

# Statistics for Action Water Quality: Read Before You Drink

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# Introduction

Does the foul odor or brown color of our tap water mean it's unsafe? Is the water in our nearby river safe for the kids to play in? Is it alright to eat the fish we catch? How do we find out if the water quality in our local stream has changed or will change with the construction of a new facility? In the U.S. and other countries, threats to lakes, rivers, streams raise questions like these. The threats come from various sources, including:

- Chemicals used in manufacturing
- Chemicals used for cleaning
- Chemicals used on crops
- Petroleum used to power equipment and vehicles
- Human sewage
- Animal waste
- Runoff from landfills

These threats endanger our drinking water, food supply and health. There are many ways to restore and protect our water and to minimize human health risks. Often before we can make meaningful progress on these fronts, we need to determine the current state and health of our waters. Water quality monitoring, that is sampling and testing our water, is a first step towards understanding the current status of our water.

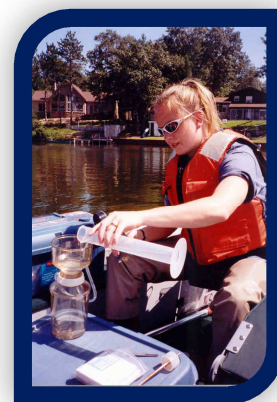
This guide provides readers with a basic introduction to water quality monitoring. It explains what to pay attention to and how to ensure public officials are appropriately accountable and responsive to citizen concerns when testing water.

# Chapter 1 | First Steps

## Why test the water?

Monitoring can confirm the presence or absence of contaminants. You or others might want to:

- Assess whether or not a particular business (current or closed) has polluted the water.
- Assess whether or not the runoff from our collective human activities is polluting a water body beyond legal limits.
- Generate data to spur government agencies to address a pollution problem you suspect, but that is not yet documented.
- Determine if community health or animal health problems are linked to contaminated water.
- Confirm that pollution is causing something unusual to happen to a local waterway or the plants and animals that live in or near it.
- Make certain the water is safe before allowing your children to fish or play in it.
- Fund and design a clean-up plan based on the extent of contamination found.
- Sample groundwater to assess contaminants that pose a risk to drinking water.
- Document baseline water quality before a new facility is built that could affect the water.
- Characterize the overall health of your watershed.
- Test your drinking water.





## Community Responsibility

Many people assume that the government monitors our waters and swiftly moves to protect communities from potential harm. Unfortunately, federal and state environmental agencies

have limited staff and funding for monitoring. The truth is only about 15% of our surface waters are fully tested. Shockingly, we know precious little about the condition of most of our waters. Citizen volunteers often must conduct their own monitoring or raise funds to pay private consultants to fully assess the condition of their water.

### Watershed

A **watershed** is the area of the land from which all of the waters that runs off it drain to the same place. Eventually all water drains to the ocean of course, but there are many **local watersheds** where water first drains to particular lake or river. Generally anything that happens within the boundaries of a watershed (formed by the highest points of land from which waters drain) can affect the water in a watershed.



Natural Resources Canada

Citizens need to take an active role to advocate for environmental concerns and ensure that environmental health problems are addressed to their satisfaction. Too often large corporations have helped elect representatives to office. Without citizen involvement, elected representatives feel obliged to represent the corporations' interests. The elected officials make laws and appoint agency heads that may limit the actions of concerned environmental professionals who work for State and federal agencies.

Community members can learn about issues impacting their water. They can take a stand on what needs to be done to protect both water and community health.

### What should community members do first?

#### 1. Become involved, educate yourself

Here are some starting places. Choose one or more that make sense given your situation.

## Water Pollution 101

Most people think that water is either safe or polluted. In fact, it's not that simple. There are many, many characteristics or **parameters** that determine water quality. If your water is free from bacteria but contains lots of phosphorus, does that make it polluted or safe? What if it's free of bacteria and phosphorus but is high in sediment? See how complicated it can become? Many parameters collectively determine water quality. The parameters that you most want to monitor depend on your specific hypothesis and the questions that you pose to test your hypothesis.

Similarly, many people assume that if they send a sample of their tap water to their health department and it tests "OK" that their water is safe. It may be, but the critical questions to ask are what parameters the water was tested for and what minimum concentrations the procedures used for testing were able to detect? Health departments typically test water for bacteria but not various toxic substances with which you may be most concerned.

- Find out who else is *concerned* in your community or **local watershed**.
- Learn what a watershed is and find out the boundaries of your watershed.
- Talk to your neighbors and ask them about their concerns or interests in the quality of water in your local river, or the quality of your drinking water. What concerns do you share?
- Find out about local non-profit groups that may already be working on these or related issues. It's a lot easier to get an existing group to pay attention to your concerns than it is to start a new group from scratch.

### 2. Organize

- Invite your friends and neighbors to a gathering. Ask who else shares your concerns.
- Start a contact list of everyone who shares an interest in water in your community and note their particular interests.
- Find ways to stay connected. Other people will support your efforts; you'll accomplish more than you could alone and you won't be as likely to get burned out or overwhelmed in the process.

### 3. Begin watershed and/or site characterization

If you and your neighbors have concerns about water in your community, begin by taking an inventory of what is known about the water and surrounding land. Again, it's difficult to provide a one-size fits all starting place, but things to consider doing first include:

- **Determine past and current land uses.** Certain land uses support water quality; other land uses pose a threat to water quality. Land use will help you focus your

efforts. For example, a farm may make it likely that you will want to focus water monitoring efforts on bacteria or nutrient runoff, such as phosphorus or nitrogen. An abandoned mine may mean that you want to focus monitoring for *pH* levels or *heavy metals*.

- **Research chemicals used and how they may affect public health.** If a certain industry is suspected of polluting your community's water it's important to find out the chemicals they use and release; those are the chemicals on which you would focus your monitoring efforts. How are humans exposed to water your community? Determine the ways water is used in your community. Is the groundwater or surface water a source for private wells or municipal drinking water? Do people swim or fish in the area? Is the water used to irrigate crops? In order for people to become sick from water they generally need to come into contact with it somehow<sup>1</sup>.

NOTE: Words appearing in green text are defined in the glossary that in Appendix A.

- **List health concerns.** If people say the water is making them sick, start a list of the specific health problems. Health concerns may be immediate and obvious (like getting a rash after showering) or long-term with a more subtle connection to contamination (like the prevalence of a particular type of cancer). Types of symptoms can be clues to what's going on. For example, it is important to find out if the health concerns present match the health problems associated with the suspected contaminants.
- **Conduct a visual survey.** Note unusual sights, signs or smells, such as plants growing in some areas but dying in others, sweet or astringent (sharp) smells, color changes in the water or, in extreme situations, fish die offs. Keep a log, and if possible, take photos. Create a community log. Use Google Maps (<http://maps.google.com/>) or IMRivers (<http://www.imrivers.com/>) to document your photos and findings online.
- **Track ownership.** If you see (or find) sites that appear contaminated, determine who owns the site(s) or the nearby properties that may have been the source of pollution. In many situations, owners are legally responsible for contamination on their property,

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<sup>1</sup> Some contaminants, such as PCB's can volatilize and enter the air from water, whereby they can be breathed in. This can even happen from shower water.

whether or not they caused it. This may be a part of state law and is always the case under federal Superfund legislation, officially termed the Comprehensive Environmental Response, Compensation, and Liability Act (**CERCLA**)<sup>2</sup>. Town offices keep records. .

- **Examine discharge permits.** Anyone who discharges anything into a water body must obtain a permit under the Clean Water Act, called an **NPDES** permit (NPDES stands for the National Pollution Discharge Elimination System). NPDES permits are usually maintained by State and tribal water quality agencies. Reviewing NPDES permits can provide you useful information about who is in or out of compliance and what chemicals are being discharged into your water body. Businesses acting within their permits may still be threatening public health or property values. The NPDES permit will also chronicle enforcement actions taken against the polluter and the results of subsequent monitoring. See Chapter 6 for more information. **Pool information.** A good starting point for both organizing community members and eliciting site and watershed information is to host a community meeting and ask what everyone knows. River Network recommends preparing a huge wall map, where community members can come up and mark places where there are important threats or uses. You may want to use different colored marks to denote threats and uses. **Threats** include places where community members identify pipes draining effluent into a river, land uses where farmers are using pesticides or herbicides, or places where businesses with a history of polluting water – like gas stations and dry cleaners – are in close proximity to waterways; critical **uses** may include places where kids swim, people fish, and so on. You also may want to color code past and present uses. Perhaps a river is used for disposing trash today, but may have been used as a place to swim 25 years ago. It's amazing how much information is collectively held by the residents in a watershed.

#### 4. Formulate a hypothesis and key questions

Based on the information you have acquired to date, the next step is to a **hypothesis**. A **hypothesis** is a fancy name for a logical guess about what is happening. For example, you might *hypothesize* that bacteria from a nearby farm are seeping into your stream, causing swimmers to get sick. Once you've developed such a hypothesis, you then *formulate specific questions* that once answered will enable you to test your hypothesis to see if it is correct. In our example, you might ask: are bacteria levels in our stream above or below

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<sup>2</sup> See Chapter 5

levels known to be associated with illnesses in swimmers; or how do bacteria levels in our stream upstream from the farm compare to bacteria levels just downstream, or what are the bacteria levels in and around the known swimming holes? There are other questions you might ask as well; these are just examples. In addition to enabling you to test your hypothesis, the questions you develop will help sculpt a monitoring plan. For example, if you decide to focus your efforts on answering how bacteria levels in your stream vary above and below the farm, that determines a couple of things: (1) the *parameter* that you want to monitor (in this case bacteria) and (2) where you will monitor (in this case, at least above and directly below the farm, and likely at a “recovery” site still further downstream).

### 5. Find out if there are existing data or plans to collect data

Because less than 15% of our nation’s river miles and streams are actually assessed regularly, citizen groups around the country have taken it into their own hands to conduct water quality monitoring. Volunteer monitoring groups that are often part of watershed associations or other environmental groups receive training to conduct scientifically credible monitoring of certain parameters of water quality. Find out if there are any watershed associations in your area doing monitoring. You may be able to interest them in your specific concerns and integrate your efforts.

There are a number of public agencies with which to check that also conduct water quality monitoring. This includes State environmental agencies and federally recognized Indian tribes. States and tribes receive money from the U.S. Environmental Protection Agency (EPA) to establish and maintain monitoring programs and report the results to the EPA. Many local governments, such as city and county environmental offices, may also conduct water quality monitoring. The EPA conducts some limited monitoring of its own.

Other Federal agencies also conduct water quality monitoring and you should check with the regional offices of each. The U.S. Geological Survey (USGS) conducts extensive river and stream monitoring around the country. The U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, and the U.S. Army Corps of Engineers also conduct water quality monitoring related to their responsibilities.

If there have been reported health concerns, it’s also possible that the Agency for Toxic Substances and Disease Registry (ATSDR) has compiled data on your community. Be aware though, historically, ATSDR has often concluded that data are insufficient to demonstrate a connection between pollution and health problems. The Agency uses conservative methods based on traditional epidemiological approaches that do not tend to be (statistically)

powerful enough to detect real world environmental health problems; such inconclusive findings do not mean a connection between contaminants and health problems does not exist.

Lastly, universities and permitted dischargers also conduct water quality monitoring. They may collect water quality data for their own purposes, or to share with government decision makers.

Depending on the specifics of your local situation, you may be able to successfully lobby any one of the above organizations to conduct monitoring to address the concerns of your community. However, you also may need to collect some cursory data that lends legitimacy to your concerns in order to prompt state or federal action.

## 6. Prompt or initiate monitoring

There may not be much in the way of existing monitoring efforts or data. When this is the case, you will need to prompt or initiate needed monitoring efforts. There are a variety of possible strategies:

- Organize citizens to create the political will (or pressure) to push for government monitoring;
- Organize citizens and businesses in your community or watershed to raise funds to hire an environmental consulting firm to conduct the needed monitoring;
- Learn how to collect samples to provide to a government, university or private lab for analysis;
- Obtain training from a non-profit organization, university extension office or similar entity to conduct your own monitoring and analysis.

There are pros and cons associated with each of these approaches. Which strategy you adopt will in part depend on the human and financial resources available to you as well as the purpose of your data collection, the particular *parameters* you need to monitor and how you or others hope to use the data. Although learning to conduct your own monitoring may seem daunting at first, there are reasons to consider this approach:

- Many individuals and groups first become concerned about environmental contamination when a problem directly impacts them; that's human nature. If we are to resolve the environmental challenges before us however, it is critical that citizens become active stewards of our watersheds. We cannot depend on government agencies with vastly underfunded resources to do this work for us. It is important for us to move beyond the perspective of "not in my back yard" when it comes to a



particular environmental threat and adopt a stewardship approach that necessitates that we learn more and actively become engaged in understanding the evolving conditions in our watersheds.

- Conducting our own monitoring provides us with tremendous flexibility to decide what, when and where we want to monitor. For example, a citizen's group can easily decide to monitor upstream and downstream of a suspected threat. Government agencies may be loath to target an individual employer.
- Citizen-based monitoring can engage large numbers of interested community members to not only help collect and analyze samples, but in the process to learn about and become more engaged in protecting their local water resources.
- Citizens groups can conduct monitoring that government agencies may not have the staffing to do. For example, many citizens groups conduct ongoing monitoring of swimming holes and post signs to alert others when it is safe or not to swim.
- If citizens have reason to distrust the data collected by government agencies in their area, collecting their own data will generate results that are more likely to be trusted by those involved.

There are of course other, more obvious reasons why citizen-based monitoring may not be the right approach in some circumstances:

- When data will be used in court and there is a need for monitoring to be conducted by an independent party.
- When there is a specific need to monitor and detect minute levels of toxic contaminants. These methods require considerable expertise and can be costly.
- When you are able to easily interest a trusted government agency to conduct the requisite monitoring.
- When your group has money but lacks time and expertise.
- When there is a need for groundwater monitoring. Groundwater monitoring often involves drilling wells which requires considerable expertise and financing.

The following information will help guide you in your decision whether to conduct your own monitoring, hire a professional, or learn to collect samples that you will hand over to professionals for analysis. **It is first important to define the *purpose and type of data that you seek*.**

Parameter \ Purpose	Specific enumeration of small quantities — and/or — Use by courts or regulatory agencies	Screening data that includes enumeration at levels to determine basic compliance — and/or — Use by community to confirm specific threats	Basic screening data, such as presence or absence — and/or — Use by community or schools for general education
<b>Toxic Substances</b>	Monitoring for toxics at this level often requires the use of a complex method called gas chromatography-mass spectrometry (GCMS). GCMS equipment analyzes the presence and quantity of specific chemical molecules; the process is costly, and requires skilled professionals and an appropriately equipped laboratory.	Citizens can easily learn to properly collect samples to then be analyzed by a professional lab at detection limits (the minimum concentration that can be detected) that would indicate the presence of a problem but won't enumerate minute concentrations. Such methods are not prohibitively expensive; for example, you could assess levels of about 100 common toxic contaminants for about \$200. per sample.	Citizens can learn to conduct monitoring for other, easier to monitor <i>proxy</i> parameters, which indicate the presence or absence of toxic substances. Examples include examining the diversity and range of benthic organisms sensitive to toxics, or examining parameters such as pH or conductivity, which are proxies for the presence of certain types of toxic substances.
<b>Pathogens (e.g., harmful bacteria and viruses)</b>	Proxy parameters ( <i>E. coli</i> bacteria in surface waters and Total coliform in drinking water) that are highly correlated with the presence of pathogens are usually monitored; they are easier to detect and quantify.  Citizens can learn these techniques, but may want to hire a professional or ask public environmental or health agencies for help if data may be used in a	<i>E. coli</i> and Total Coliform (TC) analysis methods are not difficult to learn, especially to determine the presence or absence of bacteria. Presence or absence of TC is usually all that is needed for drinking water analysis as standards require the concentration of TC to be zero. Even when specific concentrations are required, there are now many EPA certified testing methods such as IDEXX's Quanti-Tray® system that are relatively easily for citizen volunteers to learn. Initial equipment costs can run several thousand dollars, so if you only need to run a one-time analysis of a few samples, you would be better to hire a professional.	



court or regulatory arena.				
	Purpose	Specific enumeration of small quantities — and/or — Use by courts or regulatory agencies	Screening data that includes enumeration at levels to determine basic compliance  — and/or — Use by community to confirm specific threats	Basic screening data, such as presence or absence  — and/or — Use by community or schools for general education
	Parameter			
Nutrients (e. g. nitrogen, phosphorus)		Could be done by professionals or citizen volunteers. Requires some training and a few thousand dollars’ worth of laboratory equipment.	Methods very accessible to citizen volunteers. Many citizen volunteer monitoring groups access local high school science teachers and labs to help with this type of monitoring. Refer to River Network’s publication <i>Testing the Waters</i> .	Methods very accessible to citizen volunteers. Many citizen volunteer monitoring groups access local high school science teachers and labs to help with this type of monitoring. Refer to River Network’s publication <i>Testing the Waters</i> .
Ecological (aquatic life) parameters such as pH, Dissolved Oxygen, Turbidity, Conductivity		Could be done by professionals or citizen volunteers. Requires some training and a few thousand dollars’ worth of laboratory equipment.	Methods very accessible to citizen volunteers. Many citizen volunteer monitoring groups access local high school science teachers and labs to help with this type of monitoring. Refer to River Network’s publication <i>Testing the Waters</i> .	Methods very accessible to citizen volunteers. Many citizen volunteer monitoring groups access local high school science teachers and labs to help with this type of monitoring. Refer to River Network’s publication <i>Testing the Waters</i> .
Bio-assessment (benthic macroinvertebrates)		Could be done by professionals or citizen volunteers. Requires some training and a few thousand dollars’ worth of laboratory equipment.	Methods very accessible to citizen volunteers. Refer to River Network’s publication <i>Testing the Waters</i> .	Methods very accessible to citizen volunteers. Refer to River Network’s publication <i>Testing the Waters</i> .

### Other monitoring considerations

- Consider what might happen if test results show minimal or no contamination. Could that information be used to squelch still legitimate concerns?
- Consider the impact of test results that show contamination. Will that reduce the property value of nearby homes?
- If you plan to use your data in court, be aware that the confirmation of findings through monitoring could start the clock on a statute of limitations that might mean you must initiate court proceedings within a certain time frame of obtaining your results.
- Are there allies who can help answer these questions? Contact a local or regional environmental non-profit organization, faculty at a local university, or the public health department to ask for advice or resources.

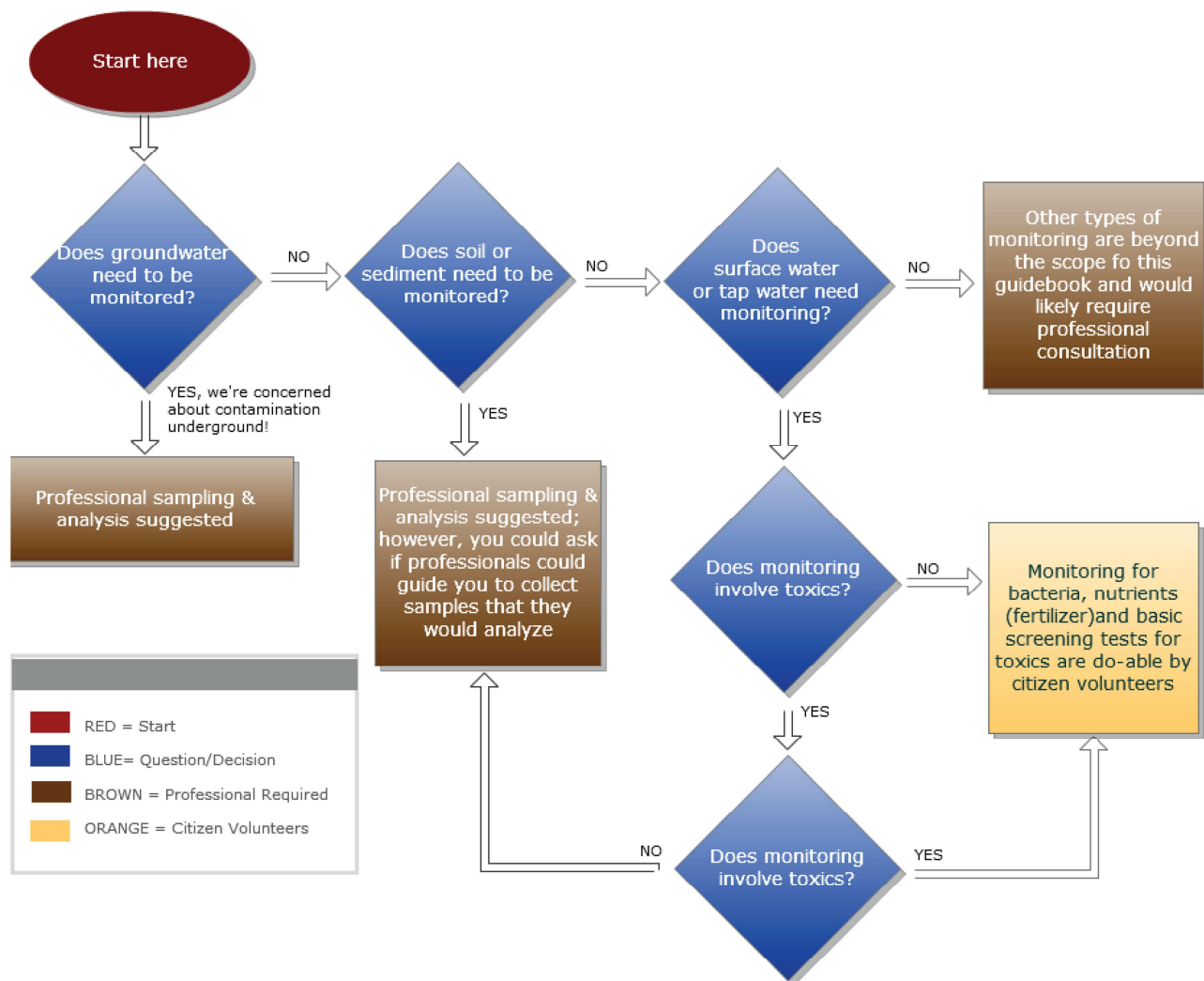
**Next, it is important to determine who you expect to use or pay attention to your data.**

- Is the data to be used primarily by community members?
- Is the data intended to be used by teachers and their students?
- Do you expect the local health officer to use your data?
- Do you expect your state environmental agency to use your data?
- Do you intend your data to be used by the EPA?

You may want to meet with the people you expect to use your data beforehand. Ask them what methods for data collection and analysis must be employed for them to use your data.

**After reflecting on all of the above information, it's time to decide on an approach to the issue of monitoring and in particular whether or not you will need to hire a professional consultant.**

The flow chart below can further help you make this determination:

**Do you need professional monitoring help?**

## CASE STUDY: Columbia, Mississippi



The Reichhold Chemical plant in Columbia, Mississippi, had a horrible environmental record that included illegally burying thousands of drums of chemical waste. They discharged wastewater containing toxic chemicals into a nearby creek without a permit. Columbia, Mississippi is a low-income community with a sizeable African American population and surrounding population of more than 26,000. There were fish kills; over 200 cattle became sick and died, downstream on the creek. Then, the unthinkable happened. The plant, located in the heart of Columbia, literally exploded. The more than 4,500 drums on site began to leak into the soil. Subsequent floods spread the toxins into surrounding farmlands, rivers and residential neighborhoods. Then the people themselves began to get sick. People complained of miscarriages, kidney disease, and red sores that appeared on many their skin after showering.

The community formed a group called Stop Toxics Onsite Pollution (STOP) and urged EPA to take action.

Here are a few key findings from a couple ponds and a drainage way on site. The monitoring results show concentrations of contaminants found in the sediment of these bodies of waters. Many heavy metals and **organic compounds** that do not dissolve well in water – such as **organochlorine pesticides** (e.g., DDT) and **PCBs** – tend to settle at the bottom of the water column; sampling the sediment can provide us with a more accurate assessment of the presence of those compounds in these water bodies.

Continued...

## CASE STUDY Continued...

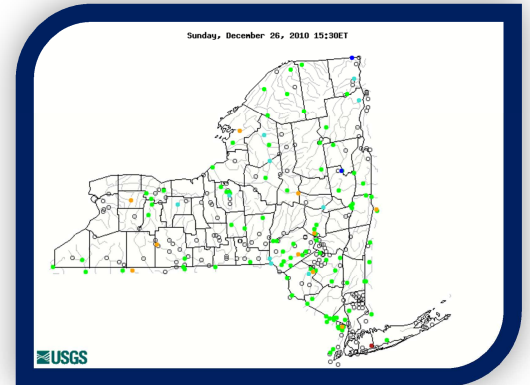
EPA Sediment Sampling Data Newsome Bros./Reichold Site Columbia, MS			
Chemical	Sample Value (ppm)	Comparison Value (ppm)	Location
Ethyl benzene	210	5,000	Drainage way
Phenol	9	20,000	Drainage way
Toluene	1,300	1,000	Drainage way

In the table above, a Comparison Value is the value that the Agency for Toxic Substances and Disease Registry (ATSDR) uses to determine whether or not a contaminant *may pose* a concern to human health. Levels above a comparison value should lead to an investigation. A Comparison Value does not determine the level at which harm occurs; it's considered a level below which no harm is expected.

What do you notice? Are the sample concentrations greater or less than the Comparison Values? By how much do they differ from Comparison Values?

The red value exceeded the Comparison Values and suggested further examination was warranted. In fact, the EPA went on to declare this site a Superfund Site, the name for a site that receives special priority for clean-up under the law popularly known as Superfund.

## Chapter 2 | Monitoring Design



The first step in water quality monitoring is the creation of a study design. A study design document is like a blue print for the water quality monitoring that will be done. Data generated from monitoring is only as good as the study design and that's why the design is so important. Many local citizen-based, volunteer river and watershed groups that have chosen to do their own monitoring have developed their own study design document. If you conduct your own monitoring, a good study design document helps to substantiate the credibility of your data, making it more likely it will be taken seriously and used in the ways you intend. Even if government or private consultants will do the monitoring, it may be important for you to have input into that design. There are many factors to consider. A monitoring design plan should answer the following questions:

- Why is the monitoring being done and what question(s) is it intended to answer?
- What will be monitored?
- Where the sampling will be done?
- When the samples will be taken?
- How the sampling and analysis will be done?
- What are the quality assurance and quality control procedures that will be employed?
- Who will do the sampling and analysis?
- What are the Data Quality Objectives?

### Why: The purpose of monitoring

The Study Design needs to clearly state why the monitoring is being done. Typically, there is a specific question that the monitoring is meant to answer.

It is important the questions asked are as specific as possible. Test the specificity your question to be sure that monitoring will provide you a clear answer.

<i>Question</i>	<i>How precise is the question? Is what we need to monitor clear, and will our monitoring answer the question?</i>
<b>How clean is our water?</b>	This question is too general.
<b>Are bacteria from dairy cows polluting the stream?</b>	Better. But the question still does not suggest exactly what we need to monitor and where.
<b>How do bacteria levels upstream of the dairy farms compare to levels downstream and how do either of those levels compare to water quality standards</b>	Great. The questions are both specific and suggest what we need to monitor, where, and what we will compare our results to (water quality standards).

### CASE STUDY: Columbia, Mississippi

The community in Columbia, Mississippi – referenced at the end of Chapter 1 – had little input into the agency's study design. The study design included deep well monitoring at distinct locations on the plant site, but limited monitoring of the surface sediment in the surrounding neighborhood and called for no sampling inside of homes. In fact, the area has very shallow groundwater and floods often; floodwater at times actually enters the homes of the surrounding neighborhood. If citizens had input into the monitoring design, that design would most likely have included a plan for extensive sampling of surface sediments from the surrounding neighborhood as well as monitoring dust from the homes surrounding the chemical plant site.

### What: Parameters to be sampled

In Chapter 1 we discussed how water quality is determined by a range of *parameters*. In the study design, we must describe what *parameters* we want to monitor. The choice of parameters should flow from the reason for monitoring and the specific questions that you have. The typical parameters studied characterize the physical, chemical or biological integrity of the water. The image below shows these three categories and some of the parameters associated with each.



### Physical Parameters

Physical parameters provide us basic information about the water body itself. This information is particularly valuable when the primary concerns relate to sedimentation (the runoff of sediment into water), erosion and flooding. Physical data also provide us with important information that enables us to better interpret chemical data.



## Chemical Parameters

Chemical parameters describe the various aspects of the chemistry of water. Typical chemical parameters that are studied to assess the ecological integrity of a stream include pH (a measure of how acidic a water body is); total alkalinity (the ability of a water body to neutralize acids); dissolved oxygen (the amount of oxygen dissolved in water and available for fish to “breathe”); and nutrients that feed aquatic plant growth, such as nitrogen and phosphorus. Chemical monitoring may also include monitoring water for the presence of toxic substances. There are over 80,000 industrial chemicals in production. The EPA specifies water quality guidelines for about 90 of them. Each one can be expensive to detect. That’s why your first job is to determine the likely chemicals that are used, or better yet, released in your watershed, so that you have a good idea for what to monitor. There are a variety of ways to determine this, including:

1. NPDES permits, discussed in Chapters 1 and 6.
2. The Toxics Release Inventory (TRI), available online at through the US EPA at <http://www.epa.gov/tri/tridata/index.htm>
3. Local fire departments, which receive reports of hazardous chemical inventories from local facilities, as mandated by the Emergency Planning and Community Right to Know Act (EPCRA).

Even if your research is unable to pinpoint specific toxic chemicals for which you want to monitor, there are screening tests that can be done for broad suites or groups of the more commonly found toxic chemicals. Then, once you’ve identified the chemicals that are present, you can always pay for much more refined tests for those individual chemicals.

When human health concerns are primary, communities are usually most interested in toxic chemicals of some type. When ecological or *aquatic life* health concerns are primary, parameters such as pH, *dissolved oxygen* and *nutrients* are typically monitored. Some parameters may be important for both concerns; while phosphorus and nitrogen are nutrients that impact stream and lake aquatic life, they can pose serious human health threats at certain concentrations in drinking water. And obviously, toxic substances can be harmful to both humans and aquatic life.

Most commonly occurring toxic chemicals tend to fall into one of the following classes:

- **Inorganic contaminants** such as heavy metals – things like lead, mercury and chromium – arsenic and nitrites from storm water runoff, industrial releases and naturally occurring sources;
- **Organic chemical contaminants** including,
  - Synthetic and volatile organics from gas stations, dry cleaners, urban storm water runoff, and septic systems.
  - Organic pesticides, including insecticides and herbicides, which may come from a variety of sources such as agriculture, storm water runoff, and residential uses;
- **Disinfectants and their by-products**, such as chlorine, chloramine, and trihalomethanes used to disinfect waste water or drinking water.
- **Radionuclides**, by-products of nuclear weapons manufacturers, and medical facilities that use radioactive materials.

### Biological Parameters

Sometimes a community's health concerns will have more to do with pathogens – various bacteria and viruses – in the water than toxic chemicals. This happens when animal and human waste (e.g., feces) get into water that is either a source of drinking water or of body contact for pets or humans, such as contact during swimming. The waste can get into the water directly, such as when cattle are allowed to water in streams, or indirectly, from livestock runoff, discharges of waste water treatment plants, or combined sewer overflows (CSOs). CSO's occur because storm water sewers are sometimes not separated from a system's wastewater stream. When this happens, during big rainstorms, wastewater treatment plants are forced to throw a by-pass switch that causes raw sewage to be discharged directly into streams!! This is done to avoid flooding the plant but results in contaminating the stream.

Another kind of biological monitoring involves looking at tiny critters – called benthic macroinvertebrates. What a mouthful! These are mostly insects still in their larval stage that live on the bottom of rivers and ponds, and which fish feed upon. Macroinvertebrates are part of the foundation of a river ecosystem on which other life depends. In other words, they are what a lot of fish eat for dinner. Monitoring the number and type of benthic macroinvertebrates tells us a lot about water quality, including the presence or absence of toxic chemicals. That is because some kinds of macroinvertebrates are especially sensitive to pollution and others are very tolerant. So, the number and distribution of different types

can be a good indicator of pollution levels in an area. Benthic macroinvertebrates tend to hang out in riffle habitat, shallow areas with rocky bottoms, and riffle habitats occur in different places along streams. Therefore, you can compare benthic populations upstream and downstream from pollution sources, just as we might do with chemicals monitoring.

There are advantages to monitoring benthic macroinvertebrates over chemical testing. First, chemical testing only takes a snapshot of water quality at the specific time it is tested. Such monitoring may miss a significant pollution event, discharge from a pipe for example, that occurs only hours after we've monitored. Benthic macroinvertebrates on the other hand live in streams for up to three months or more. They are sentinels – like canaries in a coal mine – that synthesize the overall water quality during this more extended period of time. Second, benthics are generally a lot less expensive to monitor than a suite of toxic chemicals. Citizens can learn to monitor for benthic macroinvertebrates at a basic level that can provide a decent indication of overall water conditions. The downside however is that biological monitoring of this sort does not enable you to enumerate specific levels of chemical contamination, which may be vital for health and compliance purposes.

### Where: Sampling and laboratory locations

The Study Design needs to explain where monitoring will be done. The first question to be answered in this regard is whether samples will be taken from:

- **Tap water**
  - Private wells
  - Municipal
- **Surface water**
  - Water column
  - Sediment
  - Rivers
  - Lakes
  - Oceans

Again, the answers will be determined in large part based on the questions that you are trying to answer. Monitoring protocols look very different depending on where samples will be drawn.

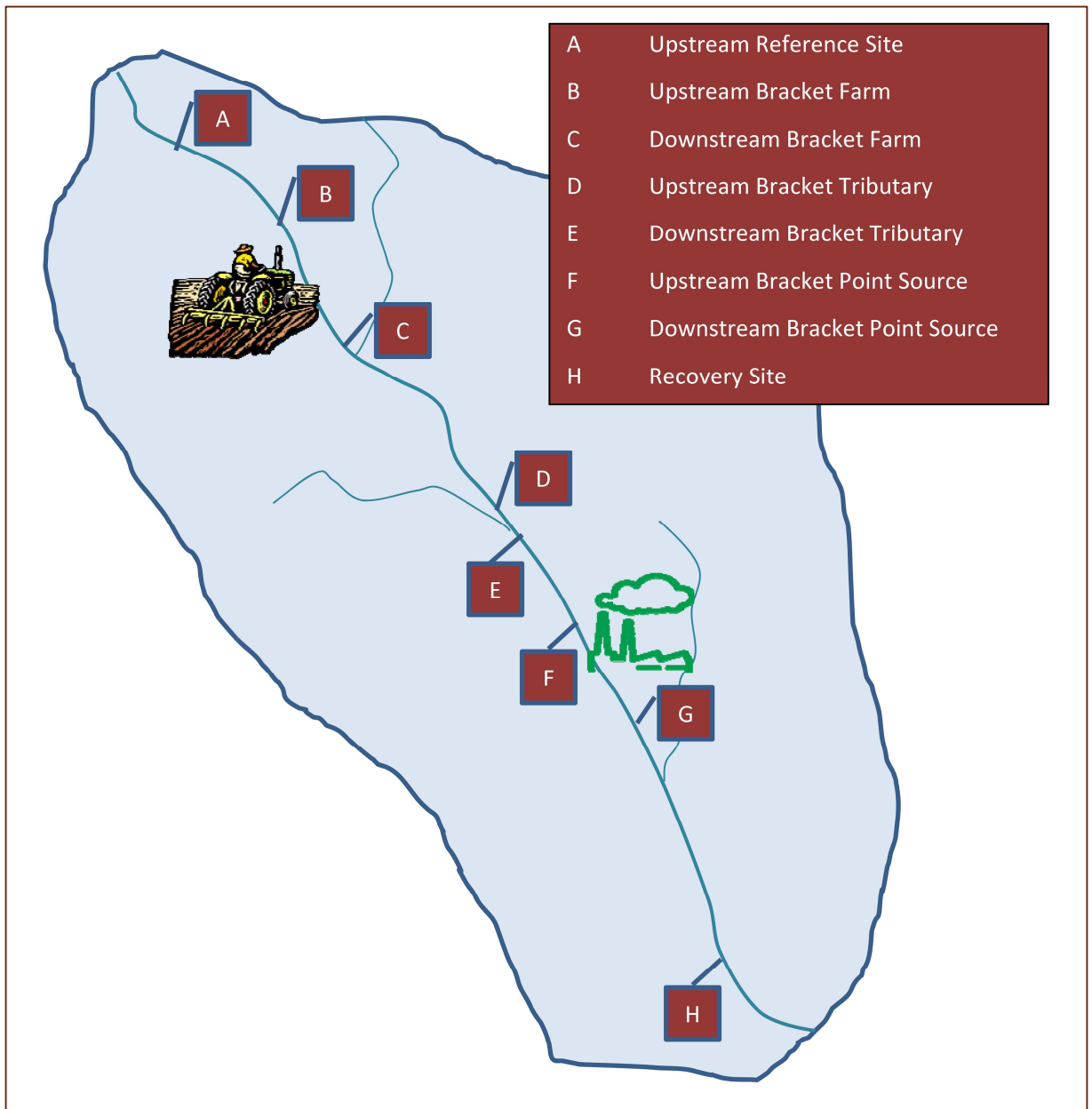
### Tap Water

Sampling tap water is usually straightforward when explaining where sampling will take place. If potential contamination of municipal well water is of concern, it will be important to sample from a number of households that receive municipal water and a comparison group of households that get their water elsewhere.

### Surface Water

**Rivers.** The location of sampling stations will depend on the type of questions that the monitoring design is intended to answer. For watershed studies that seek to characterize the state of a watershed generally, sampling locations are spaced throughout the watershed: from upstream locations through downstream. Monitoring to detect specific threats to watershed health usually involve “bracketing” those threats by locating sites both upstream, downstream and at a “recovery” site considerably downstream where the presence of the pollutant is likely to be somewhat ameliorated or diluted.

We usually choose monitoring sites by either “bracketing” potential pollution sources (sampling upstream and downstream of the source) or tributaries to measure their impact. Because certain pollution will be naturally remedied, “recovery” sites are often selected still further downstream to see if water quality has improved again, further confirming the likelihood of the source. Monitoring sites may also be selected at upstream, midstream and downstream location to characterize the overall water quality in the stream. Taking just one sample is not helpful, particularly in urban areas when large rivers have many sources of discharges.



**Lakes.** Lakes are of course much different from streams. Lakes are often deep standing bodies of water. The location of monitoring sites on a lake, similar to streams, depends a lot on the reasons for sampling. If the goal is to measure the impact of a particular source of pollution, sampling locations may be identified close to and farther way from that source. If the goal is to characterize the overall quality of water in a lake sampling sites would be identified at multiple locations across a lake. For some

parameters, sampling locations would be identified at varying depths as well as horizontal locations. Lakes often have a primary source of inflow and outflow, which are often sampled.

The most representative or average conditions in a lake are usually found where the lake is deepest. In natural lakes with a roundish shape, the deepest section is usually near the middle. Some lakes are not round of course, but may have a number of different fingers or bays. In these cases, it may be important to sample the deepest section in each bay, because each may have its own unique water quality characteristics.

*Grab samples* may be collected from a specific depth in the water column. This is the method most often used in citizen monitoring programs.

*Composite Samples* are sometimes used where equal portions of samples from different depths are combined. Deeper sampling is accomplished using a special device; two of the most common are called Kemmerers and Van Dorns. The devices are basically cylindrical tubes with rubber stoppers at each end. They are lowered to the depth where a sample is desired; a weight is released that slides down the rope holding the device. When the weight reaches the device it triggers the stoppers to close and collect a sample from that depth. The sampler is then brought back to the surface (usually in a boat or on a bridge) and the sample is poured into a container.

### When: Time of day and year

There are a number of factors to take into account that affect when you sample. The “when” in sampling refers to the time of day; the frequency of sampling, and the time of year. Some water quality conditions change with either the time of day or time of year or both.

Fish need oxygen just like we do, fish “breathe” through their gills and obtain oxygen that is dissolved in water. If there’s not enough dissolved oxygen in water, fish die. Dissolved oxygen levels in water are usually lowest first thing in the morning that’s when we would want to sample – when levels are at their lowest!

If we want to find out if a river is safe to swim in, it would make sense to sample that river during the season(s) when people are most likely to actually swim.

Frequency of monitoring will be influenced by what we are trying to assess. If our main concern is non-point source runoff (what the rain washes into the river from the land), then we may want to conduct our monitoring before, during and after big rain events. Non-point source runoff would result in water quality degradation during and after such storms. If you're trying to measure pollution from a particular pipe, you may want to sample often, both around the clock and throughout the month; discharges from such pipes may not happen continuously and if you don't monitor with sufficient frequency you could mistakenly assume that the effluent from the pipe was not impacting stream water quality when it was.

### How: Methods

Your methods should fit your reasons for monitoring and take into account how your data will be used (and by whom). Once you define your purpose, you will have a clue how rigorous the methods and how expensive the equipment required will be. Sometimes it's only necessary to obtain basic overview data, such as the presence or absence of a contaminant rather than its specific concentration. Sometimes you only want to know if water quality standards are being violated or not, but don't need to know the concentration of much smaller concentrations of the pollutant than fall below those standards. These answers will also determine whether or not you or your group is capable of collecting the samples and/or analyzing the samples or whether you'll need to engage professionals.

### Quality Assurance/Quality Control Procedures

**Quality Assurance/Quality Control (QA/QC)** measures are the things you do to ensure that your data is accurate. Quality assurance may be as simple as ensuring that everyone involved is properly trained and that all of your procedures are documented. Quality control refers to more specific steps taken to ensure the both the accuracy and precision of your data. The following paragraphs provide a brief overview of QA/QC

basics. If you begin monitoring, you will need more detail and training. Regardless of whether your citizens-based group or professionals conduct the monitoring, it's important to check that basic QA/QC procedures are followed.

**Quality Control** procedures fall into two broad categories: internal controls and external controls. Internal controls are checks performed by those who are doing the sampling and analysis. External controls are checks performed by an outside group to be sure your data is accurate. Quality Control procedures include:

**Trip Blanks:** Typically these are samples of distilled (clean) water collected at about 10% of the sites. If the trip blanks are found to contain pollutants, then you know that something is contaminating your sampling collection and analysis process.

**Field Duplicates:** A second sampling team may collect duplicate samples at the *same* sites where samples were taken by another team to ensure consistency of results. Internal duplicates are processed by the same lab. External duplicates would be processed by a different lab.

**Split samples:** Field samples are split into two samples that are then compared to ensure consistency of results in the lab. If the two samples that started out the same produce different results, you know that something is being done wrong! Again, internal split samples are both analyzed by the same lab; external split samples are analyzed by separate labs.

### Who: Who does what?

A monitoring design should state who will do what. Who will collect samples? What will be their background or training? Who will transport samples to the laboratory and what training will they receive? Who will analyze the samples in the lab and who will write up the results? Who will coordinate all of these efforts and who will provide the requisite training? All of this information should be documented. It lends significant legitimacy to the quality of your data and findings.



### What are the data quality objectives?

You already identified this in Step 1 above, "Define the purpose of the data that you seek." This is about how the data will be used. Does the community want a *rough idea* of whether or not a particular contaminant is present, or do you need to be able to enumerate *specific concentrations* of a particular contaminant? Is your data for basic educational purposes or for use in a court of law? Obviously the latter would require much more attention to quality assurance and quality control procedures than the former.

#### Presence/Absence Test for Bacteria

##### Step 1.

Add reagent to sample and incubate 24 hours.



##### Step 2.

Read results:

- Colorless = negative
- Yellow = total coliform bacteria
- Yellow/fluorescent = *e.coli*



*Photos courtesy IDEXX*

## CASE STUDY: Connecticut River Watershed

Study Design Snippets	<b>Why?</b>	To determine if agricultural best management practices implemented on a farm result in an improvement in stream water quality.
	<b>What?</b>	Monitor for benthic macroinvertebrates.
	<b>Where?</b>	Upstream and downstream of farm over a 3-year period.
	<b>How?</b>	RWN will train volunteers to collect samples that will be preserved and analyzed in a laboratory.

Midway along the New Hampshire/Vermont border, the Connecticut River has major water quality impacts associated with agricultural activity. Many of the farms are financially struggling and can't afford to implement practices that might improve water quality. To address this, New Hampshire funded the Upper Connecticut River Watershed Project in 1991.

The project involved working with farmers to demonstrate agricultural best management practices (BMPs). The demonstration farm -- whose owner was a willing participant in the project -- was located near the headwaters of Morris Brook, a tributary to another brook that feeds into the Connecticut River. Problems with sediment and stream turbidity, cow manure, and fertilizers were the main focus. Practices were adopted to address these problems. The following year, the River Network (then River Watch Network, or RWN) was contracted to monitor the water quality (chemical and macroinvertebrate monitoring) of Morris Brook to assess the effectiveness of the BMPs. RWN trained volunteers and staff of the Connecticut River Watch Program to collect water and macroinvertebrate samples and performed the data analysis.

Macroinvertebrates are stream insects and other tiny life forms that are excellent indicators of pollution, as some are more pollution tolerant than others. The macroinvertebrate community downstream from the demonstration site showed significant improvement. Over the three years, the previously impacted sites downstream began to show a greater diversity of macroinvertebrates and a shift to those such as mayflies and stoneflies that are more sensitive to pollution, demonstrating that the quality of the water was improving.

## Chapter 3 | Sampling

Monitoring primarily consists of sampling and laboratory analysis. Sampling in and of itself is not difficult in many cases. There are straightforward, simple steps called protocols that you must learn to follow. Once you've learned them, plan a review of methods and training all volunteers in an inside setting for a dry run. A dry run is important because people do make mistakes and the last thing you want is to have to re-sample after learning that someone improperly collected a sample for which you've *already* paid several hundred dollars for analysis (a professional lab will often send you sample containers after you pay up front for the analysis; sometimes they contain preservatives and can't be re-used).



*Courtesy of USGS*



*Courtesy of U.S. Air Force*

Most sampling routines involve not much more than a healthy dose of common sense. You need to avoid contaminating your sampling containers by keeping their caps on until you're ready to sample, not putting your finger in them, and not sneezing into them! Professional labs will provide you with the requisite instructions for taking samples. River Network is an excellent source of information. The following is meant as an overview.

### Tap Water Sampling

Sampling water from your tap is the simplest way to test the quality of your drinking water. The basic procedure recommended for sampling water from a tap may seem somewhat wasteful, but is important to ensure an accurate sample. Assuming that your goal is to sample the *source* of your drinking water and not simply the quality of water in your pipes, you should let the water run for about 10 minutes before filling up a sampling bottle. This clears all of the water that has been sitting in your pipes. That water may have impurities or contaminants that come from your pipes themselves, not the source water. In some instances however, you may want to sample the water in your pipes (for example, if you're trying to

determine if lead solder or PVC from your plumbing is leaching into your drinking water). Check with the lab that provides you with your sample containers for more details.

## Surface Water Sampling

Sampling **river** water requires that you sample from the mainstream of current and not side **eddies**; this provides you with a more representative sample. You fill your sample bottle with the bottle opening facing upstream and with your body downstream to avoid cross contamination from your body. **Lake** water sampling needs to be done at appropriate depths using devices that can be lowered to the proper depth and sealed before you bring them to the surface.

### Site Access

Attention needs to be paid to site accessibility advance. It's one thing for everyone to agree on sampling locations using a map. It's another when you arrive to collect your samples and find that the spot is 50 feet below a huge drop off. Ideally someone should visit the sites in advance and take photos so that volunteers going to the site know exactly what it looks like and how to get there.



*Courtesy of USGS*

### Holding Times

Samples for different types of tests have different holding times, the time that samples may be held for the laboratory analysis is done. Exceeding allowable holding times will invalidate your results. Holding times vary from samples requiring immediate analysis to those which need to be analyzed within 2 weeks. The laboratory that you work with can provide you with allowable holding times for the tests you are conducting.

### Preservation

Related to holding times are sample preservation requirements. Again, samples for different tests will require different types of preservation. Some samples, such as those for dissolved oxygen, will need to be chemically preserved on the spot, when they are collected. Other samples may simply require refrigeration. Due to this latter requirement, testing laboratories will often send you kits of sampling containers that are packed in insulated Styrofoam. The kits usually include some type of freezer gel pack similar to what you use in a picnic container. Instructions typically call for ensuring that the freezer packs are prepped (put in a freezer) 24 hours in advance. You would then put all of your collected samples back into the insulated Styrofoam box provided, with the gel pack and mail it to the laboratory.

### Shipping (when not using a local lab)

Holding times often require that shipped samples be sent overnight. Sending such samples overnight can easily cost \$50 or more per sample kit. Citizen groups need to be aware of these costs upfront and plan accordingly. You would be wise to check with your preferred shipper in advance, including ensuring that their shipping offices are open when you are planning to drop off samples. You should also ask your shipper the frequency with which shipped items do not make it overnight on certain days. For example, many shippers will caution you not to plan to ship on a Thursday or Friday as running into weekends can prove dangerous. Sometimes things go wrong in shipping and materials are delayed. While it may not be a catastrophe for a letter, your samples will become invalid and in all likelihood the lab will have already charged you. Plan your sampling days accordingly and set up a clear plan for how all samples will be gathered and who and when will bring them to the shipper.

### Documentation and Chain of Custody

Chain of custody refers to a chronological record of who has been in possession of samples during what time periods and what forms of preservation or analyses have been performed on them. Following chain-of-custody procedures when handling samples and data helps provide assurance that they have not been tampered with. It also helps you keep track of everything and ensures you can answer a variety of critical questions that could arise later. A simple log sheet can serve as your chain of custody where various people sign the sample out and in during their custody of it. Maintaining chain of custody contributes to the overall integrity of your procedures and hence your data. An alternative to a log sheet is to document this information right on a label on the sample itself. The laboratory that you work with will likely provide you with a chain of custody log.

### Date, Time and Sample Location

Labeling sample containers with the date, time and location may sound like a no-brainer, but at times volunteers forget to label all samples with this critical information. Sometimes, when collecting only one or two samples, the volunteer is confident where each sample was collected. Unfortunately, once later integrated with other samples in the lab, it becomes impossible to tell which sample is which. This has happened many times!

## Groundwater | Chapter 4

The drinking water from our taps comes from either surface water – rivers and lakes – or groundwater. Groundwater is simply the water from rain and snow that moves down into the ground, passing between sand, gravel, or rock until it reaches a depth where the ground is filled, or saturated, with water. The region under the ground that is completely saturated with water is known as an *aquifer*. Wells can be sunk into the ground to extract that water for drinking. About 56% of our drinking water comes from surface waters, but about 45% comes from groundwater. Contamination may start out in groundwater but end up in surface water, or vice versa. More than half the population of the United States depends at least *partially* on groundwater for their drinking water. In rural areas, about ninety-five percent of domestic water needs are served by groundwater.



A wide variety of contaminants – such as gasoline from undergrounds storage tanks, *solvents* from dry cleaning businesses, and chemicals from unlined landfills, *waste storage facilities* and manufacturing facilities – have seeped into our groundwater in some places, contaminating both our wells and surface waters over the years. How do we monitor for contamination that has seeped into groundwater?

### Site Characterization

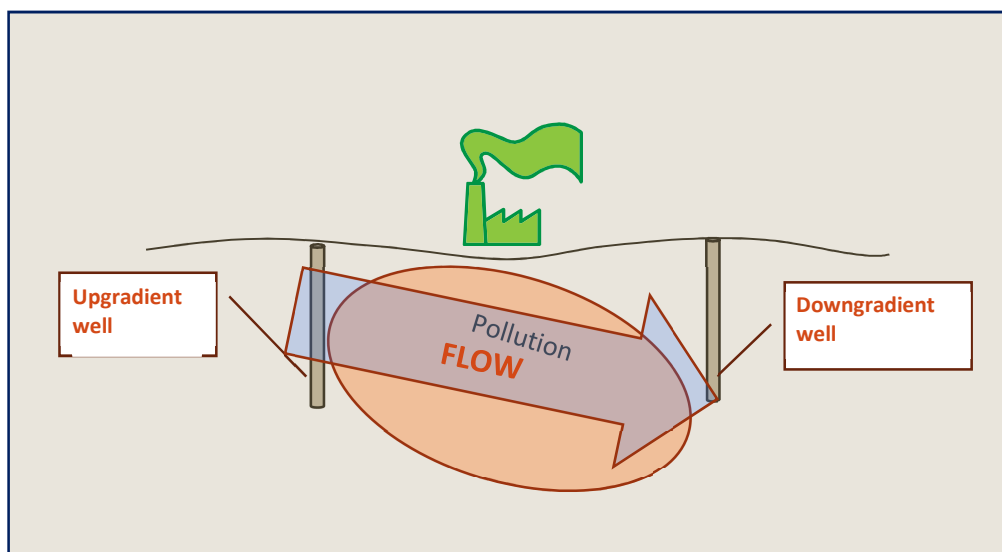
**The first and most important component of underground monitoring is the careful characterization of the area in question, or site.** It's important to understand the hydrology of a site – how water and other fluids likely move underneath the surface of the ground – in order to know where to set up monitoring wells. In Chapter 2 we described “bracketing” suspected pollution sources, meaning selecting sampling locations both upstream and downstream of a suspected threat so as to assess the impact of that threat. The goal is similar



with monitoring groundwater, but more complicated. How do we determine what is “upstream” and what is “downstream” when everything is happening below the surface? While groundwater often flows in the same direction as the contours of the surface of land would suggest, there are many exceptions that complicate ground-water sampling efforts.

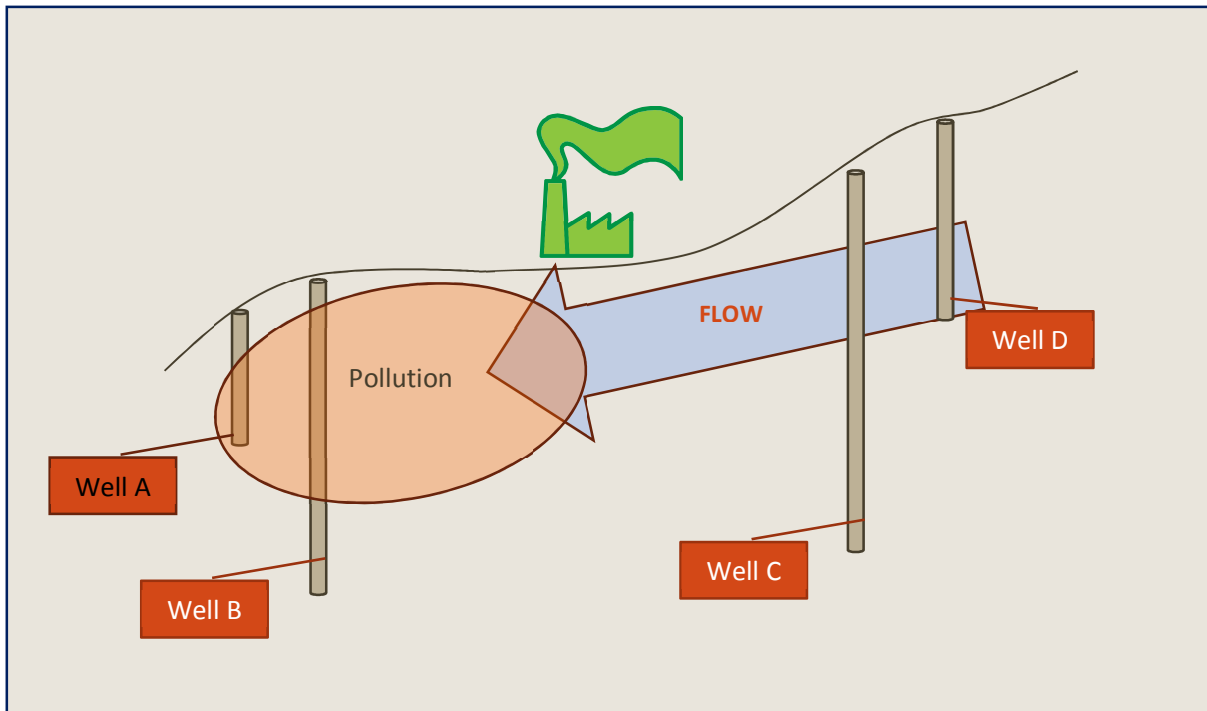
Groundwater monitoring wells must be located in places that are most likely to pick up the main groundwater flow, similar to how we grab stream samples from the main flow of a river; however, underground pollution is much more likely to be localized and thus harder to pinpoint. We might sample in one location and find nothing, but sample just a few yards away and find dangerous levels of a contaminant. Yikes! That doesn’t sound good! Knowing a site’s characteristics – geology, soil types, topography, ground-water flow directions and other variables – a hydrogeologist can predict where to establish the location and depth of monitoring sites. **That’s why your group should consult a hydrogeologist if you’re concerned about groundwater.**

In a simple world, a groundwater monitoring site would like the one below:



But in the real world conditions will vary in all sorts of ways. Consider the following examples.

1. **Groundwater monitoring on a steep slope.** Notice the effects of slope of the monitoring wells in the following diagram:



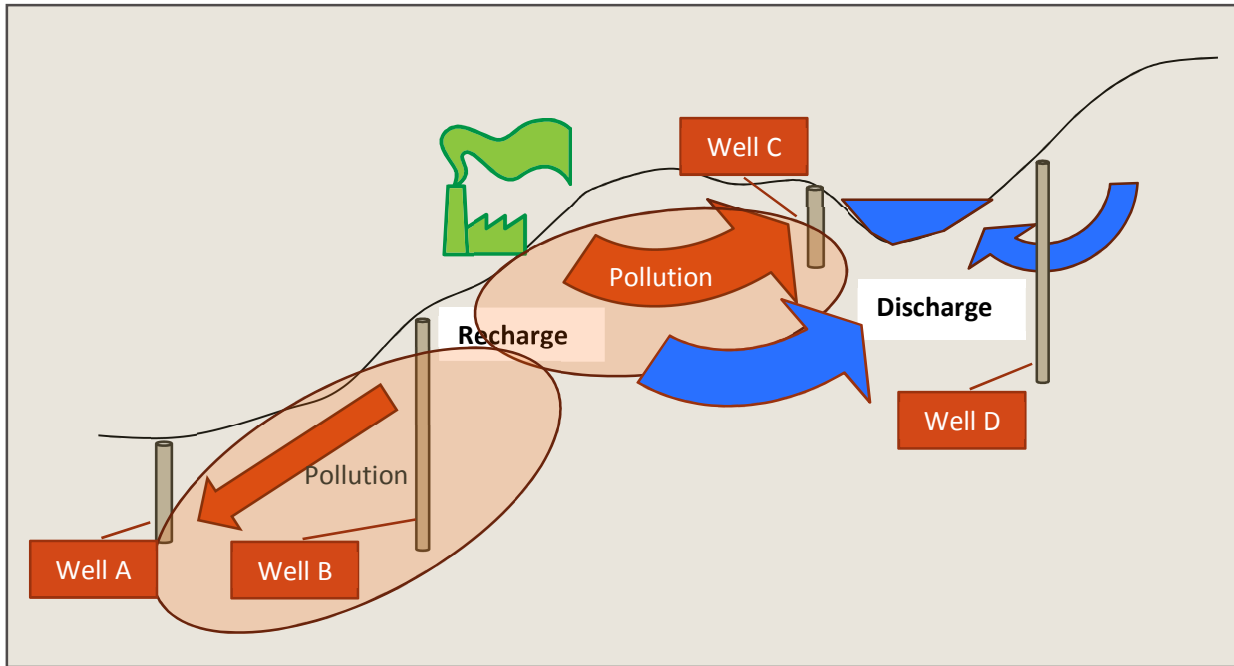
Wells C and D are upgradient of the site and provide our controls. Wells A and B are downgradient of the site. However, only Well A would produce groundwater samples that show signs of pollution. Why? Well B is too deep to detect the pollutants in this situation. So the well set-up has to take into account both position on the land and depth.

## 2. Groundwater monitoring near a stream

Sometimes groundwater flows, upstream, or in opposite directions. How is this possible? When sites are near streams, particular challenges can be created by the flow dynamics between groundwater and surface water. Sometimes the ground water flowing from a site may be contributing water to a stream – that is, flowing into the stream. When water flows from groundwater to surface water it is called a **discharge zone**. At other times, a stream may contribute water to the groundwater, creating a pressure gradient forcing water away from the stream. This is a **recharge zone**. Recharge zones are the way in which ground water is replenished. A “recharge area” also refers to any place where rain or snow runs downward into an aquifer. This is where we see springs, where groundwater discharges



because the water table intersects the land surface. This is shown in the diagram below. Springs flow into fresh water bodies, such as lakes or streams.



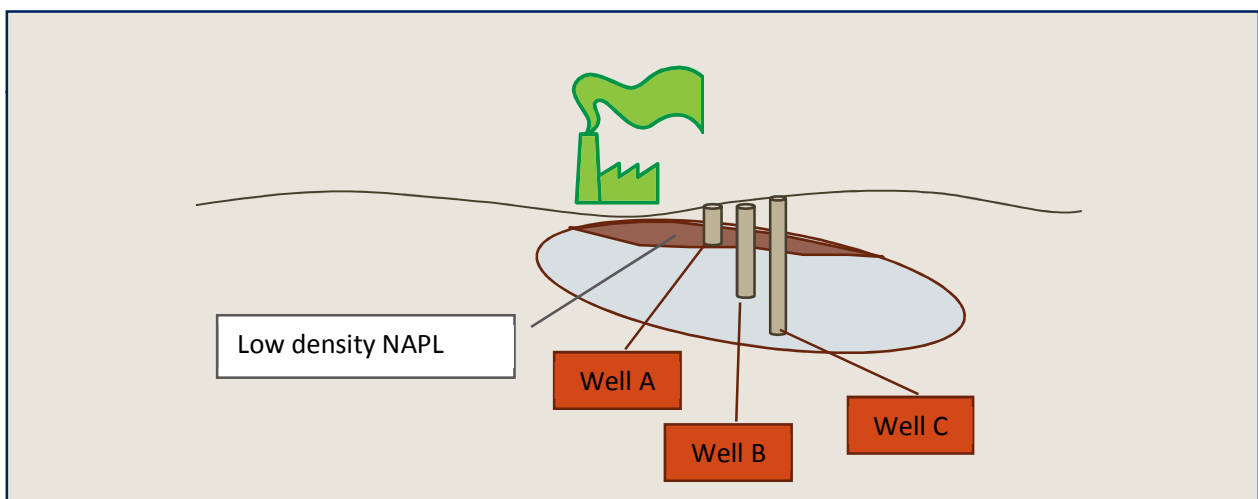
What's going on here? The pollution from the facility is detected at Wells A, B and C. We might expect to detect a plume at Wells A and B as they are "downstream" from the facility. But what about Well C? Well C is in a discharge area. While it might seem to be upstream, water is in fact flowing along the route of least resistance into the water body shown. Pollution would also show up in Well C.

### 3. Groundwater monitoring for oil and oil-like substances

Oil does not dissolve well in water. So testing for oil or oil-like substances makes the set-up more complex. These contaminants are known as non-aqueous phase liquids (NAPLs). That's a mouthful, but you wouldn't want most of them in your mouth! They consist of petroleum hydrocarbons such as gasoline, kerosene, and fuel oil; they also consist of organic solvents, such as *trichloroethylene* and *perchloroethylene*. Some NAPLs, such as gasoline, are less dense than water; and other NAPLs, such as trichloroethylene, are denser than water. Dense non-aqueous phase liquids are referred to as DNAPLs. The DNAPLs are tricky substances that may be gooey enough to move so slowly that they remain a long-term

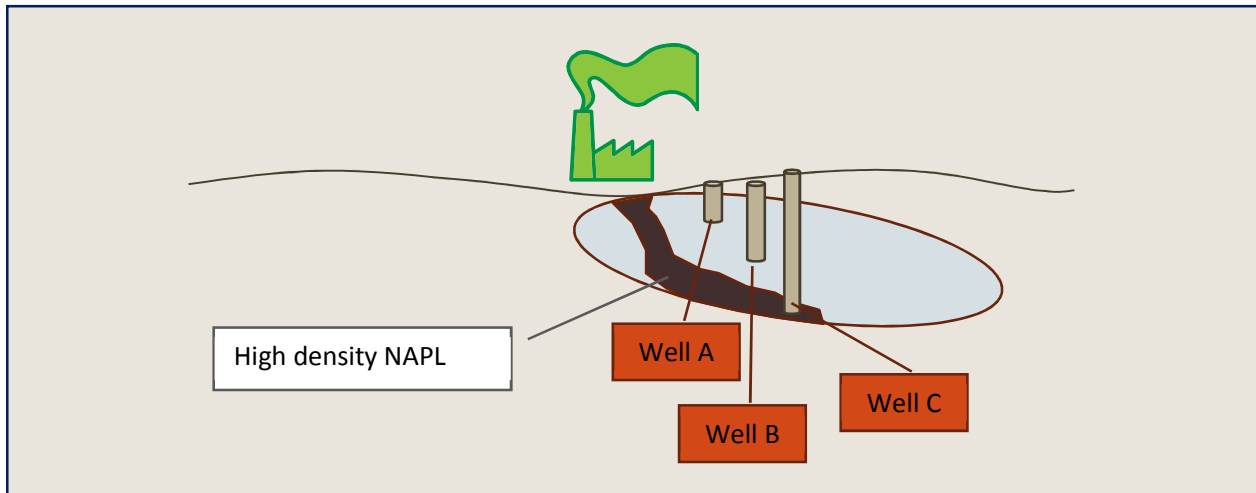
potential source of contamination but can also move fast enough to contaminate water supplies and pose a human health threat. DNAPL tends to move vertically downward through the soil, and once it hits a barrier like clay or bedrock, it tends to pool and then move horizontally until it finds a place of low resistance where it can once again travel downward.

The resulting plumes of these contaminants will look different depending on their density. Consider the two diagrams below.



The dark color in the diagram above represents pollution. Notice that only Well A, a shallow well, will detect pollution in the case of a low density NAPL.

Next consider the case of a high density NAPL, which we call a DNAPL.



In this case, only the samples from the deeper well, Well C, will show signs of pollution.

**NAPLs in general can vary in their concentration by several orders of magnitude over horizontal or vertical distances of a few feet; in other words, one sample located within a few feet of second sample could show 10 times more contamination!** This obviously presents a huge monitoring challenge. This is why, given financial constraints, **sampling many more sites at a screening level may be more important than taking a few very precise samples.** **Hot spots of contamination are likely to be detected only if sampling is conducted every few meters horizontally and every meter vertically.**

Traditional approaches rarely do approach sampling this intensively. Newer, improved methods can be used to achieve this. It is also why it is so important to spend time and money up front to characterize a site well so that the sampling sites chosen are most likely to be representative. It's important for citizen's groups to understand this so that they can advocate for proper well siting, ideally with the help of an experienced consultant.

Traditionally, the most common practice for monitoring contaminants at a site was to install ground-water monitoring wells. Hundreds of thousands of such wells have been installed since the late 1970's. Unfortunately, many of these wells were designed and installed by people who were not aware of appropriate monitoring design, and who did not conduct or

apply the types of site characterization procedures described above. As a result, many existing monitoring wells have serious design flaws that produce unrepresentative samples that lead to inaccurate findings (Nielsen and Schalla, 2006).

If contamination is highly localized and only covers small areas within a large site, detecting the contamination can be like searching for a needle in haystack; if the contamination is widely dispersed throughout the area of concern, fewer monitoring wells be needed to detect it. The following table shows the likelihood of detecting contamination based on the number of monitoring sites established, assuming that about 1/10<sup>th</sup> of the area monitored is actually contaminated.

<i>Number of monitoring sites</i>	<i>Likelihood of detection</i>
3	30%
5	50%
16	100%

And if a contaminated area is very small – for example, 1/100<sup>th</sup> of the size of the area in question, it could require hundreds of borings to detect the contamination with any certainty. This can present a real conundrum in terms of what is financially viable to do, very quickly. It is therefore essential to employ approaches that enable an overall view of the dynamics of site contaminants at minimal cost. These approaches may include any of the following:

Site characterization is the first step. Careful site characterization should include information on:

1. The location, type and extent of contaminants released into the environment.
2. Site hydrology such as: whether the soils porous or clay-like; if the groundwater clearly travels in a particular direction; if there is a geological formation below which contaminants are unlikely to move. Remember, this is why you're consulting a hydrogeologist.

3. Chemical, physical and biological factors that affect how contamination moves (or spreads) such as the amount of rainfall, snowfall, and sunlight that reach the area.
4. Characteristics of contaminants: some contaminants may bind to soil particles; other contaminants readily dissolve in water; some contaminants *volatilize* and exist as vapor in the pore spaces of soil; and some to liquid contaminants (non-aqueous phase liquids -- NAPLs) that do not readily dissolve in water.
5. The location of nearby point of exposure, where humans are most likely to be exposed to contaminants. This may include nearby private wells, source water locations for municipal drinking water, schools, parks and gardens.

Part of initial site characterization requires a search for any existing site data. This may include previous monitoring done at the site, information amount the amount and type of contaminants present and released into the environment, as well as historical data on site usage, topography, soil types and hydrogeology.

Site characterization happens in phases. Phase I investigations usually map out the perimeter of contamination but do not attempt to quantify areas where contamination is most concentrated. Phase I characterizations include the types of site characterization described above and typically are the first step in developing a monitoring plan. Up to a dozen or so soil *borings* are often done to determine soil conditions on the site. Water level measurements are taken to determine direction of groundwater flow. Phase II investigations involve extensive monitoring and concentrate on defining the specific spread and concentration of contaminants identified in Phase I investigations. Monitoring is conducted on at least one and often several types of environmental media: this may include sampling soil, groundwater, soil gas, surface water or sediment.

### Newer Screening Approaches

More detailed site characterization, including monitoring, may involve some of the following newer approaches, all of which screen for the location of contaminants over a wider area.

**Aerial and satellite photos** (e.g., such as those found on Google Earth) can provide possible clues to contaminant sources, when they are not immediately known. Historical photos can sometimes indicate areas where waste pits may have since been filled in. State regulatory

agency files may contain important historical information about the area. Other important historical information can be gleaned from interviews with area residents and former employees of the responsible party.

**Remote sensing techniques** that include sonar and radar can provide useful information on the distribution of certain contaminants under certain conditions. This includes airborne or satellite remote sensing, land geophysics (such as the use of ground penetrating radar and electromagnetics) and marine geophysics.

There are also a number of less expensive field methods for analyzing samples that should be considered as a way to quickly assess the presence of contaminants in a wide area. These include a range of **reagent test kits** for measuring the presence of metals in water; the Hanby Field Test Kit for a range of petroleum compounds and PCBs in either soil or water; the Envirol Quick Test for assessing **pentachlorophenol** and **PAHs**; the AccuSensor test kit for examining trichlorethylene in water, and a range of immunoassay techniques for assessing pesticides, gasoline and PCBs.

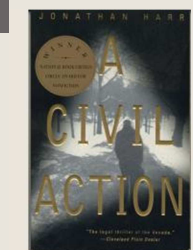
Another newer and more specific technology is **Direct Push (DP) drilling**. DP techniques rely on much lighter weight and mobile equipment attached to all-terrain vehicles or vans that can much less expensively collect samples from numerous locations and depths. DP technology can only be used in certain site conditions, again underscoring the importance of a thorough understanding of hydrogeology before sampling is begun.

The results of rapid sampling using the above techniques can then be displayed to create a 3-dimensional image and understanding of the contaminant plume. This leads to better characterization of the site. More detailed conventional drilling can then be used to more accurately assess the location and movement of contaminants from discovered hot spots.



Geoprobe (direct push) drilling at Gandy Salt Marsh, Snake Valley, Utah. (Utah Geological Survey)

## Case Study: Woburn, Massachusetts



It began when the parent of a young child with leukemia ran into another parent from her neighborhood at her doctor's office. Her child also had leukemia. They learned that numerous children in the community had leukemia. Residents suspected that nearby chemical plants had contaminated their drinking water. The case was popularized by the book and movie, *A Civil Action*. If you read the book, you'll recall just how challenging a legal case this proved to be for the residents. Establishing cause amidst very complicated data that the jury did not understand well was difficult. Before the trial even began, U.S. District Judge Walter J. Skinner divided it into three parts: the first to determine if the possible responsible parties W.R. Grace, Unifirst and Beatrice Foods contaminated the drinking water supply. Unifirst settled early and paid \$1,000,000.

Subsequent analysis helped us to better understand some of what happened at the site. Let's examine that information.

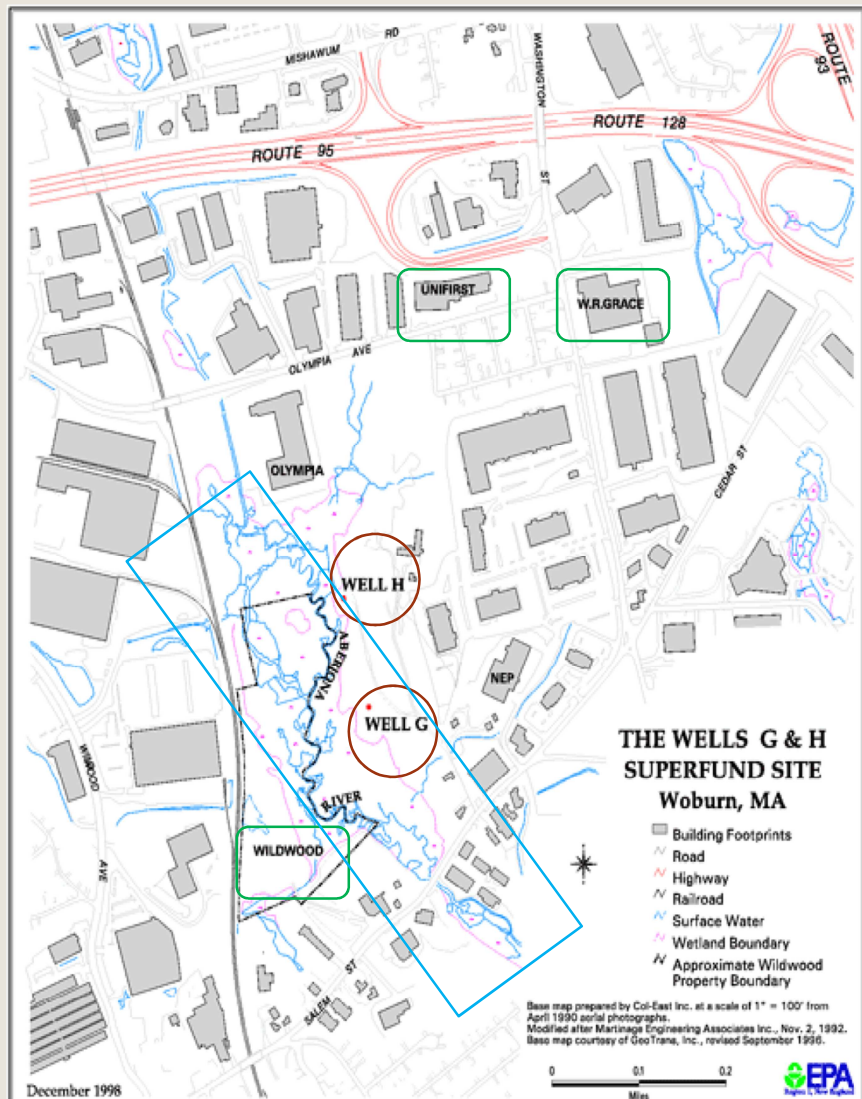
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### Case Study continued...

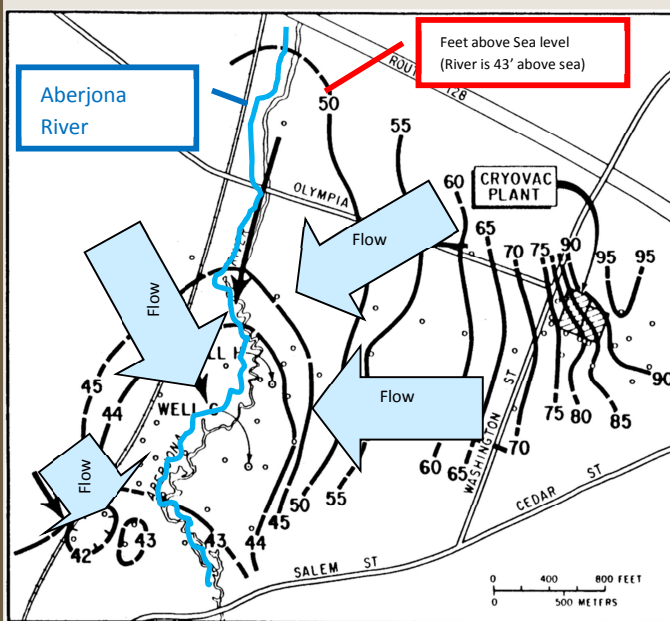
Here's an EPA map of the area. Note several facts: Wells H and G (dark blue circles) are the primary city drinking water wells thought to have been contaminated.

Two of the suspected responsible parties are Unifirst and WR Grace (green rectangles). Both are located to the northeast of the wells. Note the Aberjona River (blue rectangle) flows from north to south by the site. Lastly, note the word Wildwood (green rectangle) in the lower left corner of the site; that is the location of a former tannery, now owned by Beatrice Foods. One of the key legal debates was whether or not the contamination of the 15 acres owned by Beatrice could be responsible for the contamination of the city's wells.



### Case Study continued...

The following diagrams provide us with an initial overview of the direction of flow of

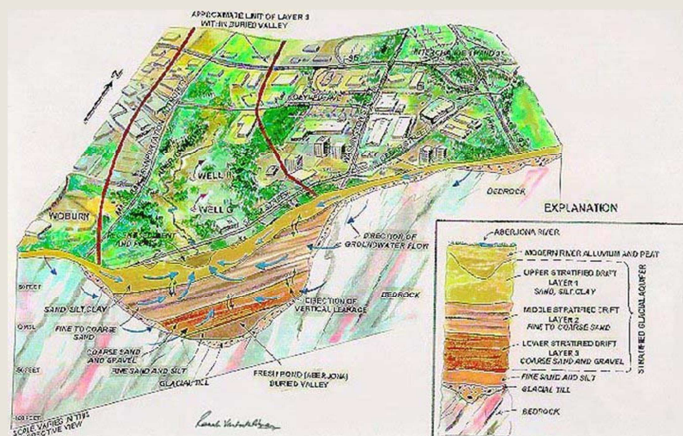


groundwater at the site. We already know that the Aberjona River flows from north to south. In fact, the first diagram below shows us the lateral direction of groundwater, which also flows from the northeast to the southwest (top right to bottom left).

The second diagram shows the direction of groundwater flow 3-dimensionally. Does this look at all familiar? You may recall a previous diagram where we showed a discharge zone; that is an area where groundwater feeds a river. That is

exactly the case here.

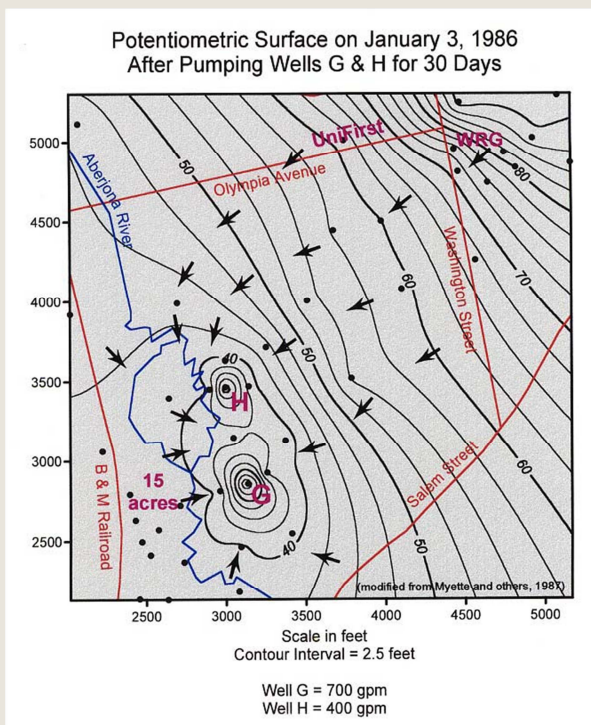
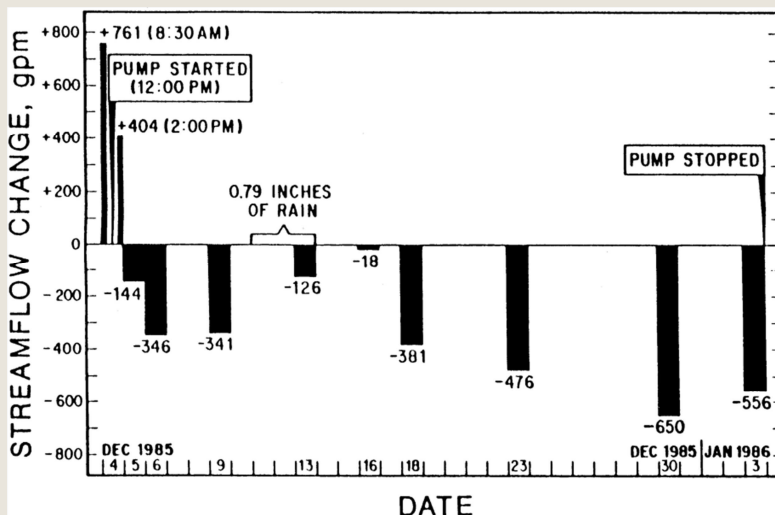
Based on what we can see up until this point, it appears unlikely that Beatrice could be held responsible for the contamination. Any contamination on its lands would appear to leach to the southwest, away from the city's drinking water wells, and if it was discharged into the river, the river would flow to the south and carry the contamination away from the City wells.



### Case Study continued...

What do you imagine would happen however if we pumped groundwater from deep in the aquifer to distribute throughout the city as drinking water? That was the normal state of affairs when the City Wells were operating. That's what the USGS wanted to know. They conducted pumping tests.

The USGS discovered two things: First, look what happened to the flow in the river. The chart to the right shows the difference in flow in the river from upstream to downstream on different dates. Before the pumping began, we see a positive



change in flow (that is, an increase in flow) in the river from upstream to downstream. That's normally what we expect to see in a river, as more water flows into it and it becomes larger from upstream to downstream. However, look what happens after the pump test began and the USGS began pumping water from the City's wells. All of the sudden, the river loses flow from upstream to downstream. How could that be? It's because the river is losing water to the groundwater when pumping happens. Now look at the map that depicts the direction of groundwater flow while pumping is occurring.

### Case Study continued...

All of the water is flowing directly into Wells G and H, including groundwater from the southwest corner, the location of Beatrice Foods. So what seemed implausible on the surface – that Beatrice could be held responsible for the contamination on their lands contaminating the City drinking water wells – now appears quite plausible.

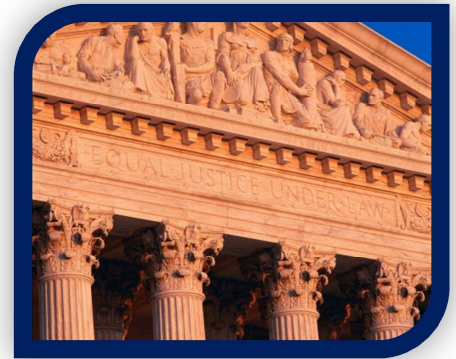
An excerpt from an article in the Daily Times Chronicle from July 1995 summarized what happened in this part of the trial:

*At the end of a lengthy phase one, with confusing technical testimony and directions from the judge which limited their options, the jurors found W. R. Grace liable for the contamination, but absolved Beatrice Foods. An appeal of the jury's Beatrice verdict by Schlichtmann resulted in the censuring of Mary Ryan, the lawyer for John J. Riley, the former owner of the leather company, for her failure to provide all the requested documents and company records during discovery, and in the censuring of Schlichtmann on a separate matter. The case was never reopened, even though a subsequent EPA report provided ample evidence that Beatrice Food's property contaminated the wells.*



# Federal Legislation |

## Chapter 5



There are a number of federal laws that pertain to surface water and groundwater. This chapter presents a brief overview of the six primary pieces of applicable federal legislation. We describe the laws in brief and explain for each how the law can benefit citizen's groups.

### The Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) regulates the production, storage and disposal of hazardous wastes, including underground storage tanks. It also regulates solid waste, or what most of us call garbage. RCRA requires that industries use appropriate practices to limit the impact of waste on groundwater. In order to ensure that such practices are implemented RCRA requires treatment, storage and disposal facilities to conduct groundwater monitoring. Such monitoring not only applies to the present, but for up to 30 years after a RCRA facility closes.

**Why it's important for citizens to know about:** RCRA authorizes private citizens to file suit demanding compliance with RCRA's performance standards and the abatement of "imminent and substantial endangerments to public health and the environment" in the absence of government enforcement.

Unlike the Clean Water Act or CERCLA, citizens are not required to allege past violations of RCRA's substantive provisions, but instead can allege a future (near-term) "imminent and

substantial” harm, which they can then ask the court to order the defendant to take action to avoid.

### **The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA – the Superfund Program)**

The Superfund Program was created to address the most dangerous of the large number of hazardous waste sites throughout the country. Superfund requires “responsible parties” to pay for clean-up costs. It established a Trust Fund to cover the clean-up costs of emergency situations and situations where no responsible party could be found. The taxes that funded the Trust expired in 1995 and unobligated money in the trust fell to zero in 2003; general revenues alone have funded the program since.

**Why it’s important for citizens to know about:** The following is a description of the specific steps that EPA will take to implement CERCLA at a site. The opportunities for citizen involvement at each step appear in orange text, below.

1. The initial step that is taken when a site of concern is identified is called the **Preliminary Assessment and Site Investigation (PA/SI)**. This is when the site is initially assessed for danger and EPA determines if immediate action is required and/or where to rank the site in the overall list.

Citizens can provide important input by sharing any information they have about a site to EPA at this time.

2. If EPA decides that the conditions at the site are serious enough to warrant listing on the **National Priorities List** (which qualifies it as a Superfund site), a public notice is issued so that citizens can comment on the recommendation.

Public comment is important because some stakeholders may not want the site listed.

3. Once a site is listed on the NPL, EPA will appoint a Community Involvement Coordinator (CIC) to work with and involve citizens during the site clean-up process. Initially the CIC will survey community members to determine their preferences. EPA will then produce a **Community Involvement Plan** that explains how community members’ concerns will be addressed.

Citizens should engage the CIC and develop an ongoing relationship to provide regular input and ensure that they receive notification of formal opportunities for comment.

4. EPA will establish a location where all site documents will be made available to the public. The location is typically a local public library.

Citizens should become familiar with the information in the public records repository. It's a good idea for someone who has some technical knowledge to read through and summarize and interpret what's there for others.

5. The **Remedial Investigation and Feasibility Study (RI/FS)** then identifies the type and amount of contamination at the site and reviews the available approaches and costs of clean-up. Documents that pertain to each step of the process are added to the Administrative Record at the local public library. Once the RI/FS is complete, EPA develops a proposed cleanup plan or plans for citizen review.

Citizens can have significant impact on clean-up plans at this time.

Interested citizens can form a **Community Advisory Group** to provide ongoing input to EPA. Groups can also apply for a **Technical Assistance Grant**; these EPA grants provide funds for local groups that want to hire a technical expert to help them understand site data and clean-up plans. There will be numerous opportunities for involvement in public hearings throughout the process. Community groups can also invite EPA to attend their events to discuss the site and proposed clean-up.

6. Once clean-up plans are decided, a **Record of Decision (ROD)** will describe those plans for the site. The ROD provides a synthesis of the RI/FS, public participation, the clean-up actions selected for the site, and how the site may be used post clean-up.

The public can comment on the ROD, which may be later amended. It's important that citizens weigh in on the ROD, especially with regard to future uses of the site. Those planned future uses, may have enormous impact on the type of clean-up required. Obviously, here again, a technical advisor may be important.

7. **Remedial Design/Remedial Action (RD/RA)** phase is a final, detailed clean-up plan is delineated and implemented.



Citizens should stay involved at this point and visit the site to observe and verify plan implementation.

**Construction and Post-construction Completion.** Sometimes clean-up involves physical construction of some kind. Once complete, EPA may operate and maintain cleanup technologies over time.

The community should continue to exert its own oversight of the process, including for applying for a Technical Assistance Grant as necessary to obtain technical assistance to understand and monitor events.

8. **Deletion from the NPL.** When all site clean-up has been completed and all cleanup goals have been achieved, EPA publishes a notice of its intention to delete the site from the NPL in the Federal Register and notifies the community of its availability for comment. EPA then prepares a Responsiveness Summary to delineate how it is responding to citizen comments.

It's critical that citizens review any proposed delisting carefully to ensure that monitoring data reveals that the site has been satisfactorily cleaned up. Were clean-up goals met? Were detection limits of any monitoring below any established clean-up goals?

## Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)

Only politicians and lobbyists can come up with a name like this one! The quick take is that FIFRA requires that any pesticide sold, distributed or used be registered by EPA, unless it meets a specific exemption provided in the regulations. When a pesticide is registered the EPA reviews the pesticide's label, which must give detailed instructions for its safe use. The EPA classifies each pesticide for either general use, which can be applied by anyone, or restricted use, which can only be applied by certified applicators or persons working under their direct supervision.

**Why it's important for citizens to know about:** Unlike most of the other laws listed here, FIFRA offers no opportunities for direct citizen enforcement nor a mechanism to sue violators.

## The Clean Water Act

The Clean Water Act (CWA) is the main federal law that protects surface waters in the United States. The CWA was intended to *eliminate* all point source discharges, minimize impacts from non-point source discharges, restore all threatened waters and protect healthy waters from degradation. Although we provide a brief overview here, there is much to know, and we suggest that those who are interested read River Network's widely acclaimed *The Clean Water Act: An Owner's Manual*, available online at:

[https://www.rivernetwork.org/marketplace/product\\_details.php?item\\_id=55334](https://www.rivernetwork.org/marketplace/product_details.php?item_id=55334), or access an online learning tool, River Network's Clean Water Act Course at: <http://www.rivernetwork.org/rn/cwa/home/>.

The Act authorizes the EPA to establish Water Quality Criteria that are protective of aquatic and human life. States and Tribes then develop Water Quality Standards based on those criteria that protect, maintain and improve the quality of surface waters. State and Tribal standards are developed to protect the *designated uses* for a water body. Designated uses are things such as drinking or swimming – basically the way in which a waterway is used. You may wonder who gets to determine the designated uses. That's often a hot political issue and the bottom line is that citizens get to have input into the process!

Water Quality Standards are ambient standards not discharge standards, meaning that they describe the overall conditions that should exist in a river or lake, not the levels specific to the discharge itself. These ambient standards, through a calculation process can be used determine what are known as the Total Maximum Daily Loads (TMDLs) and effluent standards that form the basis of water quality based permit limitations that regulate pollutants under the National Pollutant Discharge Elimination System (NPDES) permit program.

Anyone who discharges anything into a waterway must obtain a permit to do so. States and the EPA authorize these permits if the proposed discharge will not lead to the violation of the established Water Quality Standards.

**Why it's important for citizens to know about:** There many opportunities for public involvement under the Clean Water Act. Again, please consult the River Network resources described above for more detailed information. Here is a list of just a few of the ways that citizens can have impact:

- Comment on designated uses ascribed to specific waterways
- Comment on proposed or revised Water Quality Standards
- Request specific changes to Water Quality Standards
- Comment on proposed or revised NPDES permits
- Sue violators of the Act directly

### **The Safe Drinking Water Act (SDWA)**

The purpose of the Safe Drinking Water Act (SDWA) is to protect public health by requiring all public water systems to comply with certain specified health-based standards. The law also requires public water systems to report their water quality annually to their customers and produce an annual compliance report. The SDWA establishes enforceable National Primary Drinking Water Standards (NPDWSs) that set maximum allowable levels of a range of chemicals. The Maximum Contaminant Levels (MCLs) set the maximum concentration levels for particular contaminants in drinking water. The MCLs also may be used to establish groundwater clean-up levels for RCRA sites. Unfortunately, in either case, MCLs may be set above levels known to cause human health problems. This happens if meeting Maximum Contaminant Level Goals (MCLGs) is deemed to be too costly.

**Why it's important for citizens to know about:** The Safe Drinking Water Act authorizes citizens to file a lawsuit to enforce compliance with any part of the Act. Citizens must be adversely affected by the violation of the Act in order to file suit. Citizens must normally provide sixty days' notice to the violator, State and EPA prior to filing suit; this is to allow the violator an opportunity to correct their violation.

## The Surface Mining Control and Reclamation Act

The Surface Mining Control and Reclamation Act (SMCRA) regulates the environmental effects of coal mining in the United States. Coal mining has done very nasty things to our water! SMCRA regulates both active coal mines and the reclamation of abandoned mines. SMCRA requires that companies obtain permits before conducting mining. Permit applications must describe how the mine will meet the SMCRA performance standards, and how the land will be reclaimed after mining is complete. SMCRA created a fund to pay for the cleanup of abandoned mine lands. The fund is financed by a tax on mined coal. Most of these funds are distributed to states to fund reclamation activities. A smaller percentage of the fund is used by the federal government to carry out high priority cleanups in states without approved programs.

**Why it's important for citizens to know about:** The Act provides citizens with the ability to report on suspected violations and to sue to ensure compliance with the law. For details, please see the *Strip Mining Handbook*, available for free online at <http://sites.google.com/site/stripmininghandbook/about>.

## Small Business Liability Relief and Brownfields Revitalization Act

The Small Business Liability Relief and Brownfields Revitalization Act amended CERCLA (see above) to make it easier to cleanup and reuse closed contaminated industrial sites, known as *brownfields*. It's a ridiculously long name for an Act; most just refer to it as "Brownfields Legislation". Its main purpose is to provide financial assistance to promote brownfields revitalization. As you may imagine, cleaning up these old abandoned sites can be really costly. The law amends CERCLA to allow parties who are unable or who have limited ability to pay clean-up costs, to expeditiously settle for small amounts. It exempts owners of properties whose groundwater is contaminated from offsite sources from having to conduct groundwater investigations or to install groundwater remediation systems.

It enables EPA to enter into certain prospective land purchaser agreements, on a case-by-case basis, where the prospective purchaser has tested the land and discovered the presence of contaminants. The Act allows the EPA to release the purchaser from liability in exchange for

monetary and other consideration. That sounds like a dirty pay-off, but it's not! The prospective purchaser must be able to show that the contamination occurred prior to their ownership, that they made all appropriate inquiries into previous ownership and uses of the facility, and a number of other provisions which basically amount to demonstrating good judgment and good faith and never having been affiliated with the party responsible for the contamination.

The Act provides grants for assessments, revolving loan funds, direct cleanups, and job training. It allows up to 10 percent of the grant funds to be used to monitor the health of exposed populations. Brownfields Revolving Loan Fund Grants provide funding to address sites contaminated by hazardous substances. Brownfields Job Training Grants provide environmental training for residents of brownfields communities. Brownfields Cleanup Grants provide direct funding for cleanup activities at certain properties, and to help with planned green space, recreational, or other nonprofit uses.

**Why it's important for citizens to know about:** Brownfields legislation creates opportunities for site redevelopment. Citizens should be aware that as they work with key stakeholders in their communities that Brownfields legislation provides opportunities through the revolving loan fund and other tools to help with site revitalization and reuse efforts. The legislation also funds the Brownfields programs operated by EPA. EPA has a number of useful tools to also help citizens with these efforts.

# Permit Compliance

## Monitoring |

### Chapter 6

As mentioned in Chapter One, any entity that discharges waste into a water body must obtain an NPDES (National Pollution Discharge Elimination System) permit under the Clean Water Act. In most states, NPDES permits are issued by State water quality agencies; the EPA oversees NPDES permits in Alaska, Arizona, Idaho, Massachusetts, New Hampshire, New Mexico, tribal governments, Washington, DC, and Puerto Rico. NPDES permits not only regulate the type and quantity of substances that can be discharged, but also specify how often and by what means discharges should be monitored for compliance. Discharge Monitoring Reports (DMRs) are usually required to be submitted by the discharger to the permitting authority monthly.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) DISCHARGE MONITORING REPORT (DMR)																																			
(2-16)						(17-19)																													
PERMIT NUMBER						DISCHARGE NUMBER																													
MONITORING PERIOD																																			
FROM			YEAR			MO			DAY			TO			YEAR			MO			DAY														
10			01			01			11			01			01			11			01			01											
(20-21)						(22-23)						(24-25)						(26-27)						(28-29)						(30-31)					
QUANTITY OR LOADING						(4 Card Only)						QUALITY OR CONCENTRATION																							
(54-61)						(38-45)						(46-53)																							
MAXIMUM						UNITS						MINIMUM						AVERAGE																	
																		125/100ml																	

There are a number of opportunities for citizens to have input into the development, approval and implementation of NPDES Permits. See River Network's publication, *Permitting an End to Pollution, for details*. The publication is available at <https://www.rivernetwork.org/marketplace>. We provide a brief overview here.

#### Opportunities for citizen input:

1. **At the time of issue.** Permitting agencies must notify the public when discharge permits are about to be issued. Citizens can request that their permitting agency place them on a list to be directly notified when permits are issued.
2. **At the time of modification or renewal.** When permits a permit modification is requested by the discharger or when a permit comes up for renewal (the latter happens once every five years), the public has an important opportunity to comment. Citizens may request a public hearing during the comment period for a permit, usually 30 days.

These are important opportunities to make a difference. Bear in mind though, the process can be quite political. If citizens oppose proposed discharges from a major employer in a State, their efforts will almost certainly require considerable organizing and a campaign strategy that goes well beyond simply commenting.

Citizens should request a copy of the draft permit (if one has been issued) and a copy of the permit fact sheet. The permit will list the specific substances that can be discharged and their limits. The fact sheet will explain how and why these limits were arrived at. One of the most important facts for citizens to know about permits is that the Clean Water Act states that no permits may be issued if a discharge will contribute to a violation of water quality standards. That means that if the receiving body of water is threatened (request a list of threatened waters that appear on a list called the 303d list from your permitting agency) generally no new permits or increased discharges for existing permits should be issued.

3. **Compliance during course of permit.** If a permit has been issued, citizens can monitor compliance with that permit. **Discharge Monitoring Reports (DMRs)** can provide you with a lot of information about who is in or out of compliance and what chemicals are being discharged into your water body. Where does one go about getting a copy of an NPDES permit and these important DMRs? Fortunately, this process is becoming easier. In the past, citizens had to visit the office of the agency that issued the discharge permit to obtain a copy (sometimes you still do). It wasn't unusual to hear stories of citizens being brought to a room with hundreds of files, shown a particular file drawer and told to go at it. Needless to say it was often difficult for the untrained observer to know where to begin. With electronic innovation all of this is changing. EAP has some great new online tools. Much NPDES data is now available through these tools. Citizens can access the EPA's Enforcement and Compliance History Online (ECHO) at [www.epa-echo.gov/echo/](http://www.epa-echo.gov/echo/). As of the start of 2011, available data is variable: some states have 80% of the available data entered; others have only about 5%. The percent of data available will likely continue to increase over time.

ECHO is part of a series of helpful new sites and tools established by the EPA under Administrator Lisa Jackson. One important part of ECHO that is the Noncompliance Report Site. The site provides interactive information from EPA's 2008 Annual Noncompliance Report, which pertains to about 40,000 permitted Clean Water Act dischargers across the country. The report lists state-by-state summary data of violations and enforcement actions taken by the states for smaller facilities. The site makes it easy to compare states by compliance rates and enforcement actions taken. View the interactive map for the Clean Water Act Annual Noncompliance Report here: <http://www.epa-echo.gov/echo/ancr/us/>

Regardless of whether you obtain a DMR online or in-person, you will need to understand some how to read the document and what to look for. A sample NPDES



Discharge Monitoring Report appears on the following page. There are several important things to notice in the report:

1. The left hand column lists the parameters that are required to be monitored.
2. **The purple rectangle** and accompanying arrow points to the concentration (or load) of the pollutant *allowed* by the permit. **The blue rectangle** and accompanying arrow points the level *actually found* by monitoring.
3. Compare the permitted amount and monitored amount for each parameter (curved orange arrows). Which monitored amount exceeds the permitted allowance? [It's the level of lead].
4. The permitted amount described is an average, as is the monitored amount. How many times was the permitted amount exceeded? The number of *exceedances* can be found in the column circled in red. There were 20 exceedances of the permitted lead level.
5. The column highlighted by the **green rectangle** identifies the required frequency of monitoring. The frequency reported is the number of days out of a week (7), month (30) or quarter (90). Look at the purple circle. Was copper monitored as frequently as required by the permit? [No]. The permit required sampling 1 day per month (30 days); sampling was conducted once in a quarter (1/90 days).

Again, this overview provides just some of the basics that citizens should examine in these reports. Some of the online material found in Echo will make this task even easier. For example, you may find tables that simply list the number of violation by facility within a given zip code.

PERMITTEE NAME/ADDRESS (Include Facility Name/Location if Different)

NAME John DoeADDRESS 1 Main St.FACILITY Fictitious Inc.LOCATION Washington, DC

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

DISCHARGE MONITORING REPORT (DMR)

(2-16)

(17-19)

000000000

PERMIT NUMBER

000000000

DISCHARGE NUMBER

Form Approved.

OMB No. 2040-0004

Approval expires 05-31-98

MONITORING PERIOD					
FROM			TO		
YEAR	MO	DAY	YEAR	MO	DAY
10	01	01	11	01	01
(20-21)		(22-23)	(24-25)	(26-27) (28-29) (30-31)	

☐ Check here if No Discharge

NOTE: Read Instructions before completing this form

PARAMETER (32-37)	SAMPLE MEASUREMENT	QUANTITY OR LOADING (46-53)			QUALITY OR CONCENTRATION (46-53)			UNITS	NO. EX (62-63)	SEQUENC OF ANALYSIS (64-68)	SAMPLE TYPE (69-70)
		AVERAGE (46-53)	MAXIMUM (54-61)	UNITS	MINIMUM (38-45)	AVERAGE (46-53)	MAXIMUM (54-61)				
E.Coli	SAMPLE MEASUREMENT					125/100ml	750		4	5/7	24HC
	PERMIT REQUIREMENT					126/100ml	200				
Copper	SAMPLE MEASUREMENT					.0599 mg/l			0	1/90	Grab
	PERMIT REQUIREMENT					0.0600 mg/l				1/30	
Lead	SAMPLE MEASUREMENT					0.0120 mg/l			20		Grab
	PERMIT REQUIREMENT					0.0085 mg/l				1/30	
	SAMPLE MEASUREMENT										
	PERMIT REQUIREMENT										
	SAMPLE MEASUREMENT										
	PERMIT REQUIREMENT										
	SAMPLE MEASUREMENT										
	PERMIT REQUIREMENT										
	SAMPLE MEASUREMENT										
	PERMIT REQUIREMENT										

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER	I CERTIFY UNDER PENALTY OF LAW THAT THIS DOCUMENT AND ALL ATTACHMENTS WERE PREPARED UNDER MY DIRECTION OR SUPERVISION IN ACCORDANCE WITH A SYSTEM DESIGNED TO ASSURE THAT QUALIFIED PERSONNEL PROPERLY GATHER AND EVALUATE THE INFORMATION SUBMITTED. BASED ON MY INQUIRY OF THE PERSON OR PERSONS WHO MANAGE THE SYSTEM, OR THOSE PERSONS DIRECTLY RESPONSIBLE FOR GATHERING THE INFORMATION, THE INFORMATION SUBMITTED IS, TO THE BEST OF MY KNOWLEDGE AND BELIEF, TRUE, ACCURATE, AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION, INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT FOR KNOWING VIOLATIONS. SEE 18 U.S.C. § 1001 AND 33 U.S.C. § 1319. (Penalties under these statutes may include fines up to \$10,000 and or maximum imprisonment of between 6 months and 5 years.)	TELEPHONE		DATE		
Jane Smith, CEO		802	999-9999	2011	01	03
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA CODE	NUMBER	YEAR	MO

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

## CASE STUDY:

The Surfrider Foundation is a non-profit grassroots organization dedicated to the protection and enjoyment of the world's oceans, waves and beaches. In the late 80's two pulp mills on the Humboldt Bay peninsula on California's northern coast discharged millions of gallons of waste into the Bay under an NPDES permit. The mills began to violate their discharge permits. Recreational surfers reported skin and eye irritation and gastrointestinal problems. Monitoring revealed dioxin and furan in fish and crabs near the plants' discharge.



*Courtesy of NASA*

After nearly a year of research, Surfrider discovered that the mills discharges exceeded the NPDES limitations for pH, chronic toxicity, total suspended solids, ammonia nitrogen and other parameters. Surfrider filed suit under the citizen suit provision of the Clean Water Act. The violations listed in Surfrider's suit came directly from the DMRs. After two months the citizen suit prompted EPA to sue the mills as well. The courts consolidated the two suits. The result of the suits was a consent decree whereby the mills had to pay penalties in excess of \$5 Million, implement changes in procedures that would ensure future NPDES compliance, and set up a special fund to support local water quality projects.

## Analysis | Chapter 7

In the last chapter we saw that it was relatively straightforward to compare the data that appears in NPDES Discharge Monitoring Reports (DMRs) with the allowable effluent levels granted in permits. The DMRs contain the monitored amounts and permitted levels side-by-side. But other monitoring data (or types of reports) may not be so straightforward. How does one go about interpreting other types of monitoring data (i.e., not NPDES related) that are collected by a federal, state or tribal agency, a watershed group or a private consultant that your group hires?



Once monitoring is completed, you will want to review the results of the samples tested. The results will likely list each parameter monitored at each sampling location on a specific date and will specify the results as some number. Those numbers will have varying units depending on the parameter studied. How does one go about understanding that data?

This chapter provides you a few hints on how to begin interpreting such reports. By understanding a few basic concepts, such as the units that most data are reported in and what you can compare those numbers to in order to understand their significance, you'll be well on your way. Let's consider first the units of measurement by which most monitoring data is reported.

Although data will be reported in different units depending on the parameter studied, most chemical monitoring data will be reported as concentrations. Concentrations of contaminants are most often reported in one of several units: mg/l, ppm, ug/l or ppb. You may also see a number indicating the MDL or minimum detection limit in the same units. What do those mean?

Mg/l stands for milligrams per liter, which conveniently works out to be the same as ppm, which is parts per million. Some contaminants may typically only be found in relatively minute quantities and rather than report those results as a number with numerous zeros after the decimal point (e.g., 0.001), they will often be reported as ug/l (e.g., 1), which stands

for micrograms per liter. There are 1,000 micrograms in a milligram. Ug/l are the same as ppb or parts per billion. How much is a mg/l or ppm anyway? One ppm is equivalent to one drop of water diluted into 50 liters, which is about the fuel tank capacity of a compact car. A part per billion is equivalent to 1 drop of water diluted into 250 chemical drums filled with liquid. Although these are indeed small numbers, certain contaminants can be harmful to human health if they are present in the parts per trillion, or even present at all.

## Toxicity

Would you rather consume a teaspoon of sugar or a teaspoon of dioxin with your morning coffee? Different chemical compounds have different degrees of toxicity. A teaspoon of sugar won't do you much harm; a teaspoon of dioxin will! So, for example, look at the table below. Phosphorus and arsenic are both present at concentrations of 0.2 mg/l.

<i>Chemical</i>	<i>Amount (mg/L)</i>
Phosphorous	0.2
Arsenic	0.2

In fact, both phosphorus and arsenic in this example are present at more than 20 times an acceptable level. However, arsenic is far more toxic than phosphorus and would pose a far greater human health risk. The relative toxicity of different chemical compounds is determined by a number called the LD50. The LD50 is the "lethal dose," of the chemical that kills 50% of the lab animals exposed to it. This is a rough, not a perfect way, to compare toxicity of different chemicals. For example, in the table you can see how much salt it takes to kill 50% of the rats compared to how much arsenic, dioxin and other substances it takes.

Chemical	Means of exposure, Animal	LD50 (mg/kg)
Sugar	Oral, rat	29,700
Salt	Oral, rat	3,000
Caffeine	Oral, rat	192
Nicotine	Oral, rat	50
Arsenic	Oral, rat	13
Dioxin	Oral, rat	0.02

So, back to our question. Would you rather consume a teaspoon of sugar or a teaspoon of dioxin with your morning coffee? Obviously it took far more sugar to kill 50% of the rats than it did dioxin.

In the table above we see a new unit introduced, mg/kg. This stands for milligram per kilogram. It tends to be used more in toxicology than in water quality monitoring. You will see mg/L used with fish tissue and sediment samples. Toxicology is concerned with doses; water quality monitoring is concerned most often with concentrations. Mg/kg is a measure of dose. It means the number of milligrams of a substance consumed per kilogram weight of the animal (or human) consuming it. Experiments in the field of toxicology provide us with numbers for what are considered approximations of doses that are safe for laboratory animals. Those numbers are then manipulated to render a number for a dose that is assumed to be safe for humans, typically called the *Reference Dose*. The manipulation is no more than a very gross approximation. Water quality criteria for toxic chemicals are actually derived from these Reference Doses. By multiplying the Reference Dose by the body weight of human you want to protect and dividing by the average estimated liters of water consumed and the kg of fish consumed daily, you arrive at a concentration<sup>3</sup>. The US EPA and states usually use the following assumptions in this derivation: the average human weighs 70kg and the average person consumes 2 liter of water per day. Interestingly, 70 kg is the average weight of an adult male. This is one reason there is much controversy over water quality criteria.

The US EPA develops water quality criteria, which are recommendations. State and tribes usually develop legal Water quality Standards based on those recommendations. States and tribes have the right to develop standards that are different from EPA's criteria, and in fact are encouraged to do so to respond to local conditions. For example, Oregon is currently in the process of re-writing their standards to be much more stringent for toxic substances to account for new assumptions about the average weight of fish consumed per day. The old standards did not take into account the far greater fish consumption habits of tribes along the Columbia River.

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<sup>3</sup> The actual calculation is more complex but this described the heart of it.

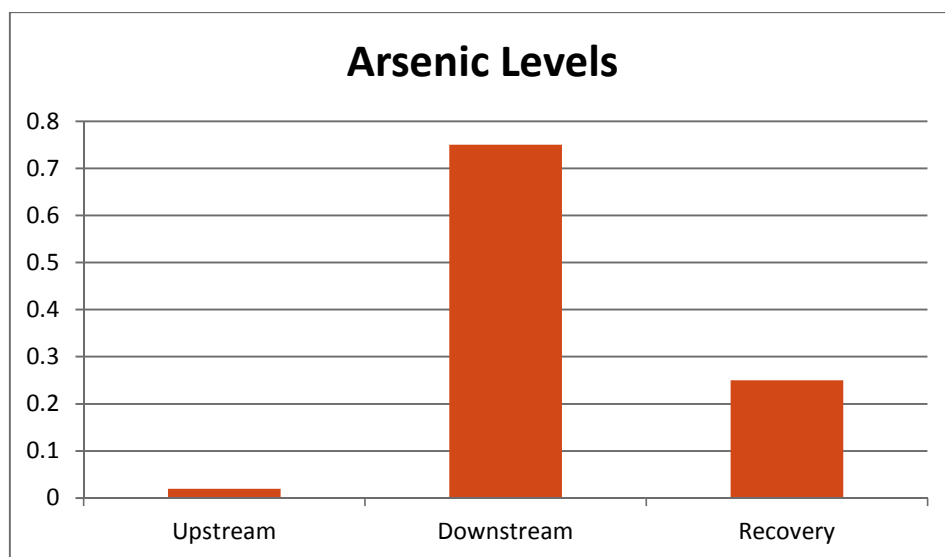
## Comparing Results to Reference Data

There are a number of ways to interpret results:

### 1. Sites may be compared to one another

Results from an upstream sampling location, for example, may be compared to the results from a downstream location. If pollution levels increase from a sampling location upstream of a suspected source (e.g., factory) to sampling location downstream of that source, there's a strong likelihood that the suspected source is indeed the source of the detected pollution. This is especially true if results from a "*recovery site*" even further downstream show that pollution levels begin to drop off again with dilution. The following table displays an example of this with arsenic levels.

Results such as those below show a strong likelihood that the suspected source is a problem. Upstream there is minimal arsenic. Downstream the levels are much higher. Further downstream, where pollution has been diluted, arsenic levels are dropping off.



### 2. Results may be compared to EPA's Water Quality Criteria (WQC)

The Clean Water Act requires that the EPA develop recommended criteria to provide tribes and states in their development of legally binding water quality standards; we'll discuss water quality standards in the next section. Very often states and tribes simply adopt EPA's suggested Water Quality Criteria. A copy of those criteria for EPA's



priority pollutants – those toxic pollutants for which EPA has established specific analytic procedures – can be found in Appendix C. These criteria are also available on the web at: <http://www.epa.gov/waterscience/criteria/wqctable/index.html>

**Here's a snapshot of what you'll find:**

**Priority Pollutants**

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health for the consumption of		FR Cite / Source
			CMC <sup>1</sup> (acute) (µg/L)	CCC <sup>1</sup> (chronic) (µg/L)	CMC <sup>1</sup> (acute) (µg/L)	CCC <sup>1</sup> (chronic) (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
1	Antimony	7440360					5.6 B	640 B	<a href="#">65 FR 66443</a>
2	Arsenic	7440382	340 A,D,K	150 A,D,K	69 A,D,bb	36 A,D,bb	0.018 C,M,S	0.14 C,M,S	<a href="#">65 FR 31682</a> 57 FR 60848
3	Beryllium	7440417					Z		<a href="#">65 FR 31682</a>
4	Cadmium	7440439	2.0 D,E,K,bb	0.25 D,E,K,bb	40 D,bb	8.8 D,bb	Z		<a href="#">EPA 822R-01-001</a> <a href="#">65 FR 31682</a>

To assess your data from a human health impact, you would compare your results to the numbers found in the two columns with the heading “Human Health for consumption of...”. The sub-column entitled “Water + Organism” is used if people both drink the water *and* consume fish from the water body (5.6 ug/L for Antimony); the sub-column headed entitled “Organism Only” is used if people *only* consume fish from the water body (640 ug/L for Antimony), and do not drink from it. In the chart above, the letters that appear in columns are footnotes; they are explained in the full charts found in the Appendix.

### 3. Results may be compared to State or Tribal Water Quality Standards (WQS).

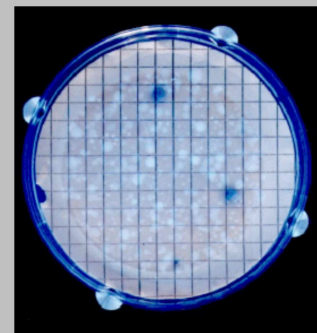
This is a fairly straightforward way to determine if there is a violation of the Clean Water Act. Under the Clean Water Act, water quality standards are developed to support what are termed “designated uses” of particular water bodies. Examples of designated uses include things such as drinking, swimming, fishing and boating. A water body designated as a source of drinking water will have much stricter standards than one designated for farm irrigation.

It’s important to be careful when comparing monitoring results to some water quality standards. For example, bacteria standards may state, “no single sample shall exceed 120 colonies per 100ml and the geometric mean [a fancy name for a type of average] of 4 samples collected over a month shall not exceed 77 colonies per 100ml.” Don’t claim that there is a violation of water quality standards based on a one-time sample that shows 100 colonies per 100ml.

The following chart is a brief excerpt from the water quality standards of the State of Virginia. Standards listed as “acute” relate to short-term exposures; standards listed under “chronic” relate to ongoing long-term exposures.

#### Bacteria Results

Bacteria results are reported on the basis of the number of colonies detected per 100 ml of water. 100ml of water are typically passed through a small circular filter. The bacteria are trapped on the filter where they are incubated and grown so that they can be counted. The filter typically has grids on it to aid in counting.



The standards below apply to certain toxic substances; often toxic standards are broken out – as they appear below – for the protection of aquatic life and humans. The criteria for the protection of human health – applicable when a designated use involves human exposure (such as drinking or swimming) are far more stringent than criteria aimed at protecting aquatic life, which are applicable if a designated use does not involve human exposure. [Notice the shaded numbers below for the pesticide Aldrin: The criteria for protecting human health is much more stringent (a smaller amount permitted) than the criteria used to protect aquatic life (e.g., fish)]

9 VAC 25-260 - Virginia Water Quality Standards  
February 2010

PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Acrolein (µg/l) 107028					6.1	9.3
Acrylonitrile (µg/l) 107131 Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.51	2.5
Aldrin (µg/l) 309002 Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .	3.0		1.3		0.00049	0.00050

**4. Monitoring results may also be compared to Safe Drinking Water Act levels known as Maximum Contaminant Levels (MCLs) or Maximum Contaminant Level Goals (MCLGs).**

The MCLGs are the preferred levels, but MCLs are established to take into account economic feasibility. Generally you would use MCLs to assess results from drinking water; Water Quality Standards are more typically used to assess monitoring results from surface waters. MCLs are required to be met by law; MCLGs are goals, which although they may define a level above which are considered unsafe, do not carry any

legal weight. MCLGs however could carry some political weight, depending on your circumstances. SDWA MCLs and MCLGs may be found in Appendix B. They may also be found on the web at: <http://www.epa.gov/safewater/contaminants/index.html>

**Here's a snapshot of what you'll find:**

Organic Chemicals				
Contaminant	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<i>Alachlor</i>	zero	0.002	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops
<i>Atrazine</i>	0.003	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops
<i>Benzene</i>	zero	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills

**5. Results may also be compared to “Comparison Values” established by the Agency for Toxic Substances and Disease Registry (ATSDR)**

The ATSDR, part of the Centers for Disease Control (CDC), establishes Comparison Values for each type of environmental media: air, soil, surface water and ground water. These are conservative estimates of levels *not* expected to cause harm. They act as a screening tool to determine if further investigation is warranted. ATSDR does not publish this information. River Network can provide you with assistance if you are wondering how your data does compare to ATSDR Comparison Values.

The chart below provides an overview of how Comparison Values may be used in analysis. The process has been likened to using a dog on a search. The dog's role is to tell you where to focus your search.

Results for a contaminant show it is:	What could happen next...	What it means...
<b>Higher than comparison values or state or federal levels</b>	More samples and lab tests are needed  Regulatory agency may need to be notified	This contaminant is present on the site. More samples are needed to see how extensive the contamination is and to determine the vertical and horizontal extent of contamination. More sensitive equipment might be used.
<b>Lower than comparison values</b>	No further testing	Some contamination is present, but the amounts are considered not harmful to humans.  Carefully review location of samples to determine if it's possible there is more contamination on-site. If the sample locations were placed properly, the site may not need more testing.
<b>Not detected</b>	No further testing or testing with more sensitive equipment	Very little if any of this chemical is present on site (assuming detection limits are below comparison values).

#### **6. Monitoring results (data) may also be compared to State and Tribal Health Department guidelines for fish consumption.**

Obviously this comparison would only be made if you had results from the sampling of fish tissue to determine contaminant levels. Guidelines will typically specify the concentration of mercury, PCBs and other contaminants in fish tissue (in mg/kg) that are safe for consumption.

## Water Quality Standards and Human Health

**If your results exceed water quality criteria or standards, does that always mean that health problems will result?** Not necessarily! There are many things that determine whether or not the presence of contaminants poses an imminent health danger. Remember, health problems may result when there is a pathway that connects contaminants in the environment to human exposure. Is the water in question source water for drinking water? If it is, then there is reason for concern. Do people eat the fish that have mercury levels that exceed allowable levels? If so, then there is reason for action. .

**If your results do not exceed water quality criteria or standards, does that mean that the contaminants present are *not* causing health problems?** Not necessarily! If your samples do not exceed water quality standards that's great news! If some levels are close to these standards that could mean that there's a need for ongoing testing.

Remember the process for setting water quality standards is complex and political. Also, new scientific evidence can lead to a change in the standards. . For example, to incorporate the most recent scientific research, in January, 2001 EPA adopted a new standard for arsenic in drinking water at 10 ppb, replacing the old standard of 50 ppb. Note that this was no small change; the old drinking water standard was five times the new one! Furthermore, arsenic is carcinogenic and even at 5 ppb there is still an increased chance of cancer; no amount in drinking water is actually safe.

## Interpreting Groundwater Data

Groundwater data is usually more complex to interpret than surface water data. Look at the results along with a hydrogeologist. There are some obvious things to look for first, such as:

- How contaminant levels at any known contamination sites compare to contaminant levels down gradient and elsewhere.
- Is an underground plume in evidence? Does it seem to be heading in one particular direction? If so, what's ahead in its apparent path?
- What do monitoring wells at different depths detect?
- Do soil samples in the root zone seem indicate the transport of contamination closer to the surface (and hence possibly not detected in deeper wells)?
- How does the monitoring data compare to Safe Drinking Water Act Maximum Contaminant Levels? As mentioned in the chapter on groundwater, generally Safe Drinking Water Act Maximum Contaminant Levels are often used as the clean-up

standard, given the frequent connection between groundwater and source water for drinking water.

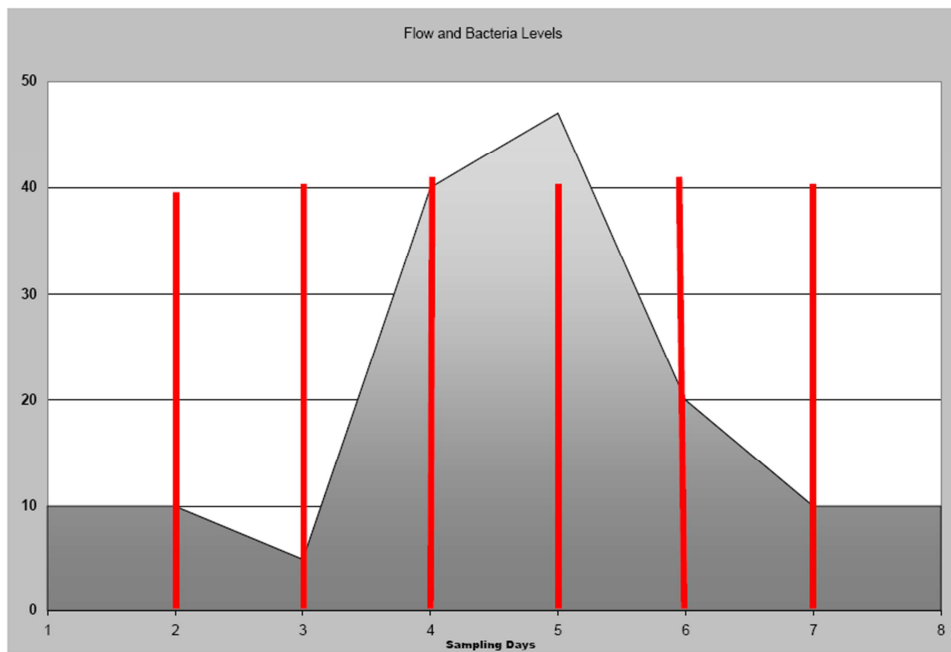
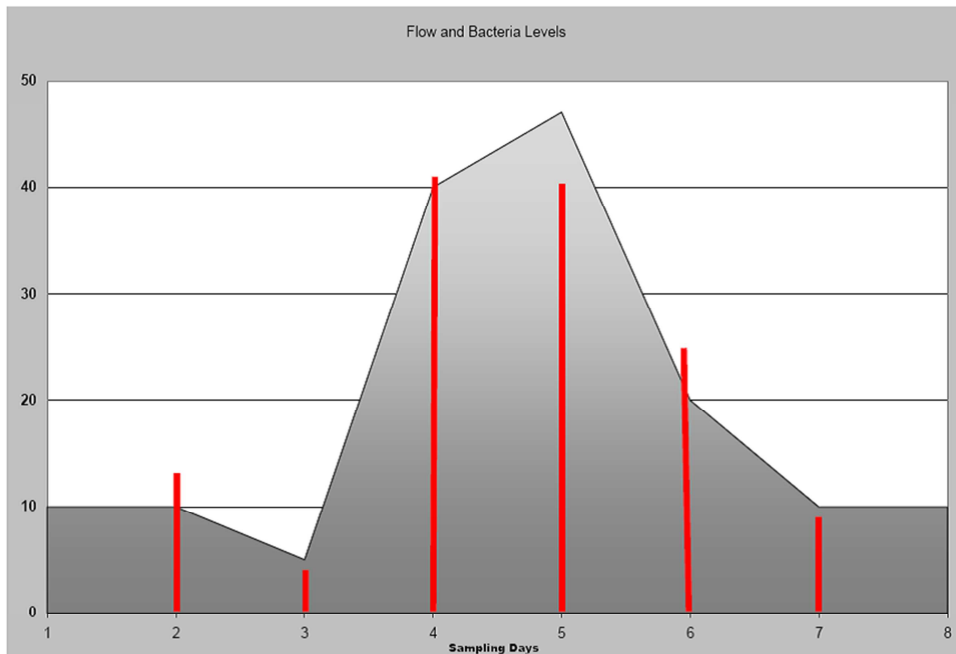
- How does the groundwater data compare to criteria established under Section 304 of the Clean Water Act?

Ask what else stands out to a hydrogeologist.

### Comparing Sampling Data to Flow Data

If you have data from different days, particularly if the results are from before, during and after rain events, compare your monitoring data to flow data. Flow data is available online from the United States Geological Survey (USGS). The USGS maintains gaging stations on many of the nation's rivers. Unfortunately due to federal budget cuts in the past two decades, some gaging stations have since closed. If you cannot obtain flow data, call the National Weather Service and ask for precipitation data for the days just prior to and during your sampling. Flow (or precipitation) data can provide you with useful clues about the nature of the pollution that you are measuring. Do high levels of contaminants coincide with days of high flow and/or precipitation? If so, the likely source of those pollutants is non-point source run-off from the land. Runoff could be from residential areas, industrial plants, farms, orchards, or other land uses. If high levels of contaminants occur on days with low flow and on days with high flow, chances are, you're dealing with a point source of pollution, such as a pipe from a factory.

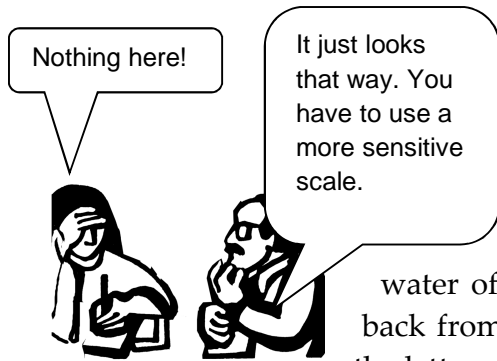
Note the two charts on the next page. The graphs show flow data (gray area graph) plotted alongside bacteria levels (red bar charts). Note that in the first graph bacteria levels seem to rise and fall with flow, indicating that most bacteria are likely coming from non-point source runoff. In the second graph by contrast, bacteria levels appear high on all sampling dates, regardless of flow, indicating that more likely the bacteria is coming from a regularly flowing point source.





## Minimum Detection Limit (MDL)

Don't forget to check the minimum detection limits of the test procedures and equipment used for the parameters you are examining. All lab results will list an MDL, that is the lowest level that the procedures and equipment used were capable of detecting. Why is that important?



Assume that we knew that minute quantities of an endocrine disrupting chemical were mistaken by the human body for natural hormones at a concentration in water of 50 part per trillion. Let's say we received our test results back from the lab and the results beside that contaminant indicated the letters ND under amount, meaning not detected. We might hastily conclude that this chemical was not found and therefore is not a factor in affecting human health in this source of drinking water. However, what if we noticed that the minimum detection limit for the test was 500 parts per trillion (ppt)? We may indeed not have detected this chemical at amounts higher than 500 ppt, but that doesn't mean there aren't levels of this chemical present at levels less than 500 ppt but greater than the 50 ppt known to cause harm.

If the detection limits are higher than the levels known to cause human harm, they are practically useless. (Vitale and Braids, 2006)

### Sample from ATSDR Public Health Statement on Arsenic

Inorganic arsenic has been recognized as a human poison since ancient times, and large oral doses (above 60,000 ppb in food or water) can produce death. If you swallow lower levels of inorganic arsenic (ranging from about 300 to 30,000 ppb in food or water), you may experience irritation of your stomach and intestines, with symptoms such as stomach ache, nausea, vomiting, and diarrhea. Other effects that you might experience from swallowing inorganic arsenic include decreased production of red and white blood cells which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a "pins and needles" sensation in your hands and feet.

Perhaps the single most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. The Department of Health and Human Services (DHHS) has determined that inorganic arsenic is a known carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans. Both the EPA and the National Toxicology Program (NTP) have classified inorganic arsenic as a known human carcinogen.

If you breathe high levels of inorganic arsenic, you are likely to experience a sore throat and irritated lungs. You may also develop some of the skin effects mentioned above.

### Drawing the connections to human health

You have:

- Reviewed the monitoring results, and
- Determined which chemicals are present at levels that may pose concern.

The next step should be to research the known health effects of those chemicals. The two best places to research this information are ATSDR's Public Health Statements at <http://www.atsdr.cdc.gov/PHS/Index.asp> and the National Library of Medicine's ToxNet at <http://toxnet.nlm.nih.gov/>.

ATSDR provides a good overview of the more common chemicals and what is known of their impacts. ATSDR's information tends to be fairly conservative. ToxNet provides you with access to actual research databases where you can find toxicological studies that have been done on the chemical of concern.

## Community Case Study: Woburn, MA *Revisited*

See the Case Study at the end of Chapter 4 for background. If this was your community, and you wanted to investigate the possible connection between these contaminants and childhood leukemia, how would you begin? Do you need to research every chemical? Limit the scope by comparing the results from monitoring to the ATSDR Comparison Value for the media you tested (e.g., soil, drinking water).

Contaminant	Concentration Range (ppb)	Comparison Value (ppb)	Source
Antimony	18-36	3	LTHA
Arsenic	2-201	0.02	CREG
Beryllium	1	0.008	CREG
Cadmium	3	5	MCL
Chromium	4-145	50	Child RMEG
Cobalt	4-54	None	None
Copper	3-6	1300	MCL
Lead	1-5	15	MCL
Manganese	6-259	50	Child RMEG
Mercury	200	2	MCL
Nickel	10-20	100	MCL
Selenium	200	30	Chronic child EMEG
Silver	4	50	Chronic child EMEG
Thallium	3-30	0.4	LTHA
Vanadium	4-181	30	Interm. Child EMEG
Zinc	ND-335	2000	LTHA

The table that appears to the left shows a partial list of contaminants. The concentrations of nine of them exceed ATSDR Comparison Values.

NOTE: ATSDR Comparison Values are the concentration anticipated to be safe to the average adult exposed daily. Levels above these values are meant to trigger further investigation, but do not necessarily predict harm.

## Data to Information |

### Chapter 8

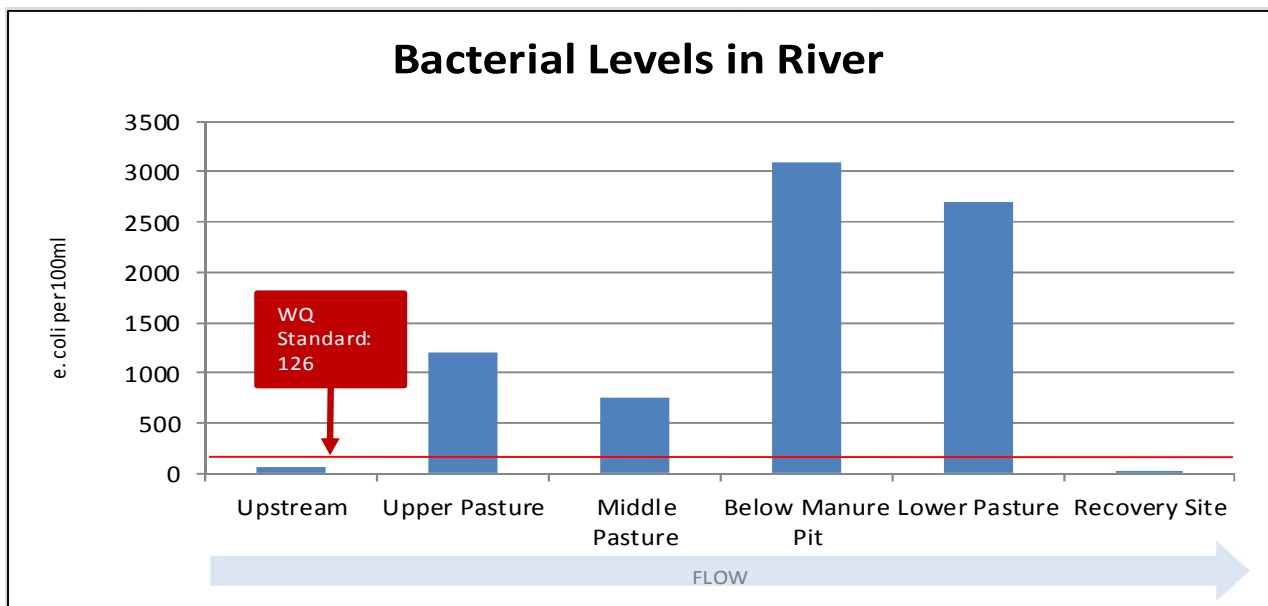


Once your group – or a consultant whom your group has hired – has analyzed your data, it's important to convert your data into a form that others in your community can easily understand. Only a technically literate few will be interested in your raw data. If you want to interest your neighbors, the media and political leaders, you must convert the test results to meaningful information. How do you do that?

The idea is to make the raw numbers that represent your data come to life in a way that ordinary people will both understand and find compelling. Let's look at some simple examples first, followed by some more elaborate ones. Consider the following table and the raw monitoring data contained within it. The data lists the number of *e.coli* bacteria colonies that were found in a sample of 100ml of water at each of the sites below.

Site	E.Coli/100ml
1	20
2	2700
3	3100
4	750
5	1200
6	65

How can we make this raw data come to life? We could describe where each of the sites is located and inform people which sites exceed State Water Quality Standards. But is there a way we can present the data so that the data describes this information for us? Consider the chart on the following page and how we've transformed the above raw data.

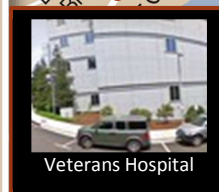
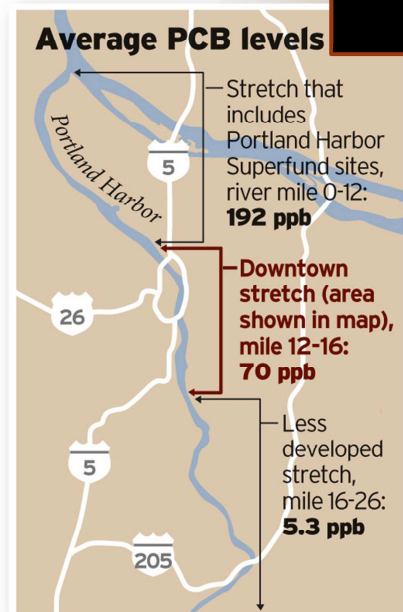


The above chart displays the exact same data as the table before, but along with labels for key information and a bar graph to offer a visual. Most people will quickly be able to grasp the main point. Might we take this a step farther?

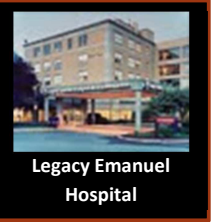
Look at the figure on the following page of PCB levels at toxic hot spots along the Willamette River in Portland, Oregon. In that figure, data on concentrations of PCBs in the river sediment is graphed right on a map that shows specific monitoring locations. Notice how we also added the location of area hospitals to the map. While there's no explanation why hospitals have been plotted, their close proximity to these toxic hot spots will likely prompt readers to ask important questions about possible health effects. This is not simply a fear tactic. In fact PCBs have been shown to volatilize from rivers and adversely impact surrounding air quality. Many patients who are in hospitals will have compromised immune systems. This is far from an ideal situation. Before you present data to others, think about ways to present it to make it easy for others understand what is going on.

## PCBs on the Willamette River

River-bottom mud was tested for dozens of toxic pollutants. Among the worst: polychlorinated biophenyls, or PCBs, a partly banned toxic linked to cancer. A potential hot spot starts at concentrations of 200 parts per billion and higher – well above the river average. The highest reading came from a site just south of the Hawthorne Bridge near the east bank.



### PCB level by site In parts per billion



0 1/2  
MILE

Source: Oregon Department of Environmental Quality

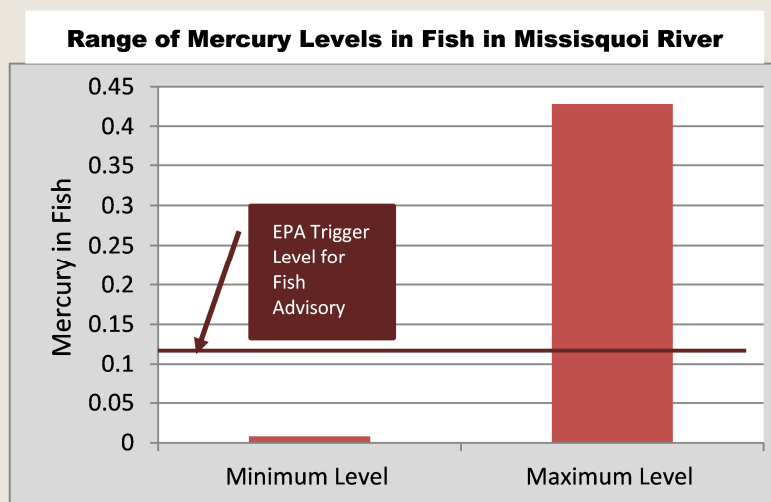
ERIC BAKER/THE OREGONIAN

## CASE STUDY: ABENAKI NATION, VERMONT

River Network assisted the Abenaki Nation conduct a health study that examined mercury levels in fish in the Missisquoi River in northern Vermont. The Missisquoi River begins in the Northeast corner of Vermont, flows into the Province of Quebec and then returns to Vermont where it eventually flows west into Lake Champlain. The Abenaki, a Native American tribe that traditionally depended on fish from the river as staple food in their diet, were concerned about reports of mercury levels in the river.

River Network worked with Green Mountain Laboratories and the Abenaki Nation to collect and analyze fish from the Missisquoi River for levels of mercury. Abenaki fishermen caught the fish and froze them according to procedures prescribed by the laboratory. River Network transported the fish to the laboratory and assisted laboratory personnel to analyze the fish samples.

We found that most fish exceeded the guidelines for levels of mercury that are considered safe. Individual fish samples varied widely. The concentrations of mercury in individual fish ranged from a low of 0.008 mg/kg to a high of 0.428 mg/kg. How could this data be presented simply? Below, is one of the many data-to-information graphs of results that were produced.





# Communication and Action | Chapter 9

You have:

- 1) analyzed your data and
- 2) converted it to a format that is easily understood by others



The next step is to share your findings with your community. Plan carefully how you will do that. Groups that haphazardly approach publicizing their results are sometimes met with unexpected consequences, including having their group and their data rapidly discredited.

The important point is to plan ahead and to think through the implications of each of your actions. What is the best way to convey information to *your* community? What would be the likely result of hosting a community meeting? What about holding a press conference? Are there sympathetic political leaders with whom you might meet who in turn might help you with this process? The best communication avenue for your community will depend on your community. If your group feels unsure about the best way to proceed, reach out to a like-minded group that has experience. They may provide you with guidance and help.

Be aware that public health agencies may try to slow the process down. Most often that's not usually due to some conspiracy! It's because public health officials are usually trained in a very traditional approach to epidemiology – the science that investigates the occurrence and causes of disease. Traditional epidemiology most concerns itself with disease outbreaks that are not caused by environmental exposures to toxic substances. The instruments or tools used in the field of epidemiology tend to be very imprecise and work best when there is some huge outbreak of disease. The tools of the field are often times not powerful enough to detect the types of adverse health outcomes that are a consequence of exposures to toxic substances.

Consider the following example. Suppose that parents have noticed that a number of children who attend a local elementary school report frequent headaches. A study reveals that the drinking water in an area elementary school contains slightly elevated levels of a substance that could be the cause of these headaches. A subsequent health study reveals that there's an 80% likelihood that an association found between frequent headaches and children who regularly drink from the school's water fountains is *not* due to chance; in other words there's a 20% possibility that this association is due to chance alone. The rules of academic epidemiology would consider this association not statistically significant. Generally an association needs to have less than a 5% probability that it is due to chance to be considered statistically significant.

Public health officials may thus argue that the data is inconclusive and that parents should not jump to conclusions. While those officials would be absolutely correct that the data is inconclusive by academic standards, most parents would likely consider an 80% probability of an association sufficient to push their School Board to take action. It's not that the parents would be correct – that this contaminant is the cause of the frequent headaches experienced by children – but their action would be simply precautionary in nature. Precautionary actions are taken not when a known cause to a health problem is confirmed but rather when one is strongly suspected and the precautionary thing to do would be to take action in case that casual association exists.

Therefore, you may need to push for action even when health officials express caution about jumping to conclusions. Realize that you may in fact be jumping to a conclusion, but that there are reasons to do that.

The goal of presenting your monitoring data should not be to prove a causal association between the elevated levels of a contaminant and adverse health outcomes – unless you're planning to publish your data or use it in court – but rather it should be to convince most reasonable people that precautionary action is warranted to address the threat.

The Toxics Action Center recommends the following:

*Defining the problem is important, but only a first step. As you publicize testing results with community members, public officials, and elected legislators, be sure to ask for the solution your community group is seeking. This may be a full clean up. It may be continued monitoring. It may be a change in policy to protect other communities moving forward. It may be that the polluter has to change their practices, and stop using the toxin. You may want the state to fine the polluter for breaking the law. As a group, decide what you want and use the publicity you generate around the testing results to put your solution on the table.*

### Next Steps

If testing establishes that a site that is contributing to surface or groundwater contamination, clean-up will likely be a next step. Cleanup is a multi-step process. See the Terc Statistics for Action *Hazardous Waste Cleanup Guide* for an overview.

Though you may feel like a nag or a crazy person, quick action on the part of individuals or community groups may save lives and prevent further contamination. Your attention to water issues is a gift.

### CASE STUDY: Hattiesburg, Mississippi

Both a stream and groundwater running through this southern Mississippi community were contaminated with the creosote. Community members learned that exposure to creosote can cause mild health problems such as rashes and more severe illnesses, including liver and kidney problems and cancer. The largely African American community was outraged when they learned that there was evidence of serious creosote contamination and that only the residents in the adjoining white neighborhood had been told years before.

Meanwhile, the City hired a consultant who told City officials and residents that their exposure to creosote did not likely pose a health risk, but the community members who formed the Forest County Environmental Support Team (FCEST) remained skeptical. They saw lab results that showed no creosote was detected, but given the contamination had existed just upstream, on the other side of the tracks, the results didn't make sense. River Network helped FCEST secure the services of a local monitoring professional who reviewed the methods and data collected by the City's consultant.

Through her review, FCEST discovered that the City's consultant did not follow basic methodological monitoring requirements set forth by EPA. The monitoring expert testified about this at an important meeting of the City Council. Now, the EPA agrees. In a seven-page letter, a member of the EPA's Site Evaluation Section told Mayor Johnny DuPree that APEX Environmental Consultants failed to test for the primary constituents normally associated with creosote contamination. Steve Irving, a Louisiana environmental attorney who has been consulting with FCEST, told the Hattiesburg American newspaper, "The APEX effort was a joke at best. ... This was an effort to not find anything." Officials at APEX declined to comment for the newspaper on the matter. Now city leaders hope to sit down with EPA representatives to determine what the next step will be. Actions ranging from further monitoring to contaminant clean-up are likely to be on the table.

## Appendix A | Glossary

borings	Drill holes used to monitor groundwater.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act, commonly known as Superfund
disinfectants	Chemicals intended to kill bacteria and viruses.
dissolved oxygen	Oxygen dissolved in the water and required for fish to "breathe" through their gills.
eddies	Side currents (in rivers).
heavy metals	Toxic metal contaminants
NPDES	National Pollutant Discharge Elimination System -- See Chapter 6
nutrients	Generally Phosphorus and Nitrogen required for plant growth.
organic chemical contaminants	Chemicals that contain Carbon
organic compounds	A class of compounds that contain Carbon.
organochlorine pesticides	Persistent pesticides that contain Carbon and Chlorine.
PAHs	Polycyclic aromatic hydrocarbons are potent atmospheric pollutants. They mix more easily with oil than water. PAHs are one of the most widespread organic pollutants. In addition to their presence in fossil fuels they are also formed by incomplete combustion of carbon-containing fuels such as wood, coal, diesel, fat, tobacco, and incense. <sup>[7]</sup>
parameter	Any of a number of particular measures of water quality.
PCBs	Polychlorine Biphenols. Banned in the U.S. Used to insulate electrical components.
pentachlorophenol	A dangerous chemical used as an insecticide, disinfectant and other products.
perchloroethylene	A harmful chemical most often used in dry cleaning.
pH	A measure of acidity
radionuclides	Radioactive substances found in water.
reagent	A substance used to bring about a chemical reaction.
recovery site	
solvents	A chemical intended to dissolve another substance.
trichloroethylene	A chlorinated hydrocarbon often used as an industrial solvent.
volatilize	Evaporate

## Appendix B | Maximum Contaminant Levels

### Safe Drinking Water Act

# **2009 Edition of the Drinking Water Standards and Health Advisories**



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# **2009 Edition of the Drinking Water Standards and Health Advisories**

**EPA 822-R-09-011**

**Office of Water  
U.S. Environmental Protection Agency  
Washington, DC**

**Fall 2009**

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The *Drinking Water Standards and Health Advisories* Tables are revised periodically by EPA's Office of Water in order to update RfD and Cancer values so that they are consistent with the most current Agency assessments of chemical contaminants that may occur in drinking water and to introduce new Health Advisories. The following information should be kept in mind when using the 2009 Edition of the Tables:

Reference dose (RfD) values are updated to reflect the values in the Integrated Risk Information System (IRIS) and the Office of Pesticide Programs (OPP) Reregistration Eligibility Decisions (RED) Documents. The Drinking Water Equivalent Level (DWEL) has been adjusted accordingly. Thus, both the RfD and DWEL in the Tables differ from the values in the Health Advisory document when the IRIS or OPP RfD is more recent than the Health Advisory document value. RfD values from IRIS that differ from the values in the Health Advisory documents are presented in **BOLD** type. Values derived from the REDs are given in ***BOLD*** italics. For unregulated chemicals with a recent IRIS or OPP RfD, the lifetime Health Advisory is calculated from the DWEL using the relative source contribution value published in the Health Advisory document. For regulated chemicals, no lifetime value is provided in the Tables when the revised lifetime value would differ from the Maximum Contaminant Level Goal (MCLG).

The cancer group designation or cancer classification and  $10^{-4}$  cancer risk values reflect those presently in IRIS or in the OPP RED. New IRIS cancer designations and  $10^{-4}$  cancer risk values are presented in **BOLD** type and those derived from the REDs are in ***BOLD*** italics.

The IRIS Toxicological Reviews can be accessed at: <http://www.epa.gov/IRIS>. The OPP REDs can be accessed at: <http://www.epa.gov/pesticides/reregistration/status.htm>.

In some cases there is a Health Advisory value for a contaminant but there is no reference to a Health Advisory document. These Health Advisory values can be found in the Drinking Water Criteria Document for the contaminant.

With a few exceptions, the RfDs, Health Advisory, and cancer risk values have been rounded to one significant figure following the convention adopted by IRIS.

The *Drinking Water Standards and Health Advisories* Tables may be reached from the Water Science home page at: <http://www.epa.gov/waterscience/>. The Tables are accessed under the Drinking Water icon.

Copies the Tables may be ordered free of charge from

SAFE DRINKING WATER HOTLINE  
1-800-426-4791  
Monday thru Friday, 9:00 AM to 5:30 PM EST

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## DEFINITIONS

The following definitions for terms used in the Tables are not all-encompassing, and should not be construed to be “official” definitions. They are intended to assist the user in understanding terms found on the following pages.

**Action Level:** The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow. It is the level of lead or copper which, if exceeded in over 10% of the homes tested, triggers treatment for corrosion control.

**Cancer Classification:** A descriptive weight-of-evidence judgment as to the likelihood that an agent is a human carcinogen and the conditions under which the carcinogenic effects may be expressed. Under the 2005 EPA *Guidelines for Carcinogen Risk Assessment*, descriptive terms for carcinogenicity replace the earlier alpha numeric Cancer Group designations (US EPA 1986 guidelines). The suggested descriptive terms are as follows:

- Carcinogenic to humans (**H**)
- Likely to be carcinogenic to humans (**L**)
- Likely to be carcinogenic above a specified dose but not likely to be carcinogenic below that dose because a key event in tumor formation does not occur below that dose (**L/N**)
- Suggestive evidence of carcinogenic potential (**S**)
- Inadequate information to assess carcinogenic potential (**I**)
- Not likely to be carcinogenic to humans (**N**)

The letter abbreviations provided parenthetically above are now used in the Tables in place of the prior alpha numeric identifiers for chemicals that have been evaluated under the new guidelines (the 2005 guidelines or the 1996 and 1999 draft guidelines).

**Cancer Group:** A qualitative weight-of-evidence judgment as to the likelihood that a chemical may be a carcinogen for humans. Each chemical was placed into one of the following five categories (US EPA 1986 guidelines). The Cancer Group designations are given in the Tables for chemicals that have not yet been evaluated under the new guidelines.

### Group Category

- A** Human carcinogen
- B** Probable human carcinogen:
  - B1** indicates limited human evidence
  - B2** indicates sufficient evidence in animals and inadequate or no evidence in humans
- C** Possible human carcinogen
- D** Not classifiable as to human carcinogenicity
- E** Evidence of noncarcinogenicity for humans

**10<sup>-4</sup> Cancer Risk:** The concentration of a chemical in drinking water corresponding to an excess estimated lifetime cancer risk of 1 in 10,000.

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**Drinking Water Advisory:** A nonregulatory concentration of a contaminant in water that is likely to be without adverse effects on health and aesthetics.

**DWEL:** Drinking Water Equivalent Level. A lifetime exposure concentration protective of adverse, non-cancer health effects, which assumes that all of the exposure to a contaminant is from drinking water.

**HA:** Health Advisory. An estimate of acceptable drinking water levels for a chemical substance based on health effects information; a Health Advisory is not a legally enforceable Federal standard, but serves as technical guidance to assist Federal, State, and local officials.

**One-Day HA:** The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to one day of exposure. The One-Day HA is normally designed to protect a 10-kg child consuming 1 liter of water per day.

**Ten-Day HA:** The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to ten days of exposure. The Ten-Day HA is also normally designed to protect a 10-kg child consuming 1 liter of water per day.

**Lifetime HA:** The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure. The Lifetime HA is based on exposure of a 70-kg adult consuming 2 liters of water per day. The Lifetime HA for Group C carcinogens includes an adjustment for possible carcinogenicity.

**MCLG:** Maximum Contaminant Level Goal. A non-enforceable health goal which is set at a level at which no known or anticipated adverse effect on the health of persons occurs and which allows an adequate margin of safety.

**MCL:** Maximum Contaminant Level. The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLG as feasible using the best available analytical and treatment technologies and taking cost into consideration. MCLs are enforceable standards.

**RfD:** Reference Dose. An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

**SDWR:** Secondary Drinking Water Regulations. Non-enforceable Federal guidelines regarding cosmetic effects (such as tooth or skin discoloration) or aesthetic effects (such as taste, odor, or color) of drinking water.

**TT:** Treatment Technique. A required process intended to reduce the level of a contaminant in drinking water.

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## ABBREVIATIONS

<b>D</b>	Draft
<b>F</b>	Final
<b>I</b>	Interim
<b>NA</b>	Not Applicable
<b>NOAEL</b>	No-Observed-Adverse-Effect Level
<b>OPP</b>	Office of Pesticide Programs
<b>P</b>	Proposed
<b>Pv</b>	Provisional
<b>Reg</b>	Regulation
<b>TT</b>	Treatment Technique

# Drinking Water Standards and Health Advisories

Summer 2009

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Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor <sup>1</sup>
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		10-kg Child		RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10 <sup>-4</sup> Cancer Risk	
						One-day (mg/L)	Ten-day (mg/L)					
ORGANICS												
Acenaphthene	83-32-9	-	-	-	-	-	-	0.06	2	-	-	-
Acifluorfen (sodium)	62476-59-9		-	-	F '88	2	2	0.01	0.4	-	0.1	<i>L/N</i>
Acrylamide	79-06-1	F	zero	TT <sup>2</sup>	F '87	1.5	0.3	0.0002	0.007	-	<b>0.0008</b>	B2
Acrylonitrile	107-13-1		-	-	-	-	-	-	-	-	0.006	B1
Alachlor	15972-60-8	F	zero	0.002	F '88	0.1	0.1	0.01	0.4	-	<b>0.04</b>	<b>B2</b>
Aldicarb <sup>3</sup>	116-06-3	F <sup>4</sup>	0.001	0.003	F '95	0.01	0.01	0.001	0.035	0.007	-	D
Aldicarb sulfone <sup>3</sup>	1646-88-4	F <sup>4</sup>	0.001	0.002	F '95	0.01	0.01	0.001	0.035	0.007	-	D
Aldicarb sulfoxide <sup>3</sup>	1646-87-3	F <sup>4</sup>	0.001	0.004	F '95	0.01	0.01	0.001	0.035	0.007	-	D
Aldrin	309-00-2	-	-	-	F '92	0.0003	0.0003	0.00003	0.001	-	0.0002	B2
Ametryn	834-12-8	-	-	-	F '88	9	9	0.009	0.3	0.06	-	D
Ammonium sulfamate	7773-06-0	-	-	-	F '88	20	20	0.2	8	2	-	D
Anthracene (PAH) <sup>5</sup>	120-12-7	-	-	-	-	-	-	0.3	10	-	-	D
Atrazine	1912-24-9	F	0.003	0.003	F '88	-	-	<b>0.02</b>	0.7	-	-	<i>N</i>
Baygon	114-26-1	-	-	-	F '88	0.04	0.04	0.004	0.1	0.003	-	C
Bentazon	25057-89-0	-	-	-	F '99	0.3	0.3	0.03	1	0.2	-	E
Benz[a]anthracene (PAH)	56-55-3	-	-	-	-	-	-	-	-	-	-	B2
Benzene	71-43-2	F	zero	0.005	F '87	0.2	0.2	<b>0.004</b>	0.1	-	0.1	<b>H</b>
Benzo[a]pyrene (PAH)	50-32-8	F	zero	0.0002	-	-	-	-	-	-	<b>0.0005</b>	B2
Benzo[b]fluoranthene (PAH)	205-99-2	-	-	-	-	-	-	-	-	-	-	B2
Benzo[g,h,i]perylene (PAH)	191-24-2	-	-	-	-	-	-	-	-	-	-	D
Benzo[k]fluoranthene (PAH)	207-08-9	-	-	-	-	-	-	-	-	-	-	B2
bis-2-Chloroisopropyl ether	39638-32-9	-	-	-	F '89	4	4	0.04	1	0.3	-	D
Bromacil	314-40-9	-	-	-	F '88	5	5	<b>0.1</b>	3.5	0.07	-	C
Bromobenzene	108-86-1	-	-	-	D '86	4	4	<b>0.008</b>	0.3	0.07	-	<b>I</b>

<sup>1</sup> Chemicals evaluated under the 2005 Cancer Guidelines or the 1996 or 1999 drafts are demoted by an abbreviation for their weight-of-the-evidence descriptor (see page iii). If the agency has not completed a new assessment for the chemical, the 1986 Guidelines Group designation (see page iii) is given in the Cancer Descriptor column.

<sup>2</sup> When Acrylamide is used in drinking water systems, the combination (or product) of dose and monomer level shall not exceed that equivalent to a polyacrylamide polymer containing 0.05% monomer dosed at 1 mg/L.

<sup>3</sup> The MCL value for any combination of two or more of these three chemicals should not exceed 0.007 mg/L because of a similar mode of action.

<sup>4</sup> Administrative stay of the effective date.

<sup>5</sup> PAH = Polycyclic aromatic hydrocarbon.

# Drinking Water Standards and Health Advisories

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Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		10-kg Child		RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10 <sup>-4</sup> Cancer Risk	
						One-day (mg/L)	Ten-day (mg/L)					
Bromochloromethane	74-97-5	-	-	-	F '89	50	1	0.01	0.5	0.09	-	D
Bromodichloromethane (THM)	75-27-4	F	zero	0.08 <sup>1</sup>	-	1	0.6	0.003	0.1	-	0.1	L
Bromoform (THM)	75-25-2	F	zero	0.08 <sup>1</sup>	-	5	0.2	0.03	1	-	0.8	L
Bromomethane	74-83-9	-	-	-	D '89	0.1	0.1	0.001	0.05	0.01	-	D
Butyl benzyl phthalate	85-68-7	-	-	-	-	-	-	0.2	7	-	-	C
Butylate	2008-41-5	-	-	-	F '89	2	2	0.05	2	0.4	-	D
Carbaryl	63-25-2	-	-	-	F '88	1	1	<b>0.01</b>	0.4	-	4	<b>L</b>
Carbofuran	1563-66-2	F	0.04	0.04	F '87	-	-	<b>0.00006</b>	-	-	-	<b>N</b>
Carbon tetrachloride	56-23-5	F	zero	0.005	F '87	4	0.2	0.0007	0.03	-	0.03	B2
Carboxin	5234-68-4	-	-	-	F '88	1	1	0.1	3.5	0.7	-	D
Chloramben	133-90-4	-	-	-	F '88	3	3	0.015	0.5	0.1	-	D
Chlordane	57-74-9	F	zero	0.002	F '87	0.06	0.06	<b>0.0005</b>	0.02	-	<b>0.01</b>	B2
Chloroform (THM)	67-66-3	F	0.07	0.08 <sup>1</sup>	-	4	4	<b>0.01</b>	0.35	0.07	-	<b>L/N</b>
Chloromethane	74-87-3	-	-	-	F '89	9	0.4	0.004	0.1	0.03	-	<b>D</b>
Chlorophenol (2-)	95-57-8	-	-	-	D '94	0.5	0.5	0.005	0.2	0.04	-	D
Chlorothalonil	1897-45-6	-	-	-	F '88	0.2	0.2	0.015	0.5	-	0.15	B2
Chlorotoluene o-	95-49-8	-	-	-	F '89	2	2	0.02	0.7	0.1	-	D
Chlorotoluene p-	106-43-4	-	-	-	F '89	2	2	0.02	0.7	0.1	-	D
Chlorpyrifos	2921-88-2	-	-	-	F '92	0.03	0.03	<b>0.0003</b>	0.01	0.002	-	<b>D</b>
Chrysene (PAH)	218-01-9	-	-	-	-	-	-	-	-	-	-	B2
Cyanazine	21725-46-2	-	-	-	D '96	0.1	0.1	0.002	0.07	0.001	-	

<sup>1</sup> 1998 Final Rule for Disinfectants and Disinfection By-products: The total for trihalomethanes (THM) is 0.08 mg/L.

# Drinking Water Standards and Health Advisories

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Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		10-kg Child		RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10 <sup>-4</sup> Cancer Risk	
						One-day (mg/L)	Ten-day (mg/L)					
Cyanogen chloride <sup>1</sup>	506-77-4	-	-	-	-	0.05	0.05	0.05	2	-	-	D
2,4-D (2,4-dichlorophenoxyacetic acid)	94-75-7	F	0.07	0.07	F '87	1	0.3	<b>0.005</b>	0.2	-	-	<b>D</b>
DCPA (Dacthal)	1861-32-1	-	-	-	F '08	2	2	<b>0.01</b>	0.35	0.07	-	<b>C</b>
Dalapon (sodium salt)	75-99-0	F	0.2	0.2	F '89	3	3	0.03	0.9	0.2	-	D
Di(2-ethylhexyl)adipate	103-23-1	F	0.4	0.4	-	20	20	0.6	20	0.4	3	C
Di(2-ethylhexyl)phthalate	117-81-7	F	zero	0.006	-	-	-	0.02	0.7	-	0.3	B2
Diazinon	333-41-5	-	-	-	F '88	0.02	0.02	<b>0.0002</b>	0.007	0.001	-	<b>E</b>
Dibromochloromethane (THM)	124-48-1	F	0.06	0.08 <sup>2</sup>	-	0.6	0.6	0.02	0.7	0.06	0.08	S
Dibromochloropropane (DBCP)	96-12-8	F	zero	0.0002	F '87	0.2	0.05	-	-	-	<b>0.003</b>	B2
Dibutyl phthalate	84-74-2	-	-	-	-	-	-	<b>0.1</b>	4	-	-	D
Dicamba	1918-00-9	-	-	-	F '88	-	-	<b>0.5</b>	18	4	-	N
Dichloroacetic acid	76-43-6	F	zero	0.06 <sup>3</sup>	-	5	5	<b>0.004</b>	0.1	-	<b>0.07</b>	<b>L</b>
Dichlorobenzene o-	95-50-1	F	0.6	0.6	F '87	9	9	0.09	3	0.6	-	D
Dichlorobenzene — <sup>4</sup>	541-73-1	-	-	-	F '87	9	9	0.09	3	0.6	-	D
Dichlorobenzene p-	106-46-7	F	0.075	0.075	F '87	11	11	0.1	4	0.075	-	C
Dichlorodifluoromethane	75-71-8	-	-	-	F '89	40	40	0.2	5	1	-	D
Dichloroethane (1,2-)	107-06-2	F	zero	0.005	F '87	0.7	0.7	-	-	-	0.04	B2
Dichloroethylene (1,1-)	75-35-4	F	0.007	0.007	F '87	2	1	<b>0.05</b>	2	-	<b>0.006</b>	<b>S</b>
Dichloroethylene (cis-1,2-)	156-59-2	F	0.07	0.07	F '90	4	1	0.01	0.35	0.07	-	D
Dichloroethylene (trans-1,2-)	156-60-5	F	0.1	0.1	F '87	20	1	<b>0.02</b>	0.7	0.1	-	D
Dichloromethane	75-09-2	F	zero	0.005	D '93	10	2	0.06	2	-	0.5	B2
Dichlorophenol (2,4-)	120-83-2	-	-	-	D '94	0.03	0.03	0.003	0.1	0.02	-	E
Dichloropropane (1,2-)	78-87-5	F	zero	0.005	F '87	-	0.09	-	-	-	0.06	B2
Dichloropropene (1,3-)	542-75-6	-	-	-	F '88	0.03	0.03	<b>0.03</b>	1	-	<b>0.04</b>	<b>L</b>
Dieldrin	60-57-1	-	-	-	F '88	0.0005	0.0005	0.00005	0.002	-	0.0002	B2
Diethyl phthalate	84-66-2	-	-	-	-	-	-	0.8	30	-	-	D

<sup>1</sup> Under review.

<sup>2</sup> 1998 Final Rule for Disinfectants and Disinfection By-products: The total for trihalomethanes is 0.08 mg/L.

<sup>3</sup> 1998 Final Rule for Disinfectants and Disinfection By-products: The total for five haloacetic acids is 0.06 mg/L.

<sup>4</sup> The values for m-dichlorobenzene are based on data for o-dichlorobenzene.



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Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		10-kg Child		RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10 <sup>-4</sup> Cancer Risk	
Diisopropyl methylphosphonate	1445-75-6	-	-	-	F '89	8	8	0.08	3	0.6	-	D
Dimethrin	70-38-2	-	-	-	F '88	10	10	0.3	10	2	-	D
Dimethyl methylphosphonate	756-79-6	-	-	-	F '92	2	2	0.2	7	0.1	0.7	C
Dimethyl phthalate	131-11-3	-	-	-	-	-	-	-	-	-	-	D
Dinitrobenzene (1,3-)	99-65-0	-	-	-	F '91	0.04	0.04	0.0001	0.005	0.001	-	D
Dinitrotoluene (2,4-)	121-14-2	-	-	-	F '08	1	1	0.002	0.1	-	0.005	L
Dinitrotoluene (2,6-)	606-20-2	-	-	-	F '08	0.4	0.04	0.001	0.04	-	0.005	L
Dinitrotoluene (2,6 & 2,4) <sup>1</sup>		-	-	-	F '92	-	-	-	-	-	0.005	B2
Dinoseb	88-85-7	F	0.007	0.007	F '88	0.3	0.3	0.001	0.035	0.007	-	D
Dioxane p-	123-91-1	-	-	-	F '87	4	0.4	-	-	-	<b>0.3</b>	B2
Diphenamid	957-51-7	-	-	-	F '88	0.3	0.3	0.03	1	0.2	-	D
Diquat	85-00-7	F	0.02	0.02	-	-	-	<b>0.005</b>	0.02	-	-	<b>E</b>
Disulfoton	298-04-4	-	-	-	F '88	0.01	0.01	<b>0.0001</b>	0.0035	0.0007	-	<b>E</b>
Dithiane (1,4-)	505-29-3	-	-	-	F '92	0.4	0.4	0.01	0.4	0.08	-	D
Diuron	330-54-1	-	-	-	F '88	1	1	<b>0.003</b>	0.1	-	<b>0.2</b>	<b>L</b>
Endothall	145-73-3	F	0.1	0.1	F '88	0.8	0.8	<b>0.007</b>	0.25	0.05	-	<b>N</b>
Endrin	72-20-8	F	0.002	0.002	F '87	0.02	0.005	<b>0.0003</b>	0.01	0.002	-	D
Epichlorohydrin	106-89-8	F	zero	TT <sup>2</sup>	F '87	0.1	0.1	0.002	0.07	-	<b>0.3</b>	B2
Ethylbenzene	100-41-4	F	0.7	0.7	F '87	30	3	0.1	3	0.7	-	D
Ethylene dibromide (EDB) <sup>3</sup>	106-93-4	F	zero	0.00005	F '87	0.008	0.008	<b>0.009</b>	0.3	-	<b>0.002</b>	<b>L</b>
Ethylene glycol	107-21-1	-	-	-	F '87	20	6	<b>2</b>	70	14	-	D
Ethylene Thiourea (ETU)	96-45-7	-	-	-	F '88	0.3	0.3	<b>0.0002</b>	0.007	-	<b>0.06</b>	B2
Fenamiphos	22224-92-6	-	-	-	F '88	0.009	0.009	<b>0.0001</b>	0.0035	0.0007	-	<b>E</b>

<sup>1</sup> Technical grade.

<sup>2</sup> When epichlorohydrin is used in drinking water systems, the combination (or product) of dose and monomer level shall not exceed that equivalent to an epichlorohydrin-based polymer containing 0.01% monomer dosed at 20 mg/L.

<sup>3</sup> 1,2-dibromoethane.

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Chemicals	CAS Number	Standards			Status HA Standards	Health Advisories						Cancer Descriptor
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		10-kg Child						
						One-day (mg/L)	Ten-day (mg/L)	RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10 <sup>-4</sup> Cancer Risk	
Fluometuron	2164-17-2	-	-	-	F '88	2	2	0.01	0.5	0.09		D
Fluorene (PAH)	86-73-7	-	-	-	-	-	-	0.04	1	-	-	D
Fonofos	944-22-9	-	-	-	F '88	0.02	0.02	0.002	0.07	0.01	-	D
Formaldehyde	50-00-0	-	-	-	D '93	10	5	<b>0.2</b>	7	1	-	B1 <sup>1</sup>
Glyphosate	1071-83-6	F	0.7	0.7	F '88	20	20	<b>2</b>	70	-	-	D
Heptachlor	76-44-8	F	zero	0.0004	F '87	0.01	0.01	0.0005	0.02	-	0.0008	B2
Heptachlor epoxide	1024-57-3	F	zero	0.0002	F '87	0.01	-	0.00001	0.0004	-	0.0004	B2
Hexachlorobenzene	118-74-1	F	zero	0.001	F '87	0.05	0.05	0.0008	0.03	-	0.002	B2
Hexachlorobutadiene <sup>2</sup>	87-68-3	-	-	-	-	0.3	0.3	0.0003	0.01	-	0.09	L
Hexachlorocyclopentadiene	77-47-4	F	0.05	0.05	-	-	-	<b>0.006</b>	0.2	-	-	N
Hexachloroethane	67-72-1	-	-	-	F '91	5	5	0.001	0.04	0.001	<b>0.3</b>	C
Hexane (n-)	110-54-3	-	-	-	F '87	10	4	-	-	-	-	I
Hexazinone	51235-04-2	-	-	-	F '96	3	2	<b>0.05</b>	2	0.4	-	D
HMX <sup>3</sup>	2691-41-0	-	-	-	F '88	5	5	0.05	2	0.4	-	D
Indeno[1,2,3,-c,d]pyrene (PAH)	193-39-5	-	-	-	-	-	-	-	-	-	-	B2
Isophorone	78-59-1	-	-	-	F '92	15	15	0.2	7	0.1	4	C
Isopropyl methylphosphonate	1832-54-8	-	-	-	F '92	30	30	0.1	3.5	0.7	-	D
Isopropylbenzene (cumene)	98-82-8	-	-	-	D '87	11	11	0.1	4	-	-	D
Lindane <sup>4</sup>	58-89-9	F	0.0002	0.0002	F '87	1	1	<b>0.005</b>	0.2	-	-	S
Malathion	121-75-5	-	-	-	F '92	0.2	0.2	<b>0.07</b>	2	0.5	-	S
Maleic hydrazide	123-33-1	-	-	-	F '88	10	10	0.5	20	4	-	D
MCPA <sup>5</sup>	94-74-6	-	-	-	F '88	0.1	0.1	<b>0.004</b>	0.14	0.03	-	N
Methomyl	16752-77-5	-	-	-	F '88	0.3	0.3	0.025	0.9	0.2	-	E
Methoxychlor	72-43-5	F	0.04	0.04	F '87	0.05	0.05	<b>0.005</b>	0.2	0.04	-	D
Methyl ethyl ketone	78-93-3	-	-	-	F '87	75	7.5	<b>0.6</b>	20	4	-	D
Methyl parathion	298-00-0	-	-	-	F '88	0.3	0.3	<b>0.0002</b>	0.007	0.001	-	N

<sup>1</sup> Carcinogenicity based on inhalation exposure.

<sup>2</sup> Regulatory Determination Health Effects Support Document for Hexachlorobutadiene ([http://www.epa.gov/safewater/ccl/pdfs/reg\\_determine1/support\\_cc1\\_hexachlorobutadiene\\_healtheffects.pdf](http://www.epa.gov/safewater/ccl/pdfs/reg_determine1/support_cc1_hexachlorobutadiene_healtheffects.pdf)).

<sup>3</sup> HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.

<sup>4</sup> Lindane =  $\gamma$  - hexachlorocyclohexane.

<sup>5</sup> MCPA = 4 (chloro-2-methoxyphenoxy) acetic acid.

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Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		10-kg Child		RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10 <sup>-4</sup> Cancer Risk	
						One-day (mg/L)	Ten-day (mg/L)					
Metolachlor	51218-45-2	-	-	-	F '88	2	2	<b>0.1</b>	3.5	0.7	-	<b>C</b>
Metribuzin	21087-64-9	-	-	-	F '88	5	5	<b>0.01</b>	0.35	0.07	-	<b>D</b>
Monochloroacetic acid	79-11-8	F	0.03	0.06 <sup>1</sup>	-	0.2	0.2	0.01	0.35	0.07	-	I
Monochlorobenzene	108-90-7	F	0.1	0.1	F '87	4	4	<b>0.02</b>	0.7	0.1	-	D
Naphthalene	91-20-3	-	-	-	F '90	0.5	0.5	<b>0.02</b>	0.7	0.1	-	<b>I</b>
Nitrocellulose <sup>2</sup>	9004-70-0	-	-	-	F '88	-	-	-	-	-	-	-
Nitroguanidine	556-88-7	-	-	-	F '90	10	10	0.1	3.5	0.7	-	D
Nitrophenol p-	100-02-7	-	-	-	F '92	0.8	0.8	0.008	0.3	0.06	-	D
N-nitrosodimethylamine	62-75-9	-	-	-	-	-	-	-	-	-	<b>0.00007</b>	<b>B<sub>2</sub></b>
Oxamyl (Vydate)	23135-22-0	F	0.2	0.2	F '05	0.01	0.01	0.001	0.035	-	-	N
Paraquat	1910-42-5	-	-	-	F '88	0.1	0.1	<b>0.0045</b>	0.2	0.03	-	<b>E</b>
Pentachlorophenol	87-86-5	F	zero	0.001	F '87	1	0.3	0.03	1	-	0.03	B2
PFOA <sup>3</sup>	335-67-1	-	-	-	Pv '09	-	-	-	-	-	-	-
PFOS <sup>4</sup>	1763-23-1	-	-	-	Pv '09	-	-	-	-	-	-	-
Phenanthrene (PAH)	85-01-8	-	-	-	-	-	-	-	-	-	-	D
Phenol	108-95-2	-	-	-	D '92	6	6	<b>0.3</b>	11	2	-	D
Picloram	1918-02-1	F	0.5	0.5	F '88	20	20	<b>0.02</b>	0.7	-	-	D
Polychlorinated biphenyls (PCBs)	1336-36-3	F	zero	0.0005	D '93	-	-	-	-	-	0.01	B2
Prometon	1610-18-0	-	-	-	F '88	0.2	0.2	<b>0.05</b>	2	0.4	-	<b>N</b>
Pronamide	23950-58-5	-	-	-	F '88	0.8	0.8	<b>0.08</b>	3	-	<b>0.1</b>	<b>B2</b>
Propachlor	1918-16-7	-	-	-	F '88	0.5	0.5	<b>0.05</b>	2	-	0.1	<b>L</b>
Propazine	139-40-2	-	-	-	F '88	-	-	<b>0.02</b>	0.7	0.01	-	<b>N</b>
Propham	122-42-9	-	-	-	F '88	5	5	0.02	0.6	0.1	-	D
Pyrene (PAH)	129-00-0	-	-	-	-	-	-	0.03	-	-	-	D
RDX <sup>5</sup>	121-82-4	-	-	-	F '88	0.1	0.1	0.003	0.1	0.002	0.03	C
Simazine	122-34-9	F	0.004	0.004	F '88	-	-	<b>0.02</b>	0.7	-	-	<b>N</b>
Styrene	100-42-5	F	0.1	0.1	F '87	20	2	0.2	7	0.1	-	C
2,4,5-T (Trichlorophenoxy-acetic acid)	93-76-5	-	-	-	F '88	0.8	0.8	0.01	0.35	0.07	-	D

<sup>1</sup> 1998 Final Rule for Disinfectants and Disinfection By-products: the total for five haloacetic acids is 0.06 mg/L.

<sup>2</sup> The Health Advisory Document for nitrocellulose does not include HA values and describes this compound as relatively nontoxic.

<sup>3</sup> Perfluorooctanoic Acid. Provisional short-term value 0.0004 mg/L.

<sup>4</sup> Perfluorooctane Sulfonate. Provisional short-term value 0.0002 mg/L.

<sup>5</sup> RDX = hexahydro -1,3,5-trinitro-1,3,5-triazine.

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Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		10-kg Child						
						One-day (mg/L)	Ten-day (mg/L)	RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10 <sup>-4</sup> Cancer Risk	
2,3,7,8-TCDD (Dioxin)	1746-01-6	F	zero	3E-08	F '87	1E-06	1E-07	1E-09	4E-08	-	2E-08	B2
Tebuthiuron	34014-18-1	-	-	-	F '88	3	3	0.07	2	0.5	-	D
Terbacil	5902-51-2	-	-	-	F '88	0.3	0.3	0.01	0.4	0.09	-	E
Terbufos	13071-79-9	-	-	-	F '88	0.005	0.005	<b>0.00005</b>	0.002	0.0004	-	D
Tetrachloroethane (1,1,1,2-)	630-20-6	-	-	-	F '89	2	2	0.03	1	0.07	0.1	C
Tetrachloroethane (1,1,2,2-)	79-34-5	-	-	-	F '08	3	3	0.01	0.4	-	0.04	L
Tetrachloroethylene <sup>1</sup>	127-18-4	F	zero	0.005	F '87	2	2	0.01	0.5	0.01	-	-
Tetrachloroterephthalic acid	236-79-0	-	-	-	F '08	100	100	-	-	-	-	I
Trichlorofluoromethane	75-69-4	-	-	-	F '89	7	7	0.3	10	2	-	D
Toluene	108-88-3	F	1	1	D '93	20	2	<b>0.08</b>	3	-	-	<b>I</b>
Toxaphene	8001-35-2	F	zero	0.003	F '96	0.004	0.004	0.0004	0.01	-	0.003	B2
2,4,5-TP (Silvex)	93-72-1	F	0.05	0.05	F '88	0.2	0.2	0.008	0.3	0.05	-	D
Trichloroacetic acid	76-03-9	F	0.02	0.06 <sup>2</sup>	-	3	3	0.03	1	0.02	-	S
Trichlorobenzene (1,2,4-)	120-82-1	F	0.07	0.07	F '89	0.1	0.1	<b>0.01</b>	0.35	0.07	-	D
Trichlorobenzene (1,3,5-)	108-70-3	-	-	-	F '89	0.6	0.6	0.006	0.2	0.04	-	D
Trichloroethane (1,1,1-)	71-55-6	F	0.2	0.2	F '87	100	40	<b>2</b>	70	-	-	<b>I</b>
Trichloroethane (1,1,2-)	79-00-5	F	0.003	0.005	F '89	0.6	0.4	0.004	0.1	0.003	0.06	C
Trichloroethylene <sup>1</sup>	79-01-6	F	zero	0.005	F '87	-	-	0.007	0.2	-	0.3	B2
Trichlorophenol (2,4,6-)	88-06-2	-	-	-	D '94	0.03	0.03	0.0003	0.01	-	0.3	B2
Trichloropropane (1,2,3-)	96-18-4	-	-	-	F '89	0.6	0.6	<b>0.004</b>	0.1	-	-	<b>L</b>
Trifluralin	1582-09-8	-	-	-	F '90	0.08	0.08	<b>0.02</b>	0.7	0.01	0.4	<b>C</b>
Trimethylbenzene (1,2,4-)	95-63-6	-	-	-	D '87	-	-	-	-	-	-	D
Trimethylbenzene (1,3,5-)	108-67-8	-	-	-	D '87	10	-	-	-	-	-	D
Trinitroglycerol	55-63-0	-	-	-	F '87	0.005	0.005	-	-	0.005	0.2	-
Trinitrotoluene (2,4,6-)	118-96-7	-	-	-	F '89	0.02	0.02	0.0005	0.02	0.002	0.1	C
Vinyl chloride	75-01-4	F	zero	0.002	F '87	3	3	<b>0.003</b>	0.1	-	<b>0.002</b>	<b>H</b>
Xylenes	1330-20-7	F	10	10	D '93	40	40	<b>0.2</b>	7	-	-	<b>I</b>

<sup>1</sup> Under review.

<sup>2</sup> 1998 Final Rule for Disinfectants and Disinfection By-products: The total for five haloacetic acids is 0.06 mg/L.

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Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		10-kg Child		RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10 <sup>-4</sup> Cancer Risk	
						One-day (mg/L)	Ten-day (mg/L)					
INORGANICS												
Ammonia	7664-41-7	-	-	-	D '92	-	-	-	-	30	-	D
Antimony	7440-36-0	F	0.006	0.006	F '92	0.01	0.01	0.0004	0.01	0.006	-	D
Arsenic	7440-38-2	F	zero	0.01	-	-	-	<b>0.0003</b>	0.01	-	<b>0.002</b>	A
Asbestos (fibers/l >10Φm length)	1332-21-4	F	7 MFL <sup>1</sup>	7 MFL	-	-	-	-	-	-	700-MFL	A <sup>2</sup>
Barium	7440-39-3	F	2	2	D '93	0.7	0.7	<b>0.2</b>	7	-	-	N
Beryllium	7440-41-7	F	0.004	0.004	F '92	30	30	<b>0.002</b>	0.07	-	-	-
Boron	7440-42-8	-	-	-	F '08	3	3	<b>0.2</b>	7	6	-	I
Bromate	7789-38-0	F	zero	0.01	D '98	0.2	-	<b>0.004</b>	0.14	-	0.005	B2
Cadmium	7440-43-9	F	0.005	0.005	F '87	0.04	0.04	0.0005	0.02	0.005	-	D
Chloramine <sup>3</sup>	10599-90-3	F	4 <sup>4</sup>	4 <sup>4</sup>	D '95	-	-	0.1	3.5	3.0	-	-
Chlorine	7782-50-5	F	4 <sup>4</sup>	4 <sup>4</sup>	D '95	3	3	0.1	5	4	-	D
Chlorine dioxide	10049-04-4	F	0.8 <sup>4</sup>	0.8 <sup>4</sup>	D '98	0.8	0.8	0.03	1	0.8	-	D
Chlorite	7758-19-2	F	0.8	1	D '98	0.8	0.8	0.03	1	0.8	-	D
Chromium (total)	7440-47-3	F	0.1	0.1	F '87	1	1	<b>0.003</b> <sup>5</sup>	0.1	-	-	D
Copper (at tap)	7440-50-8	F	1.3	TT <sup>6</sup>	D '98	-	-	-	-	-	-	D
Cyanide	143-33-9	F	0.2	0.2	F '87	0.2	0.2	0.02 <sup>7</sup>	0.8	0.2	-	D
Fluoride	7681-49-4	F	4	4	-	- <sup>8</sup>	-	<b>0.06</b> <sup>9</sup>	-	-	-	-
Lead (at tap)	7439-92-1	F	zero	TT <sup>6</sup>	-	-	-	-	-	-	-	B2
Manganese	7439-96-5	-	-	-	F '04	1	1	0.14 <sup>10</sup>	1.6	0.3	-	D
Mercury (inorganic)	7487-94-7	F	0.002	0.002	F '87	0.002	0.002	<b>0.0003</b>	0.01	0.002	-	D
Molybdenum	7439-98-7	-	-	-	D '93	0.08	0.08	0.005	0.2	0.04	-	D
Nickel	7440-02-0	F	-	-	F '95	1	1	0.02	0.7	0.1	-	-

<sup>1</sup> MFL = million fibers per liter.

<sup>2</sup> Carcinogenicity based on inhalation exposure.

<sup>3</sup> Monochloramine; measured as free chlorine.

<sup>4</sup> 1998 Final Rule for Disinfectants and Disinfection By-products: MRDLG=Maximum Residual Disinfection Level Goal; and MRDL=Maximum Residual Disinfection Level.

<sup>5</sup> IRIS value for chromium VI.

<sup>6</sup> Copper action level 1.3 mg/L; lead action level 0.015 mg/L.

<sup>7</sup> This RfD is for hydrogen cyanide.

<sup>8</sup> In case of overfeed of the fluoridation chemical see CDC Guidelines in Engineering and Administrative Recommendations on Water Fluoridation [www.cdc.gov/mmwr/preview/mmwrhtml/00039178.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/00039178.htm). Elevated F levels ≥ 10mg/L require action by the water system operator.

<sup>9</sup> Based on dental fluorosis in children, a cosmetic effect. MCLG based on skeletal fluorosis.

<sup>10</sup> Dietary manganese. The lifetime health advisory includes a 3 fold modifying factor to account for increased bioavailability from drinking water.

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Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		10-kg Child		RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10 <sup>-4</sup> Cancer Risk	
						One-day (mg/L)	Ten-day (mg/L)					
Nitrate (as N)	14797-55-8	F	10	10	D '93	10 <sup>1</sup>	10 <sup>1</sup>	1.6	-	-	-	-
Nitrite (as N)	14797-65-0	F	1	1	D '93	1 <sup>1</sup>	1 <sup>1</sup>	0.16	-	-	-	-
Nitrate + Nitrite (both as N)		F	10	10	D '93	-	-	-	-	-	-	-
Perchlorate <sup>2</sup>	14797-73-0	-	-	-	I '08	-	-	0.007	0.025	0.015	-	L/N
Selenium	7782-49-2	F	0.05	0.05	-	-	-	0.005	0.2	0.05	-	D
Silver	7440-22-4	-	-	-	F '92	0.2	0.2	0.005 <sup>3</sup>	0.2	0.1 <sup>3</sup>	-	D
Strontium	7440-24-6	-	-	-	D '93	25	25	<b>0.6</b>	20	4	-	D
Thallium	7440-28-0	F	0.0005	0.002	F '92	0.007	0.007	-	-	-	-	<b>I</b>
White phosphorous	7723-14-0	-	-	-	F '90	-	-	0.00002	0.0005	0.0001		D
Zinc	7440-66-6	-	-	-	D '93	6	6	0.3	10	2	-	<b>I</b>
<b>RADIONUCLIDES</b>												
Beta particle and photon activity (formerly man-made radionuclides)		F	zero	4 mrem/yr	-	-	-	-	-	-	4 mrem/yr	A
Gross alpha particle activity		F	zero	15 pCi/L	-	-	-	-	-	-	15 pCi/L	A
Combined Radium 226 & 228	7440-14-4	F	zero	5 pCi/L	-	-	-	-	-	-	-	A
Radon	10043-92-2	P	zero	300 pCi/L AMCL <sup>4</sup> 4000 pCi/L	-	-	-	-	-	-	150 pCi/L	A
Uranium	7440-61-1	F	zero	0.03	-	-	-	0.0006 <sup>5</sup>	0.02	-	-	A

<sup>1</sup> These values are calculated for a 4-kg infant and are protective for all age groups.

<sup>2</sup> Subchronic value for pregnant women.

<sup>3</sup> Based on a cosmetic effect.

<sup>4</sup> AMCL = Alternative Maximum Contaminant Level.

<sup>5</sup> Soluble uranium salts. Radionuclide Rule.

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### ***Secondary Drinking Water Regulations***

<b>Chemicals</b>	<b>CAS Number</b>	<b>Status</b>	<b>SDWR</b>
Aluminum	7429-90-5	F	0.05 to 0.2 mg/L
Chloride	7647-14-5	F	250 mg/L
Color	NA	F	15 color units
Copper	7440-50-8	F	1.0 mg/L
Corrosivity	NA	F	non-corrosive
Fluoride	7681-49-4	F	2.0 mg/L
Foaming agents	NA	F	0.5 mg/L
Iron	7439-89-6	F	0.3 mg/L
Manganese	7439-96-5	F	0.05 mg/L
Odor	NA	F	3 threshold odor numbers
pH	NA	F	6.5 – 8.5
Silver	7440-22-4	F	0.1 mg/L
Sulfate	7757-82-6	F	250 mg/L
Total dissolved solids (TDS)	NA	F	500 mg/L
Zinc	7440-66-6	F	5 mg/L

## *Microbiology*

	Status Reg.	Status HA Document	MCLG	MCL	Treatment Technique
<i>Cryptosporidium</i>	F	F 01	-	TT	Systems that filter must remove 99% of <i>Cryptosporidium</i>
<i>Giardia lamblia</i>	F	F 98	-	TT	99.9% killed/inactivated
<i>Legionella</i>	F <sup>1</sup>	F 01	zero	TT	No limit; EPA believes that if <i>Giardia</i> and viruses are inactivated, <i>Legionella</i> will also be controlled
Heterotrophic Plate Count (HPC)	F <sup>1</sup>	-	NA	TT	No more than 500 bacterial colonies per milliliter.
Mycobacteria	-	F 99	-	-	-
Total Coliforms	F	-	zero	5%	No more than 5.0% samples total coliform-positive in a month. Every sample that has total coliforms must be analyzed for fecal coliforms; no fecal coliforms are allowed.
Turbidity	F	-	NA	TT	At no time can turbidity go above 5 NTU (nephelometric turbidity units)
Viruses	F <sup>1</sup>	-	zero	TT	99.99% killed/inactivated

<sup>1</sup> Regulated under the surface water treatment rule.



## ***Drinking Water Advisory Table***

<b>Chemicals</b>	<b>Status</b>	<b>Health-based Value</b>	<b>Taste Threshold</b>	<b>Odor Threshold</b>
<b>Ammonia</b>	<b>D '92</b>	<b>Not Available</b>	<b>30 mg/L</b>	
<b>Methyl tertiary butyl ether (MtBE)</b>	<b>F '98</b>	<b>Not Available</b>	<b>40 µg/L</b>	<b>20 µg/L</b>
<b>Sodium</b>	<b>F '03</b>	<b>20 mg/L (for individuals on a 500 mg/day restricted sodium diet).</b>	<b>30-60 mg/L</b>	
<b>Sulfate</b>	<b>F '03</b>	<b>500 mg/L</b>	<b>250 mg/L</b>	

Taste Threshold: Concentration at which the majority of consumers do not notice an adverse taste in drinking water; it is recognized that some sensitive individuals may detect a chemical at levels below this threshold.

Odor Threshold: Concentration at which the majority of consumers do not notice an adverse odor in drinking water; it is recognized that some sensitive individuals may detect a chemical at levels below this threshold.

# Appendix C | Water Quality Criteria

## Clean Water Act



United States  
Environmental Protection  
Agency

Office of Water  
Office of Science and Technology  
(4304T)

2009

# National Recommended Water Quality Criteria

**View this document online at <http://www.epa.gov/ost/criteria/wqctable/>**

## Priority Pollutants

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health for the consumption of		FR Cite / Source
			CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
<b>1</b>	Antimony	7440360					5.6 B	640 B	<a href="#">65 FR 66443</a>
<b>2</b>	Arsenic	7440382	340 A,D,K	150 A,D,K	69 A,D,bb	36 A,D,bb	0.018 C,M,S	0.14 C,M,S	<a href="#">65 FR 31682</a> 57 FR 60848
<b>3</b>	Beryllium	7440417					Z		<a href="#">65 FR 31682</a>
<b>4</b>	Cadmium	7440439	2.0 D,E,K,bb	0.25 D,E,K,bb	40 D,bb	8.8 D,bb	Z		<a href="#">EPA 822R-01-001</a> <a href="#">65 FR 31682</a>
<b>5a</b>	Chromium (III)	16065831	570 D,E,K	74 D,E,K			Z Total		<a href="#">EPA 820B-96-001</a> <a href="#">65 FR 31682</a>
<b>5b</b>	Chromium (VI)	18540299	16 D,K	11 D,K	1,100 D,bb	50 D,bb	Z Total		<a href="#">65 FR 31682</a>
<b>6</b>	Copper	7440508	Freshwater criteria calculated using the BLM mm - <a href="#">See Document</a> (epa.gov/waterscience/criteria/copper/)		4.8 D,cc,ff	3.1 D,cc,ff	1,300 U		<a href="#">EPA-822-R-07-001</a> <a href="#">65 FR 31682</a> <a href="#">72 FR 7983</a>
<b>7</b>	Lead	7439921	65 D,E,bb,gg	2.5 D,E,bb,gg	210 D,bb	8.1 D,bb			<a href="#">65 FR 31682</a>
<b>8a</b>	Mercury	7439976	1.4 D,K,hh	0.77 D,K,hh	1.8 D,ee,hh	0.94 D,ee,hh			<a href="#">62 FR 42160</a>
<b>8b</b>	Methylmercury	22967926						0.3 mg/kg J	<a href="#">EPA 823R-01-001</a>
<b>9</b>	Nickel	7440020	470 D,E,K	52 D,E,K	74 D,bb	8.2 D,bb	610 B	4,600 B	<a href="#">65 FR 31682</a>
<b>10</b>	Selenium	7782492	L,R,T	5.0 T	290 D,bb,dd	71 D,bb,dd	170 Z	4200	<a href="#">62 FR 42160</a> <a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health for the consumption of		FR Cite / Source
			CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
11	Silver	7440224	3.2 D,E,G		1.9 D,G				<a href="#">65 FR 31682</a>
12	Thallium	7440280					0.24	0.47	<a href="#">68 FR 75510</a>
13	Zinc	7440666	120 D,E,K	120 D,E,K	90 D,bb	81 D,bb	7,400 U	26,000 U	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>
14	Cyanide	57125	22 K,Q	5.2 K,Q	1 Q,bb	1 Q,bb	140 jj	140 jj	<a href="#">EPA 820B-96001</a> 57 FR 60848 <a href="#">68 FR 75510</a>
15	Asbestos	1332214					7 million fibers/L I		57 FR 60848
16	2,3,7,8-TCDD (Dioxin)	1746016					5.0E-9 C	5.1E-9 C	<a href="#">65 FR 66443</a>
17	Acrolein	107028	3ug/L	3ug/L			6 II	9 II	<a href="#">74 FR 27535</a> <a href="#">74 FR 46587</a>
18	Acrylonitrile	107131					0.051 B,C	0.25 B,C	<a href="#">65 FR 66443</a>
19	Benzene	71432					2.2 B,C	51 B,C	<a href="#">IRIS 01/19/00</a> <a href="#">65 FR 66443</a>
20	Bromoform	75252					4.3 B,C	140 B,C	<a href="#">65 FR 66443</a>
21	Carbon Tetrachloride	56235					0.23 B,C	1.6 B,C	<a href="#">65 FR 66443</a>
22	Chlorobenzene	108907					130 Z,U	1,600 U	<a href="#">68 FR 75510</a>
23	Chlorodibromomethane	124481					0.40 B,C	13 B,C	<a href="#">65 FR 66443</a>
24	Chloroethane	75003							
25	2-Chloroethylvinyl Ether	110758							
26	Chloroform	67663					5.7 C,P	470 C,P	<a href="#">62 FR 42160</a>

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health for the consumption of		FR Cite / Source
			CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
27	Dichlorobromomethane	75274					0.55 B,C	17 B,C	<a href="#">65 FR 66443</a>
28	1,1-Dichloroethane	75343							
29	1,2-Dichloroethane	107062					0.38 B,C	37 B,C	<a href="#">65 FR 66443</a>
30	1,1-Dichloroethylene	75354					330	7,100	<a href="#">68 FR 75510</a>
31	1,2-Dichloropropane	78875					0.50 B,C	15 B,C	<a href="#">65 FR 66443</a>
32	1,3-Dichloropropene	542756					0.34 C	21 C	<a href="#">68 FR 75510</a>
33	Ethylbenzene	100414					530	2,100	<a href="#">68 FR 75510</a>
34	Methyl Bromide	74839					47 B	1,500 B	<a href="#">65 FR 66443</a>
35	Methyl Chloride	74873							<a href="#">65 FR 31682</a>
36	Methylene Chloride	75092					4.6 B,C	590 B,C	<a href="#">65 FR 66443</a>
37	1,1,2,2-Tetrachloroethane	79345					0.17 B,C	4.0 B,C	<a href="#">65 FR 66443</a>
38	Tetrachloroethylene	127184					0.69 C	3.3 C	<a href="#">65 FR 66443</a>
39	Toluene	108883					1,300 Z	15,000	<a href="#">68 FR 75510</a>
40	1,2-Trans-Dichloroethylene	156605					140 Z	10,000	<a href="#">68 FR 75510</a>
41	1,1,1-Trichloroethane	71556					Z		<a href="#">65 FR 31682</a>
42	1,1,2-Trichloroethane	79005					0.59 B,C	16 B,C	<a href="#">65 FR 66443</a>
43	Trichloroethylene	79016					2.5 C	30 C	<a href="#">65 FR 66443</a>
44	Vinyl Chloride	75014					0.025 C,kk	2.4 C,kk	<a href="#">68 FR 75510</a>
45	2-Chlorophenol	95578					81 B,U	150 B,U	<a href="#">65 FR 66443</a>

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health for the consumption of		FR Cite / Source
			CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
46	2,4-Dichlorophenol	120832					77 B,U	290 B,U	<a href="#">65 FR 66443</a>
47	2,4-Dimethylphenol	105679					380 B	850 B,U	<a href="#">65 FR 66443</a>
48	2-Methyl-4,6Dinitrophenol	534521					13	280	<a href="#">65 FR 66443</a>
49	2,4-Dinitrophenol	51285					69 B	5,300 B	<a href="#">65 FR 66443</a>
50	2-Nitrophenol	88755							
51	4-Nitrophenol	100027							
52	3-Methyl-4-Chlorophenol	59507					U	U	
53	Pentachlorophenol	87865	19 F,K	15 F,K	13 bb	7.9 bb	0.27 B,C	3.0 B,C,H	<a href="#">65 FR 31682</a>
54	Phenol	108952					10,000 II,U	860,000 II,U	<a href="#">74 FR 27535</a>
55	2,4,6-Trichlorophenol	88062					1.4 B,C	2.4 B,C,U	<a href="#">65 FR 66443</a>
56	Acenaphthene	83329					670 B,U	990 B,U	<a href="#">65 FR 66443</a>
57	Acenaphthylene	208968							<a href="#">65 FR 66443</a>
58	Anthracene	120127					8,300 B	40,000 B	<a href="#">65 FR 66443</a>
59	Benzidine	92875					0.000086 B,C	0.00020 B,C	<a href="#">65 FR 66443</a>
60	Benzo(a) Anthracene	56553					0.0038 B,C	0.018 B,C	<a href="#">65 FR 66443</a>
61	Benzo(a) Pyrene	50328					0.0038 B,C	0.018 B,C	<a href="#">65 FR 66443</a>
62	Benzo(b) Fluoranthene	205992					0.0038 B,C	0.018 B,C	<a href="#">65 FR 66443</a>
63	Benzo(ghi) Perylene	191242							<a href="#">65 FR 66443</a>
64	Benzo(k) Fluoranthene	207089					0.0038 B,C	0.018 B,C	<a href="#">65 FR 66443</a>

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health for the consumption of		FR Cite / Source
			CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
65	Bis(2-Chloroethoxy) Methane	111911							
66	Bis(2-Chloroethyl) Ether	111444					0.030 B,C	0.53 B,C	<a href="#">65 FR 66443</a>
67	Bis(2-Chloroisopropyl) Ether	108601					1,400 B	65,000 B	<a href="#">65 FR 66443</a>
68	Bis(2-Ethylhexyl) Phthalate <sup>x</sup>	117817					1.2 B,C	2.2 B,C	<a href="#">65 FR 66443</a>
69	4-Bromophenyl Phenyl Ether	101553							
70	Butylbenzyl Phthalate <sup>w</sup>	85687					1,500 B	1,900 B	<a href="#">65 FR 66443</a>
71	2-Chloronaphthalene	91587					1,000 B	1,600 B	<a href="#">65 FR 66443</a>
72	4-Chlorophenyl Phenyl Ether	7005723							
73	Chrysene	218019					0.0038 B,C	0.018 B,C	<a href="#">65 FR 66443</a>
74	Dibenzo(a,h)Anthracene	53703					0.0038 B,C	0.018 B,C	<a href="#">65 FR 66443</a>
75	1,2-Dichlorobenzene	95501					420	1,300	<a href="#">68 FR 75510</a>
76	1,3-Dichlorobenzene	541731					320	960	<a href="#">65 FR 66443</a>
77	1,4-Dichlorobenzene	106467					63	190	<a href="#">68 FR 75510</a>
78	3,3'-Dichlorobenzidine	91941					0.021 B,C	0.028 B,C	<a href="#">65 FR 66443</a>
79	Diethyl Phthalate <sup>w</sup>	84662					17,000 B	44,000 B	<a href="#">65 FR 66443</a>
80	Dimethyl Phthalate <sup>w</sup>	131113					270,000	1,100,000	<a href="#">65 FR 66443</a>
81	Di-n-Butyl Phthalate <sup>w</sup>	84742					2,000 B	4,500 B	<a href="#">65 FR 66443</a>
82	2,4-Dinitrotoluene	121142					0.11 C	3.4 C	<a href="#">65 FR 66443</a>
83	2,6-Dinitrotoluene	606202							



NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health for the consumption of		FR Cite / Source
			CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
84	Di-n-Octyl Phthalate	117840							
85	1,2-Diphenylhydrazine	122667					0.036 B,C	0.20 B,C	<a href="#">65 FR 66443</a>
86	Fluoranthene	206440					130 B	140 B	<a href="#">65 FR 66443</a>
87	Fluorene	86737					1,100 B	5,300 B	<a href="#">65 FR 66443</a>
88	Hexachlorobenzene	118741					0.00028 B,C	0.00029 B,C	<a href="#">65 FR 66443</a>
89	Hexachlorobutadiene	87683					0.44 B,C	18 B,C	<a href="#">65 FR 66443</a>
90	Hexachlorocyclopentadiene	77474					40 U	1,100 U	<a href="#">68 FR 75510</a>
91	Hexachloroethane	67721					1.4 B,C	3.3 B,C	<a href="#">65 FR 66443</a>
92	Ideno(1,2,3-cd)Pyrene	193395					0.0038 B,C	0.018 B,C	<a href="#">65 FR 66443</a>
93	Isophorone	78591					35 B,C	960 B,C	<a href="#">65 FR 66443</a>
94	Naphthalene	91203							
95	Nitrobenzene	98953					17 B	690 B,H,U	<a href="#">65 FR 66443</a>
96	N-Nitrosodimethylamine	62759					0.00069 B,C	3.0 B,C	<a href="#">65 FR 66443</a>
97	N-Nitrosodi-n-Propylamine	621647					0.0050 B,C	0.51 B,C	<a href="#">65 FR 66443</a>
98	N-Nitrosodiphenylamine	86306					3.3 B,C	6.0 B,C	<a href="#">65 FR 66443</a>
99	Phenanthrene	85018							
100	Pyrene	129000					830 B	4,000 B	<a href="#">65 FR 66443</a>
101	1,2,4-Trichlorobenzene	120821					35	70	<a href="#">68 FR 75510</a>

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health for the consumption of		FR Cite / Source
			CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
102	Aldrin	309002	3.0 G		1.3 G		0.000049 B,C	0.000050 B,C	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>
103	alpha-BHC	319846					0.0026 B,C	0.0049 B,C	<a href="#">65 FR 66443</a>
104	beta-BHC	319857					0.0091 B,C	0.017 B,C	<a href="#">65 FR 66443</a>
105	gamma-BHC (Lindane)	58899	0.95 K		0.16 G		0.98	1.8	<a href="#">65 FR 31682</a> <a href="#">68 FR 75510</a>
106	delta-BHC	319868							
107	Chlordane	57749	2.4 G	0.0043 G,aa	0.09 G	0.004 G,aa	0.00080 B,C	0.00081 B,C	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>
108	4,4'-DDT	50293	1.1 G,ii	0.001 G,aa,ii	0.13 G,ii	0.001 G,aa,ii	0.00022 B,C	0.00022 B,C	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>
109	4,4'-DDE	72559					0.00022 B,C	0.00022 B,C	<a href="#">65 FR 66443</a>
110	4,4'-DDD	72548					0.00031 B,C	0.00031 B,C	<a href="#">65 FR 66443</a>
111	Dieldrin	60571	0.24 K	0.056 K,O	0.71 G	0.0019 G,aa	0.000052 B,C	0.000054 B,C	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>
112	alpha-Endosulfan	959988	0.22 G,Y	0.056 G,Y	0.034 G,Y	0.0087 G,Y	62 B	89 B	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>
113	beta-Endosulfan	33213659	0.22 G,Y	0.056 G,Y	0.034 G,Y	0.0087 G,Y	62 B	89 B	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>
114	Endosulfan Sulfate	1031078					62 B	89 B	<a href="#">65 FR 66443</a>
115	Endrin	72208	0.086 K	0.036 K,O	0.037 G	0.0023 G,aa	0.059	0.060	<a href="#">65 FR 31682</a> <a href="#">68 FR 75510</a>
116	Endrin Aldehyde	7421934					0.29 B	0.30 B,H	<a href="#">65 FR 66443</a>
117	Heptachlor	76448	0.52 G	0.0038 G,aa	0.053 G	0.0036 G,aa	0.000079 B,C	0.000079 B,C	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health for the consumption of		FR Cite / Source
			CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	CMC 1 (acute) (µg/L)	CCC 1 (chronic) (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
118	Heptachlor Epoxide	1024573	0.52 G,V	0.0038 G,V,aa	0.053 G,V	0.0036 G,V,aa	0.000039 B,C	0.000039 B,C	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>
119	Polychlorinated Biphenyls (PCBs)			0.014 N,aa		0.03 N,aa	0.000064 B,C,N	0.000064 B,C,N	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>
120	Toxaphene	8001352	0.73	0.0002 aa	0.21	0.0002 aa	0.00028 B,C	0.00028 B,C	<a href="#">65 FR 31682</a> <a href="#">65 FR 66443</a>

## Footnotes

**A** This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. In the [arsenic criteria document \(PDF\)](#) (74 pp., 3.2 MB) (EPA 440/5-84-033, January 1985), Species Mean Acute Values are given for both arsenic (III) and arsenic (V) for five species and the ratios of the SMAVs for each species range from 0.6 to

1.7. Chronic values are available for both arsenic (III) and arsenic (V) for one species; for the fathead minnow, the chronic value for arsenic (V) is 0.29 times the chronic value for arsenic (III). No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive.

**B** This criterion has been revised to reflect The Environmental Protection Agency's q1\* or RfD, as contained in the Integrated Risk Information System (IRIS) as of May 17, 2002. The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in each case.

**C** This criterion is based on carcinogenicity of  $10^{-6}$  risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of  $10^{-5}$ , move the decimal point in the recommended criterion one place to the right).

**D** Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The recommended water quality criteria value was calculated by using the previous 304(a) aquatic life criteria expressed in terms of total recoverable metal, and multiplying it by a conversion factor (CF). The term "Conversion Factor" (CF) represents the recommended conversion factor for converting a metal criterion expressed as the total recoverable fraction in the water column to a criterion expressed as the dissolved fraction in the water column. (Conversion Factors for saltwater CCCs are not currently available. Conversion factors derived for saltwater CMCs have been used for both saltwater CMCs and CCCs). See "[Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria \(PDF\)](#)," (49 pp., 3MB) October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available from the [Water Resource center](#) and 40CFR§131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble-Conversion Factors for Dissolved Metals.

**E** The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated from the following:  $CMC (dissolved) = \exp\{mA [\ln(hardness)] + bA\} (CF)$ , or  $CCC (dissolved) = \exp\{mC [\ln(hardness)] + bC\} (CF)$  and the parameters specified in Appendix B-Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent.

**F** Freshwater aquatic life values for pentachlorophenol are expressed as a function of pH, and are calculated as follows:  $CMC = \exp(1.005(pH) - 4.869)$ ;  $CCC = \exp(1.005(pH) - 5.134)$ . Values displayed in table correspond to a pH of 7.8.

**G** This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: [Aldrin/Dieldrin \(PDF\)](#) (153 pp., 7.3 MB) (EPA 440/5-80-019), [Chlordane \(PDF\)](#) (68 pp., 3.1 MB) (EPA 440/5-80-027), [DDT \(PDF\)](#) (175 pp., 8.3 MB) (EPA 440/5-80-038), [Endosulfan \(PDF\)](#) (155 pp., 7.3 MB) (EPA 440/5-80-046), [Endrin \(PDF\)](#) (103 pp., 4.6 MB) (EPA 440/5-80-047), [Heptachlor \(PDF\)](#) (114 pp., 5.4 MB) (EPA 440/5-80-052), [Hexachlorocyclohexane \(PDF\)](#) (109 pp., 4.8 MB) (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the [1985 Guidelines \(PDF\)](#) (104 pp., 3.3 MB). For example, a "CMC" derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.

**H** No criterion for protection of human health from consumption of aquatic organisms excluding water was presented in the 1980 criteria document or in the *1986 Quality Criteria for Water*. Nevertheless, sufficient information was presented in the 1980 document to allow the calculation of a criterion, even though the results of such a calculation were not shown in the document.

**I** This criterion for asbestos is the Maximum Contaminant Level (MCL) developed under the Safe Drinking Water Act (SDWA).

**J** This fish tissue residue criterion for methylmercury is based on a total fish consumption rate of 0.0175 kg/day.

**K** This recommended criterion is based on a 304(a) aquatic life criterion that was issued in the [1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water](#), (EPA 820-B-96-001, September 1996). This value was derived using the GLI Guidelines (60 FR 15393-15399, March 23, 1995; 40CFR132 Appendix A); the difference between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. None of the decisions concerning the derivation of this criterion were affected by any considerations that are specific to the Great Lakes.

**L** The  $CMC = 1/[(f1/CMC1) + (f2/CMC2)]$  where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 g/l and 12.82 g/l, respectively.

**M** EPA is currently reassessing the criteria for arsenic.

**N** This criterion applies to total pcbs, (e.g., the sum of all congener or all isomer or homolog or Aroclor analyses.)

**O** The derivation of the CCC for this pollutant (Endrin) did not consider exposure through the diet, which is probably important for aquatic life occupying upper trophic levels.

**P** Although a new RfD is available in IRIS, the surface water criteria will not be revised until the National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) is completed, since public comment on the relative source contribution (RSC) for chloroform is anticipated.

## NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY POLLUTANTS

**Q** This recommended water quality criterion is expressed as g free cyanide (as CN)/L.

**R** This value for selenium was announced ([61 FR 58444-58449](#), November 14, 1996) as a proposed GLI 303(c) aquatic life criterion. EPA is [currently working on this criterion](#) and so this value might change substantially in the near future.

**S** This recommended water quality criterion for arsenic refers to the inorganic form only.

**T** This recommended water quality criterion for selenium is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor (0.996-CMC or 0.922-CCC) that was used in the GLI to convert this to a value that is expressed in terms of dissolved metal.

**U** The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.

**V** This value was derived from data for heptachlor and the criteria document provides insufficient data to estimate the relative toxicities of heptachlor and heptachlor epoxide.

**W** Although EPA has not published a completed criteria document for butylbenzyl phthalate it is EPA's understanding that sufficient data exist to allow calculation of aquatic criteria. It is anticipated that industry intends to publish in the peer reviewed literature draft aquatic life criteria generated in accordance with EPA Guidelines. EPA will review such criteria for possible issuance as national WQC.

**X** There is a full set of aquatic life toxicity data that show that DEHP is not toxic to aquatic organisms at or below its solubility limit.

**Y** This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

**Z** A more stringent MCL has been issued by EPA. Refer to drinking water regulations (40 CFR 141) or Safe Drinking Water Hotline (1-800-426-4791) for values.

**aa** This criterion is based on a 304(a) aquatic life criterion issued in 1980 or 1986, and was issued in one of the following documents: [Aldrin/Dieldrin \(PDF\)](#) (153 pp., 7.3 MB) (EPA 440/5-80-019), [Chlordane \(PDF\)](#) (68 pp., 3.1 MB) (EPA 440/5-80-027), [DDT \(PDF\)](#) (175 pp., 8.3 MB) (EPA 440/5-80-038), [Endrin \(PDF\)](#) (103 pp., 4.6 MB) (EPA 440/5-80-047), [Heptachlor \(PDF\)](#) (114 pp., 5.4 MB) (EPA 440/5-80-052), Polychlorinated biphenyls (EPA 440/5-80-068), Toxaphene (EPA 440/5-86-006). This CCC is currently based on the Final Residue Value (FRV) procedure. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60 FR 15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria. Therefore, the Agency anticipates that future revisions of this CCC will not be based on the FRV procedure.

**bb** This water quality criterion is based on a 304(a) aquatic life criterion that was derived using the [1985 Guidelines \(PDF\)](#) (104 pp., 3.3 MB) (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: [Arsenic \(PDF\)](#) (74 pp., 3.2 MB) (EPA 440/5-84-033), [Cadmium](#) (EPA 822-R-01-001), [Chromium](#) (EPA 440/5-84-029), [Copper \(PDF\)](#) (150 pp., 6.2 MB) (EPA 440/5-84-031), [Cyanide \(PDF\)](#) (67 pp., 2.7 MB) (EPA 440/5-84-028), Lead (EPA 440/5-84-027), Nickel (EPA 440/5-86-004), Pentachlorophenol (EPA 440/5-86-009), Toxaphene, (EPA 440/5-86-006), Zinc (EPA 440/5-87-003).

**cc** When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.

**dd** The selenium criteria document (EPA 440/5-87-006, September 1987) provides that if selenium is as toxic to saltwater fishes in the field as it is to freshwater fishes in the field, the status of the fish community should be monitored whenever the concentration of selenium exceeds 5.0 g/L in salt water because the saltwater CCC does not take into account uptake via the food chain.

**ee** This recommended water quality criterion was derived on page 43 of the [mercury criteria document \(PDF\)](#) (144 pp., 6.4 MB) (EPA 440/5-84-026, January 1985). The saltwater CCC of 0.025 ug/L given on page 23 of the criteria document is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60 FR 15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

**ff** This recommended water quality criterion was derived in *Ambient Water Quality Criteria Saltwater Copper Addendum* (Draft, April 14, 1995) and was promulgated in the Interim final National Toxics Rule ([60 FR 22228-22237](#), May 4, 1995).

**gg** EPA is actively working on this criterion and so this recommended water quality criterion may change substantially in the near future.

**hh** This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.

**ii** This criterion applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value).

**jj** This recommended water quality criterion is expressed as total cyanide, even though the IRIS RFD we used to derive the criterion is based on free cyanide. The multiple forms of cyanide that are present in ambient water have significant differences in toxicity due to their differing abilities to liberate the CN-moiety. Some complex cyanides require even more extreme conditions than refluxing with sulfuric acid to liberate the CN-moiety. Thus, these complex cyanides are expected to have little or no 'bioavailability' to humans. If a substantial fraction of the cyanide present in a water body is present in a complexed form (e.g.,  $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ ), this criterion may be over conservative.

**kk** This recommended water quality criterion was derived using the cancer slope factor of 1.4 (LMS exposure from birth).

**ll** This criterion has been revised to reflect the Environmental Protection Agency's cancer slope factor (CSF) or reference dose (RfD), as contained in the Integrated Risk Information System (IRIS) as of (Final [FR Notice](#) June 10, 2009). The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in each case.

**mm** The available toxicity data, when evaluated using the procedures described in the "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" indicate that freshwater aquatic life should be protected if the 24-hour average and four-day average concentrations do not respectively exceed the acute and chronic criteria concentrations calculated by the Biotic Ligand Model.

## Appendix D | References

Eric Chivian, Michael McCally, Howard Hu and Andrew Haines (Eds.), *Critical Condition: Human Health and the Environment*, (Cambridge: The MIT Press, 1994).

Sharon Behar, *Testing the Waters*, (Dubuque, IA: Kendall Hunt, 1996).

Geoff Dates, *River Monitoring Study Design Workbook*, (Montpelier, VT: River Watch Network, 1995).

Steve Dickens, *Cancer Downstream: A Citizens Guide to investigating Pollution/Health Connections*, (Portland, OR: River network, 2007).

Don Elder, Galye Killam, Paul Koberstein, *The Clean Water Act: An Owner's Manual*, (Portland, OR: River Network, 1999).

Burt Gertman, *Epidemiology Kept Simple*, (New York: Wiley-Liss, 1998).

Chap T. Lee, *Health and Numbers: A problems-based introduction to biostatistics*, (New York : Wiley-Liss, 2001).

Marvin S. Legator and Sabrina F. Strawn (Eds.) *Chemical Alert*. (Austin , TX: University of Texas Press, 1993).

Robert Moore,, Merrit Frey and Gayle Killam, *Permitting an End to Pollution*, (Portland, OR: Prairie Rivers Network, Clean Water Network, River Network), 2002.

David M. Nielsen and Ronald Schalla. "Design and Installation of Ground-Water Monitoring Wells" in *Practical Handbook of Environmental Site Characterization and Ground –Water Monitoring*, ed. David M. Nielen, (Boca Raton, FL : CRC Press, 2006).

Nielsen, David M. (Ed.) 2006. *Practical Handbook of Environmental Site Characterization and Ground-Water Monitoring*. CRC Press, Boca Raton, FL.

Rosenblatt, Judah. 2002 *Basic Statistical Methods and Models for the Sciences*, , Chapman & Hall, New York

Vitale, Rock J. and Olin C. Braids. 2006 *Ground-Water Sample Analysis* in *Practical Handbook of Environmental Site Characterization and Ground –Water Monitoring*. David M. Nielen, Ed., CRC Press, Boca Raton, FL.