too small to be detected by the instrumentation used.

**Nonpotable**
Water that may contain objectionable pollution, contamination, minerals, or infective agents and is considered unsafe and/or unpalatable for drinking.

**National Sanitation Foundation (NSF)**
Independent testing organization for water treatment equipment.

**Nephelometric Turbidity Unit (NTU)**
Unit of measure for turbidity in water.

**Nonvolatile Organic Chemicals**
Organic chemicals that do not escape readily into air from water. Also known as Synthetic Organic Chemicals (SOCs).

**Organics**
A term used to refer to chemical compounds made from carbon molecules.

**Parts Per Million (ppm)**
Parts per million parts, a measurement of concentration on a weight or volume basis. This term is equivalent to milligrams per liter (mg/L).

**Parts Per Billion (ppb)**
Parts per billion parts, a measurement of concentration on a weight or volume basis. This term is equivalent to micrograms per liter (µg/L).

**Pathogens**
Microorganisms that can cause disease in other organisms or in humans, animals, and plants. They may be bacteria, viruses, or parasites, and are found in sewage in runoff from animal farms or rural areas populated with domestic and/or wild animals, and in water used for swimming.

**Pesticide**
Any substance or chemical designed or formulated to kill or control weeds or animal pests.

**pH**
An expression of the intensity of the basic or acid condition of a liquid. Mathematically related to the hydrogen ion concentration, the pH may range from 0 to 14, where 0 is most acid, 14 most basic, and 7 neutral. Natural waters usually have a pH between 6.5 and 8.5.

**Picocurie per liter (pCi/L)**
A measure of radioactivity in water, commonly used for radon. One picocurie of radioactivity is equivalent to 0.037 nuclear disintegrations per second as measured by a Geiger counter.

**Potable Water**
Water that is safe and satisfactory for drinking and cooking.

**Primary Drinking Water Standard**
See Maximum Contaminant Level (MCL).

**Public Water System**
A system for providing piped water for human consumption to the public, having at least 15 service connections or regularly providing water at least 60 days out of the year to 25 or more people per day. A public water system is either a "community water system" (town) or a "noncommunity water system" (gas station, camp, etc).

**Recommended Maximum Contaminant Level (RMCL)**
See "Secondary Maximum Contaminant Level," below.

**Septic System**
An onsite system designed to treat and dispose of domestic sewage.

**Secondary Maximum Contaminant Level (SMCL)**
Limits or standards given to pollutants that have only aesthetic effects in water. Also called Recommended Maximum Contaminant Levels or RMCLs.

**Secondary Drinking Water Standard**
See Secondary Maximum Contaminant Level (SMCL).

**Soft Water**
Water having a low concentration of calcium and magnesium ions. According to U.S. Geological Survey guidelines, soft water is water having a hardness of 60 milligrams per liter or less.

**Standard Plate Count (SPC)**
See Heterotrophic Plate Count (HPC) above.

**Surface Water**
All water naturally open to the atmosphere, and all springs, wells, or other collectors that are directly influenced by surface water.

**Synthetic Organic Chemicals (SOC)**
Term used to describe nonvolatile organic chemicals such as most pesticides.

**Total Dissolved Solids (TDS)**
A measure of all of the dissolved ions in water.

**TNTC**
Abbreviation for "Too Numerous to Count." A measure of bacteria concentration.

**Turbidity**
The cloudy appearance of water caused by the presence of suspended and colloidal matter. Used to indicate the clarity of water.

**Virus**
The smallest form of microorganism capable of causing disease.

**Volatile Organic Chemicals (VOCs)**
Organic chemicals that escape readily into the air from water.

## Quick Reference Table to Common Pollutants in Pennsylvania

| Contaminant | Source | Standard | Effects |
|---|---|---|---|
| **Microbial** | | | |
| Coliform Bacteria | Surface water, human and animal waste | 0 per 100 ml | Gastrointestinal problems, waterborne diseases |
| Fecal Coliform Bacteria | Human and animal waste | 0 per 100 ml | Gastrointestinal problems, waterborne diseases |
| Fecal Streptococcus Bacteria | Human and animal waste | 0 per 100 ml | Gastrointestinal problems, waterborne diseases |
| *E. Coli* | Human and animal waste | 0 per 100 ml | Gastrointestinal problems, waterborne diseases |
| Standard Plate Count or Heterotrophic Plate Count | Common bacteria including coliform and other groups | No standard | > 500 per milliliter may indicate coliform bacteria contamination (see above) |
| Iron Bacteria | Naturally occurring | No standard | Unsightly growth, clogged pipes, reduced well yield |
| *Giardia* | Human and animal waste, surface water | 0 cysts | Giardiasis (nausea, fever, diarrhea, etc.) |
| *Cryptosporidium* | Human and animal waste, surface water | 0 cysts | Cryptosporidiosis (nausea, fever, etc.) |
| **Inorganic Chemicals** | | | |
| Arsenic | Natural deposits, gas well brines | 0.010 mg/L | Skin lesions, nervous system disorders, cancer |
| Alkalinity | Natural sources | No standard | Influences hardness |
| Barium | Natural deposits, gas well brines | 2.0 mg/L | High blood pressure, nervous system damage |
| Chloride | Natural sources, road salt, sewage | 250 mg/L (recommended) | Salty taste, corrosion of metal |
| Copper | Corrosion of plumbing | 1.3 mg/L<br>1.0 mg/L (recommended) | Gastrointestinal illness<br>Metallic taste, bluish stains |
| Corrosivity | Natural sources | Noncorrosive (recommended) | Dissolves plumbing components |
| Hardness | Natural sources | No standard | Scaly deposits, decreased soap cleansing |
| Hydrogen Sulfide | Naturally occurring | No standard | Rotten egg odor |
| Iron | Coal mining or natural sources | 0.30 mg/L (recommended) | Metallic taste, stains |
| Lead | Plumbing corrosion, industrial wastes, gas well brines | 0.015 mg/L | Numerous health effects, especially in children |
| Manganese | Coal mining or natural sources | 0.05 mg/L (recommended) | Blackish stains, metallic taste |
| Nitrate (as Nitrogen) | Animal and human wastes, fertilizers | 10 mg/L | Blue-baby disease in infants |

## Quick Reference Table to Common Pollutants in Pennsylvania

| Contaminant | Source | Standard | Effects |
|---|---|---|---|
| pH | Natural sources, mining, acid rain | 6.5 to 8.5 (recommended) | Corrosion (low pH), taste (high pH) |
| Sulfate | Coal mining or natural sources | 500 mg/L (proposed MCL)<br>250 mg/L (recommended) | Laxative effects<br>Bitter taste |
| Total Dissolved Solids | Sum of all dissolved ions in water | 500 mg/L (recommended) | Objectionable taste, odor, color |
| Turbidity | Surface water, runoff | 1.0 NTU | Objectionable appearance, promotes bacteria |
| **Volatile Organic Chemicals (VOCs)** | | | |
| Benzene | Industrial solvent, gasoline additive | 0.005 mg/L | Carcinogen |
| Carbon Tetrachloride | Production of chlorofluorocarbons | 0.005 mg/L | Gastrointestinal and nervous system effects |
| Chloroform | Industrial processes | No standard | Possible carcinogen, part of trihalomethanes (THMs), which have a MCL of 0.08 mg/L |
| Methyl Tert-Butyl Ether (MTBE) | Gasoline additive | No standard | Possible carcinogen |
| Tetrachloroethylene (PCE) | Dry-cleaning industry, industrial solvent | 0.005 mg/L | Possible carcinogen; liver, kidney, nerve damage |
| Trichloroethylene (TCE) | Industrial solvent, metal degreaser | 0.005 mg/L | Probable carcinogen; liver, kidney, nerve damage |
| Xylenes | Gasoline, industrial processes | 10 mg/L | Liver, kidney, nervous system damage |
| **Nonvolatile (Synthetic) Organic Chemicals (SOCs)** | | | |
| Atrazine | Common herbicide | 0.003 mg/L | Possible carcinogen; liver, kidney, heart damage |
| 2,4-D | Common herbicide on farms and lawns | 0.07 mg/L | Liver, circulatory and nervous system damage |
| Chlorpyrifos (Dursban) | Common insecticide | No standard | Possible carcinogen |
| Dioxin | Production of chlorinated chemicals | 0.00000003 mg/L | Carcinogen, birth defects, liver and reproductive effects |
| Glyphosate | Common herbicide | 0.7 mg/L | Kidney and reproductive damage |
| Metolachlor | Common herbicide | No standard | Possible carcinogen |
| Polychlorinated Biphenyls (PCBs) | Insulating material, coolant, lubricant | 0.0005 mg/L | Probable carcinogens; liver, kidney, nervous system damage |
| Simazine | Common herbicide | 0.004 mg/L | Carcinogen; damage to testes, kidneys, liver, and thyroid |
| **Radiological** | | | |
| Radon | Naturally occurring gas | 300 pCi/L (proposed) | Carcinogen if inhaled, possible carcinogen if ingested |

## Important Information About Your Water Source

**Provide as much of the following information as possible about your water supply. This information will be useful should you need help solving a future water problem.**

Type of Water Supply (circle one): Drilled Well Dug Well Spring Cistern Public Water Other

How deep is your well? feet

When was it drilled or dug?

What was the approximate flow or yield from the well? gallons per minute

Do you have a copy of your completed well log? If yes, you may want to place it in the pocket inside the back cover of this publication.

If you have a spring, when was it developed or redeveloped?

What is the approximate flow or yield from the spring? gallons per minute

If you have public water, what is the name of your water supplier?

How far is your water supply from the nearest septic system?

How close are other contaminant sources (mines, gas stations, industries, farm fields etc.)?

| Contaminant Source | Distance from My Water Supply |
|---|---|
| **1.** | |
| **2.** | |
| **3.** | |

Name and address of the person who installed or developed your well, spring, or cistern:

Name

Address

City State Zip

Phone Fax E-Mail

What water treatment devices do you have on your water supply?

Name and address of the person or company who installed your water treatment equipment:

Name

Address

City State Zip

Phone E-Mail

Additional comments:

Record any water testing information from your water supply on the next page.

## Water Test Results

| Date Sampled | Water Source | Water Test Results | | Comments |
|---|---|---|---|---|
| Example: August 15, 2001 | Spring Feeding the House | OK ☐ | Not OK ☑ | Iron level high |
| | | OK ☐ | Not OK ☐ | |
| | | OK ☐ | Not OK ☐ | |
| | | OK ☐ | Not OK ☐ | |
| | | OK ☐ | Not OK ☐ | |
| | | OK ☐ | Not OK ☐ | |
| | | OK ☐ | Not OK ☐ | |
| | | OK ☐ | Not OK ☐ | |
| | | OK ☐ | Not OK ☐ | |
| | | OK ☐ | Not OK ☐ | |

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Penn State College of Agricultural Sciences research, extension, and resident education programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

This publication is available from the Publications Distribution Center, The Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802. For information telephone 814-865-6713.

Issued in furtherance of Cooperative Extension Work, Acts of Congress May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture and the Pennsylvania Legislature. T. R. Alter, Director of Cooperative Extension, The Pennsylvania State University.



Produced by Information and Communication Technologies in the College of Agricultural Sciences.

CAT AGRS-90 3M9/03ps4361

Mn

Fe

$SO_4$

Cl

Pb

$H_2S$

Cu