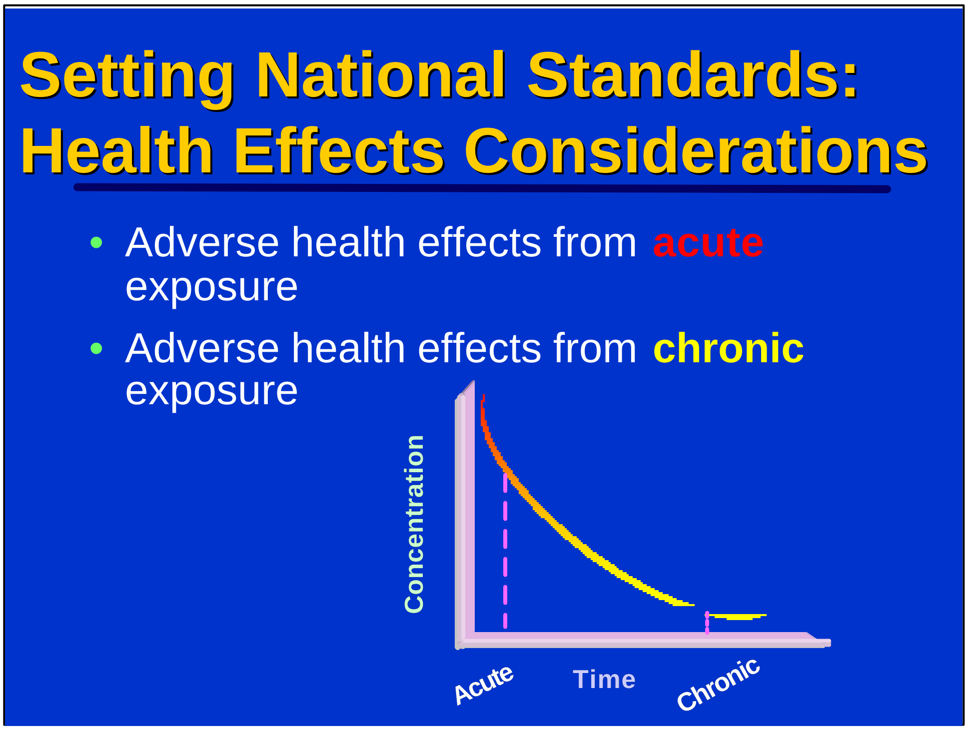

Set Goals and
Standards
CWA Water Quality
Standards
SDWA Maximum
Contaminant Levels
DRINKING WATER ACADEMY
DWA
The Watershed Academy



- Adverse health effects in people, aquatic animals and wildlife can occur from exposures of different duration.
  - ***Acute exposure health effects*** result from short-term exposures (minutes, hours or days), generally from high concentrations of a contaminant.
  - ***Chronic exposure health effects*** are associated with exposure over many years (perhaps a lifetime) to a contaminant. Chronic human health effects include cancer and other long-term health effects.
- The CWA and SDWA consider potential health effects in different ways.
  - SDWA tends to characterize individual contaminants as either acute or chronic. Pollutants are then regulated for the most sensitive population.
  - The CWA water quality criteria for a given pollutant consist of two numbers, each representing a combination of concentration and time. One is for acute exposures, and the other for chronic exposures.
- Reasons for this difference include:
  - Drinking water is treated, so in meeting the levels for chronic concerns, the water would automatically be treated to a level that would prevent acute effects.
  - A drinking water standard is set based on information about the occurrence of the contaminant in drinking water (i.e., in how many public water systems is the contaminant likely to be present and at what levels). Therefore, there must be evidence of the presence of a contaminant at acute levels in order to set a standard at such a level.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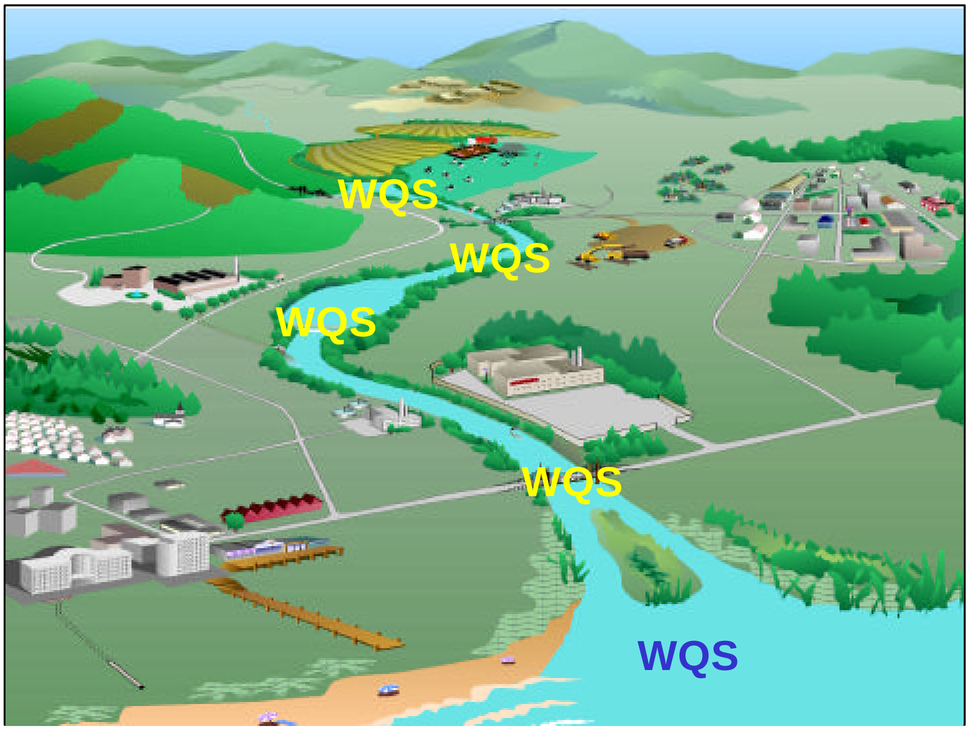


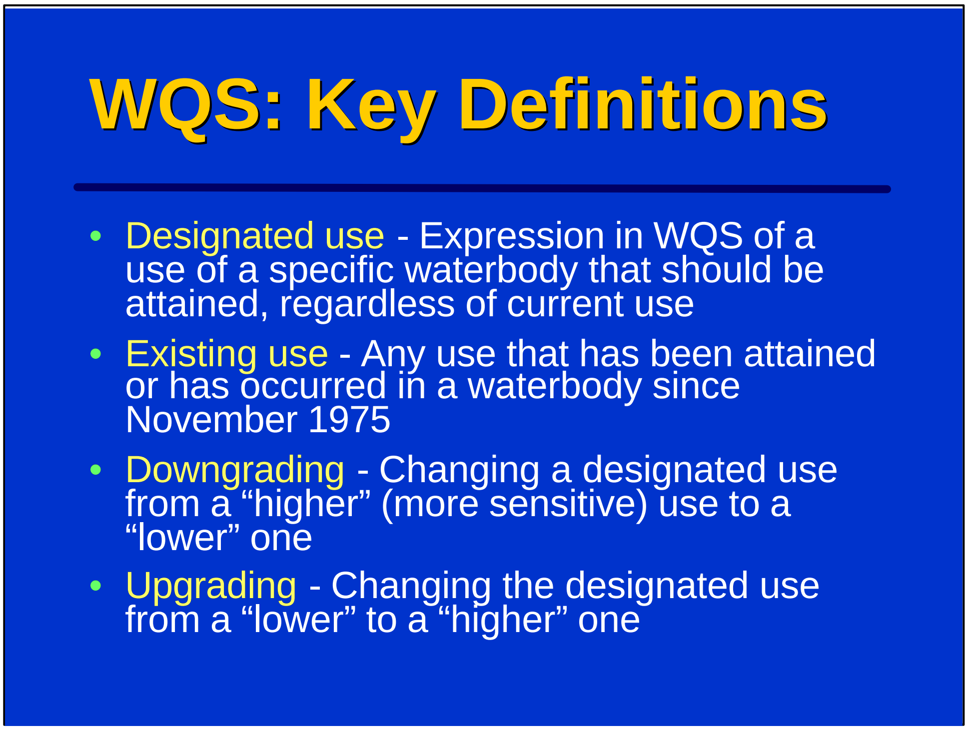
- This is the first appearance of a hypothetical watershed slide that will be used throughout the course to illustrate where various key CWA programs apply within the typical watershed landscape.
- Here, we show that water quality standards apply to all surface waters.

Water Quality Standards

- Must address all surface waters (i.e., waters of US and State)
- Key elements
  - Designated uses
  - Water quality criteria (conditions supporting DUs)
  - Antidegradation
- Optional provisions (e.g., exemptions)

- There are three key elements to a State's* WQS program:
  - ***Designated uses*** of a waterbody or segment of a waterbody;
  - ***Water quality criteria,*** i.e., conditions in the waterbody that would be necessary to protect the designated uses; and
  - An ***antidegradation policy*** aimed at keeping good-quality waters in good condition.

*** Throughout the training, in our discussion of implementing the statutes, we use State inclusively, meaning State, territory or Tribe.**



- The WQS program categorizes water uses in two ways: ***designated uses*** and ***existing uses***.
  - A designated use is the legally applicable use specified in a water quality standard. A designated use is a use that, presently, may or may not be "***attained***." It is a desired use, one that you want a waterbody to be able to support.
  - An existing use is one that has been attained; that use and the water quality necessary to support that use must be protected and maintained. An existing use is not always the same as the current or actual use. Specifying existing uses prevents degradation of the water quality.
  - Designated uses, on the other hand, may be changed on a finding that the use cannot be attained. "More sensitive use" means a use that requires higher water quality in order to be attained and maintained.

WQS: Process

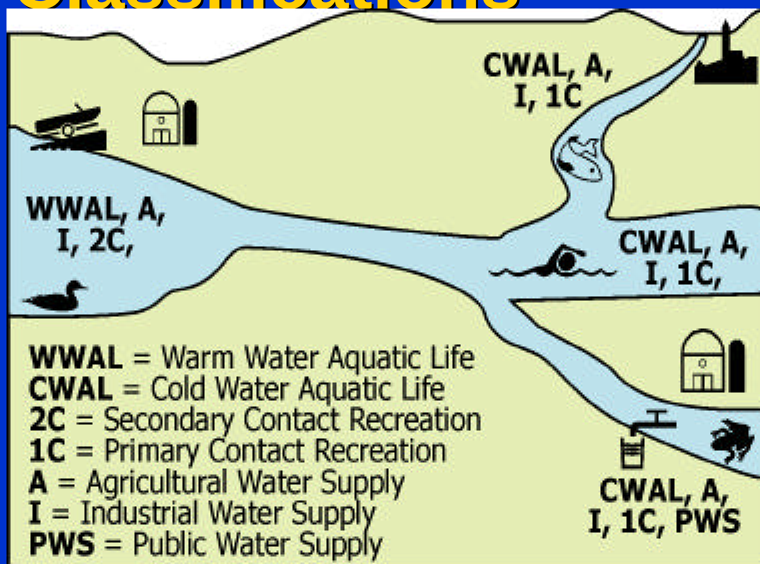
- WQS established by States and Tribes
- EPA must review and approve prior to becoming effective
- If EPA disapproves a State or Tribal WQS and State or Tribe doesn't revise it, EPA promulgates a WQS
- Public review and comment at State, Tribal, and Federal levels (if EPA promulgates)
- States must review their WQS every three years and submit them to EPA

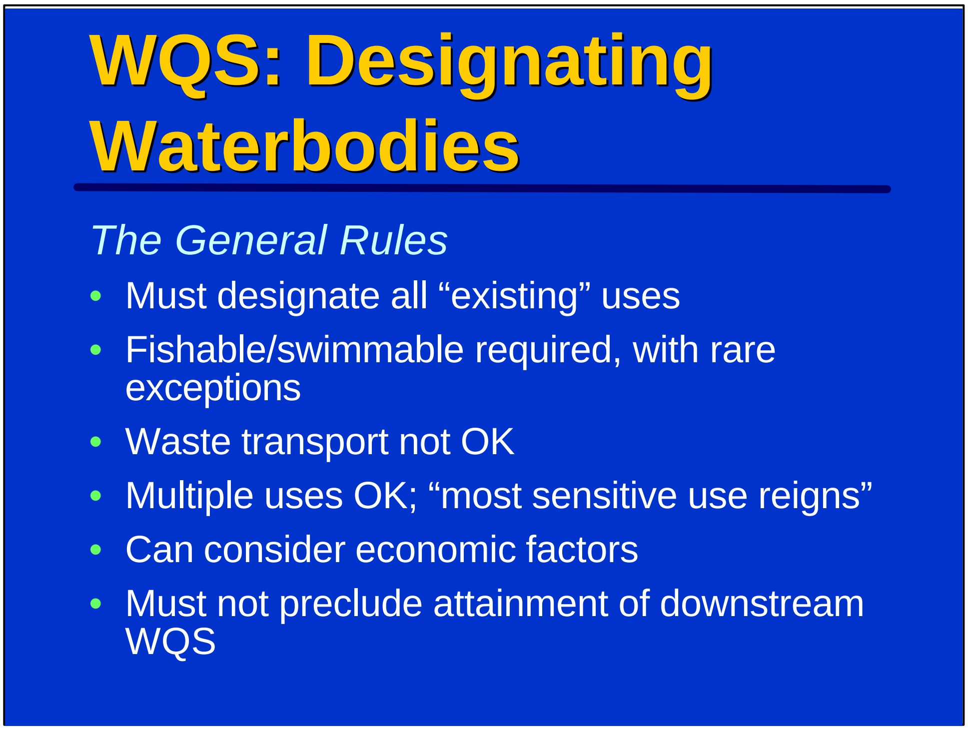
Are you aware of any examples of EPA promulgating standards?

- Tribes do not automatically have authority to develop water quality standards programs under the Clean Water Act; they must be authorized. In order to demonstrate their qualifications, a Tribe must:
  - Be Federally recognized;
  - Carry out substantial governmental duties and powers over a Federal Indian reservation;
  - Have appropriate authority to regulate the quality of reservation waters; and
  - Be reasonably expected to be capable of administering the standards program.
- As a general policy, EPA will not deny a Tribal application. Rather, EPA will continue to work cooperatively with the Tribe to resolve deficiencies in the application or the Tribal program so that tribal authorization may occur.
- Until a Tribe qualifies for the standards program and adopts WQS, EPA will, when possible, assume that existing water quality standards remain applicable. EPA may apply State standards in this case because there are no Federal standards that generally apply, and because ignoring State standards would create a regulatory void that EPA believes would not be beneficial to the reservation water quality.
- If EPA determines that a Tribe is qualified but the Tribe declines to seek authorization, EPA may promulgate Federal WQS.

- This slide lists several designated use (DU) categories commonly found in State and Tribal WQS. Aquatic life designation is often broken down into subcategories.
- Note that CWA DUs refer to surface raw water supplies for a drinking water source. Usually, though not always, water from sources such as flowing rivers and reservoirs is treated before going into people's homes and businesses. Some States distinguish between raw water that will be treated and/or filtered and that which would not.
- The "swimmable" part of fishable/swimmable is actually "recreation in and on the water." States usually break down recreational uses into primary contact (in the water) and secondary contact (on the water). This distinction speaks to the duration of time a person is likely to spend with most of their body immersed in water.
- The fishing category of designated uses applies to any kind of aquatic organism that might be eaten by humans, not just to finfish. States often distinguish between different patterns of fish consumption:
  - Commercial—organisms are caught in large quantities and sold in commerce, usually by professional fishermen.
  - Recreational—people who fish for sport bring some or all of their catch home with them to eat.
  - Subsistence—similar to recreational, except the fish that are caught and eaten represent a substantial fraction of the diet of the fishermen and their families.
- The exposure patterns (amount, frequency) of each of these uses varies, and must be taken into account when setting criteria aimed at protecting the use.

WQS: Use Classifications





- "Existing" is in quotes in the first bullet to remind us that according to CWA regulations, "existing" does not mean only "happening right now." Hence, the first bullet means that if anyone can produce solid evidence that a use has occurred at any time since November 1975, it is an "existing use," and therefore, it must be established by the State as a "designated use." Even if use is not known to have occurred, a use is considered "existing" if credible data shows that water quality has been good enough to support the use.
- "Rare exceptions" refers to the downgrading process, which is covered in the next slide. A State can only designate a use lower than fishable/swimmable if it:
  - Demonstrates that certain conditions are met; and
  - Goes through a public notice and comment process.
- Most waterbodies are designated for more than one use. "Most sensitive" uses are those which require the highest level of water quality.
- States can consider economic factors when setting the designated uses for waterbodies. In contrast, they cannot factor in economics when setting the water quality criteria that go with a particular designated use.

WQS: Reclassifying Waterbodies

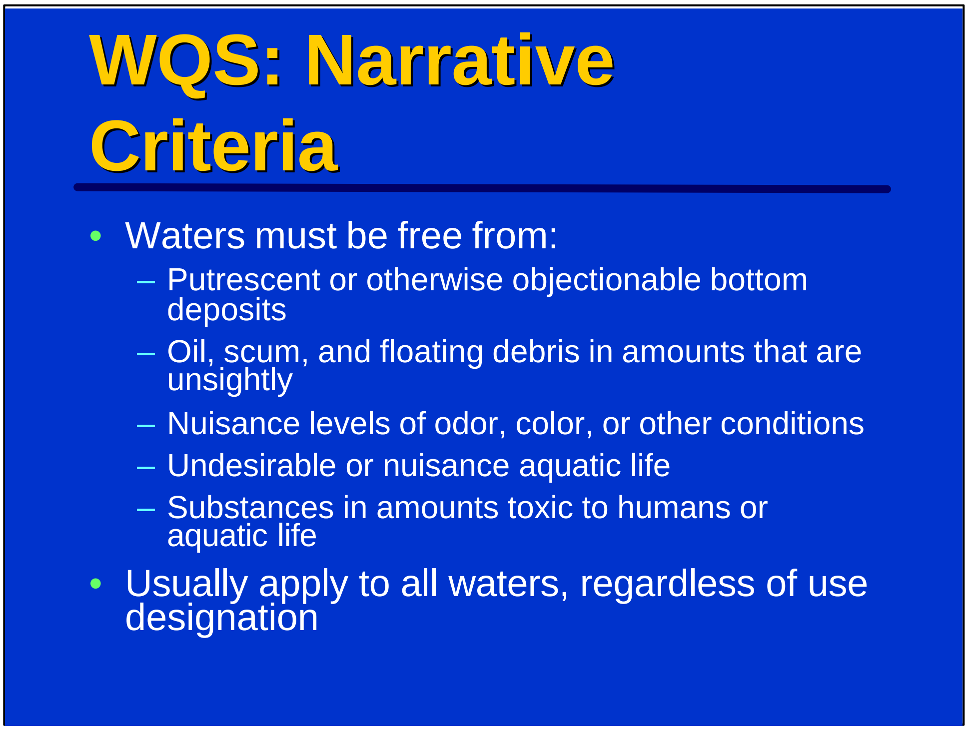
- "Downgrading" of designated (not existing) uses allowed in limited situations
- Use attainability analysis (UAA) and public review required
  - Consider and document factors listed above
  - Subject to EPA review and approval

- "Downgrading" DUs means going from higher to lower DU. (Note: can't go lower than the existing use—ever.) This is allowed in limited situations:
  - If the use cannot be attained through implementation of technology-based requirements for point sources and cost-effective and reasonable best management practices for nonpoint sources; or
  - If natural background conditions prevent attainment or if there would be irreversible human impacts or substantial and widespread social and economic costs associated with achieving the designated use.
- A State could allow downgrading if the only way to attain a DU was to impose WQ-based controls on sources that would cause "substantial and widespread social and economic costs." EPA, and most States, have provided limited guidance on the meaning of key terms such as "irreversible human impacts" and "substantial and widespread social and economic costs." (see **http://www.epa.gov/ost/econ**)
  - Although there is no Federal authority to enforce implementation of BMPs, a State should refuse to downgrade if studies indicate that a DU could be attained if BMPs were implemented.
- In order to show that the above conditions are met, a State must do a use attainability analysis. This analysis, and the accompanying proposal to downgrade a DU must go through the public notice and comment process required for any change in a WQS (and must be approved by EPA, like any WQS change).

WQS: Water Quality Criteria (WQC)

- Consistent scientifically with protecting all designated uses
- Basic types of criteria
  - Narrative, numeric
  - Water column, sediment, fish tissue
- Categories of criteria
  - Aquatic life
    - Pollutant-specific and aquatic community indices
  - Human health (drinking, fish consumption)
  - Wildlife (semiaquatic, food chain effects)

- ***Water quality criteria*** are the water quality conditions that are consistent with meeting a given DU. In making this determination, only scientific considerations can be taken into account.
- We will provide more details on narrative versus numeric criteria in a moment.
- Criteria can also be categorized by what portion of the aquatic system they apply to – the water itself (water column), bottom sediments, or the bodies of aquatic organisms.
- Human health criteria can apply to two exposure scenarios:
  - o Eating aquatic foodstuffs; and
  - o Eating aquatic foodstuffs plus using the water for drinking.
- Wildlife criteria, like human health and fish consumption criteria, deal with the effects of pollutants with high bioaccumulation factors. To date, the only example of an EPA-issued wildlife criterion is the mercury wildlife criterion for the Great Lakes, which is aimed at protecting mink, bald eagles and other creatures that feed high on the Great Lakes food chain.



- Listed are the so-called "four free-froms." They are found in most States' water quality standards regulations. One could call the first three the "no gross and disgusting" criteria. Clearly, it can be difficult to translate these rather subjective descriptions into quantitative measures.
- The last one—no toxics in toxic amounts—does lend itself to quantitative measurement. Later, we will discuss toxicity testing, which is one way to translate this narrative criterion into a quantitative measure.
- Balanced indigenous populations of aquatic life is a narrative goal that appears at certain places in the CWA, and this language has been utilized by some States.
- States usually apply these narrative criteria to all waterbodies, regardless of their use designation.

WQS: Numeric Criteria

- Parameter-specific: dissolved oxygen (DO), temperature, turbidity, N, P, Cu, dioxin
  - Level or concentration: 1 mg/L, 5 mg/kg
  - Duration
    - Acute: instantaneous, 1-hour, 1-day
    - Chronic: 4-day, 7-day, 30-day
  - Recurrence interval: 1 year, 3 years

- Water quality criteria contain three elements:
  - The level or concentration of the chemical or contaminant;
  - The period of time during which that water body exceeds the level; and
  - The frequency with which that level recurs.
- Another way of expressing this is to say that human health or aquatic life (whichever is applicable) should not be affected unacceptably if the one-hour average concentration does not exceed the established level more than once every three years on the average (acute criterion) and if the four-day average concentration does not exceed the established level more than once every three years on the average (chronic criterion).
  - The one hour average is the average of all samples taken during a one hour period by either continuous sampling or periodic grab samples.
  - The four day average is the average of all samples taken during four consecutive days by either continuous sampling or periodic grab samples (also known as a 96-hour average).
  - The acute criterion is a chemical concentration protective of human health or aquatic organisms from short term exposure to fast acting chemicals or spikes in concentrations; for example, exposure of a fish moving through an area for foraging but not residing in the area.
  - The chronic criterion is a chemical concentration protective of human health or aquatic organisms from longer term exposure to slower acting chemicals or relatively steady concentrations; for example, exposure of a fish that resides in an area.
- It is important to realize that a parameter-specific WQC does not consist merely of stated levels and concentrations. Simply because one sample has exceeded the concentration component of a WQC does not mean the WQC has been exceeded. This is only true in the case of instantaneous criteria, which are levels that are never to be exceeded. Sometimes called the "not to be exceeded" criteria. Otherwise, one must also consider the duration component of the criterion. Only if the average concentration over the specified time period (1 hour, one day, one week) exceeds the stated level is there an exceedence.
- The recurrence interval is most relevant to aquatic life criteria. Generally, scientists advising EPA have indicated that many kinds of aquatic ecosystems can endure being significantly impacted once every three years, and still remain healthy overall.

EPA Numeric Criteria

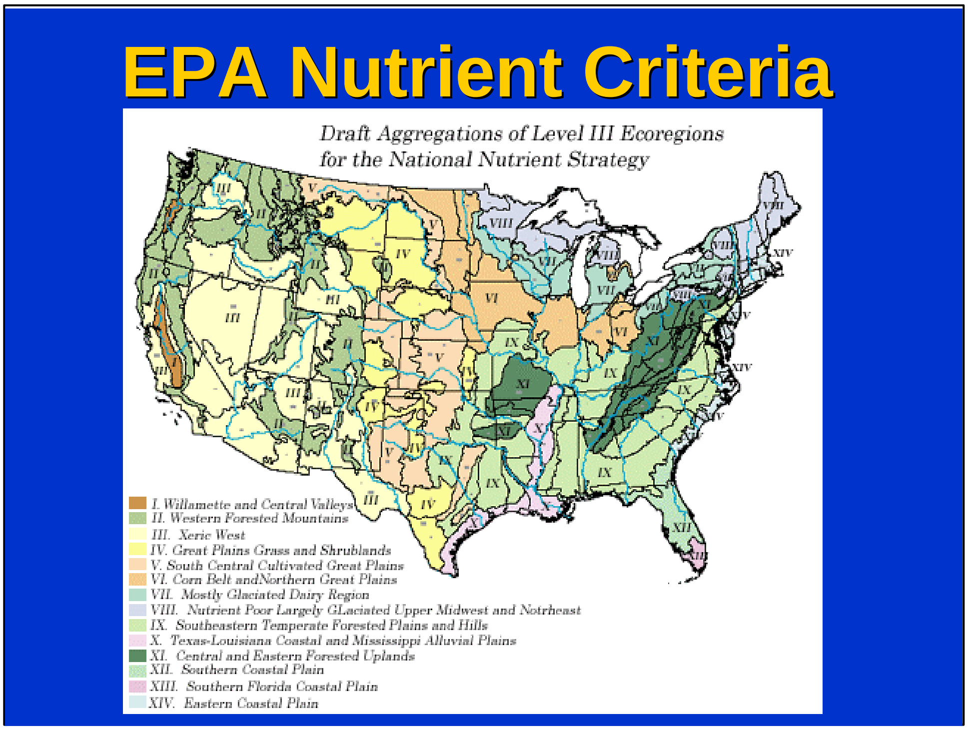
- Several for each pollutant
  - Acute, chronic; human health, aquatic life, wildlife; freshwater, marine
  - Criteria for nutrients (N, P) under development
- States and Tribes must have criteria if EPA does (for a particular use)
  - Can adjust EPA's numbers with scientifically defensible rationale

- EPA publishes WQC criteria for a variety of pollutants and parameters. For each pollutant, the Agency usually issues several different criteria, each addressing different combinations of target species, exposure pathways, exposure durations, and environmental conditions. Unfortunately, the Agency still has not been able to issue criteria for most pollutants, including several of the most common, including nitrogen, phosphorous, and clean sediments. EPA hopes to issue criteria for these three key parameters in the next couple of years. Criteria for nutrients are especially difficult because the effects of nitrogen and phosphorous as nutrients are very dependent upon site-specific factors.
- Once EPA has issued criteria for a pollutant, States must adopt numeric criteria when their WQS come up for their next triennial review. States need not employ the exact criteria that EPA has published. They can deviate from the EPA numbers, so long as they provide a credible scientific rationale.

Site-Specific Criteria: When?

- Species of aquatic life in a particular waterbody differ significantly from those used in setting EPA national criteria
- Physical and chemical characteristics of the site alter the bioavailability and/or toxicity of the pollutants
- EPA guidance on methods for developing site-specific WQC is available

- Although EPA publishes recommended aquatic life WQC that could be applied anywhere in the country,the Agency realizes that the effects of a pollutant can differ significantly from one water body to the next. Factors such as water body chemistry and differing mixes of resident species can be quite relevant.
- Therefore, EPA has published guidance on how site-specific aquatic life criteria can be derived (**http://www.epa.gov/waterscience/library/wqstandards/handbook.pdf**).
- Site-specific WQC are intended to come closer than the national criteria to providing the intended level of protection of aquatic life, in a particular water body.



- EPA's section 304(a) nutrient criteria recommendations are intended to protect against the adverse effects of cultural eutrophication. Cultural eutrophication (i.e., over-enrichment of nutrient levels associated with human activities) of United States surface waters is a long-standing problem. States and authorized tribes consistently identify excessive levels of nutrients as a major reason why as many as half of the surface waters surveyed in this country do not meet water quality objectives. The problem is national in scope, but specific levels of over-enrichment leading to these problems vary from one region of the country to another because of factors such as geographical variations in geology, vegetation, climate and soil types. For these reasons, EPA is developing its recommended nutrient water quality criteria on an ecoregional basis.
- ***Ecoregions*** are a system of classification that are based on similarities of natural geographic features and land use patterns. These features include geology, physiography, vegetation, climate, soils, wildlife, and hydrology. The relative importance of each characteristic varies from one ecoregion to another. Ecoregions can be defined at multiple scales. For example, there are 14 nutrient ecoregions and 84 level III ecoregions in the contiguous United States. Nutrient ecoregions are aggregations of level III ecoregions where the characteristics affecting nutrient levels are expected to be similar. The nutrient ecoregions can form the basis for initial development of nutrient criteria.
- EPA develops nutrient criteria for four types of ecosystems: lakes and reservoirs; rivers and streams; wetlands; and estuarine and coastal waters.
- For more information on nutrient WQC, see **http://www.epa/gov/ost/standards/nutrient.html**.

WQC: Examples

WQC	Designated Use: Freshwater AL	Designated Use: Marine AL
Copper (acute)	13 μg/L	3 μg/L
Cadmium (acute)	4.3 μg/L	42 μg/L
Cadmium (chronic)	2.2 μg/L	9.3 μg/L

- It is not important to remember the specific numbers in the chart! It's the patterns and relationships among them that is important.
- One basic "take home message" is that one often cannot predict whether a particular pollutant will be more harmful in one type of environment versus another. Here, we see that copper is more toxic in ***marine aquatic life*** (AL) environments, whereas cadmium is more toxic in ***fresh water AL*** systems.
- Also note that the acceptable chronic levels of a pollutant (4-day average concentration) are always lower than the acute levels (1-hour average concentration). Cadmium is used to illustrate this point.

Cadmium Freshwater Criteria

Criteria Equation = $e^{(1.128\ (\ln \text{Hardness})\ -\ 3.828)}$

Hardness (mg/L)	Equation	Criteria Value (µg/L)
50	$e^{(1.128\ (\ln 50)\ -\ 3.828)}$	1.8
100	$e^{(1.128\ (\ln 100)\ -\ 3.828)}$	3.9
200	$e^{(1.128\ (\ln 200)\ -\ 3.828}$	8.6

- Site-specific factors, like hardness, affect the toxicity of most heavy metals.
- EPA's WQC for metals are expressed as equations, rather than specific concentrations. The applicable concentration for a particular waterbody can be derived by inserting the hardness (concentration of $CaCO_3$) for that water into the EPA equation.
- As hardness increases, toxic effects of metals decrease. This is the result of increased binding of metal ions as the concentration of carbonate ion goes up.

Ammonia Criteria: Chronic

Temperature (pH = 7.5)	Designated Use Aquatic life Support
5 °C	7 mg/L
15 °C	4 mg/L
25 °C	2 mg/L

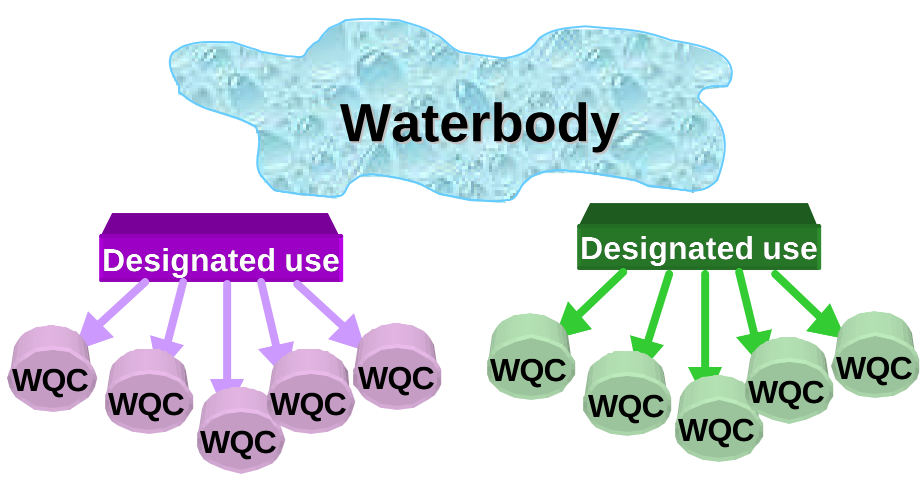
Note: varies with pH, too!

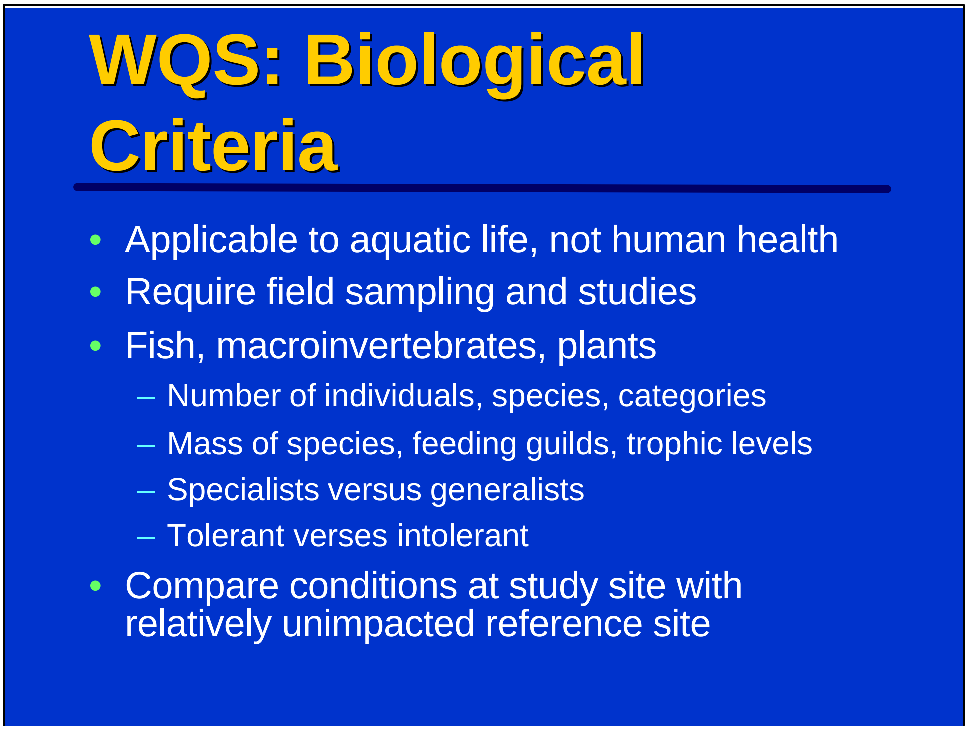
- This slide shows how the impact of a pollutant on aquatic life can vary considerably, depending on conditions in the waterbody, which in this case is temperature.
- Also, as noted in the footnote, matters are further complicated by the fact that impacts of this pollutant also vary independently with pH.

WQC: Warm Water Aquatic Life

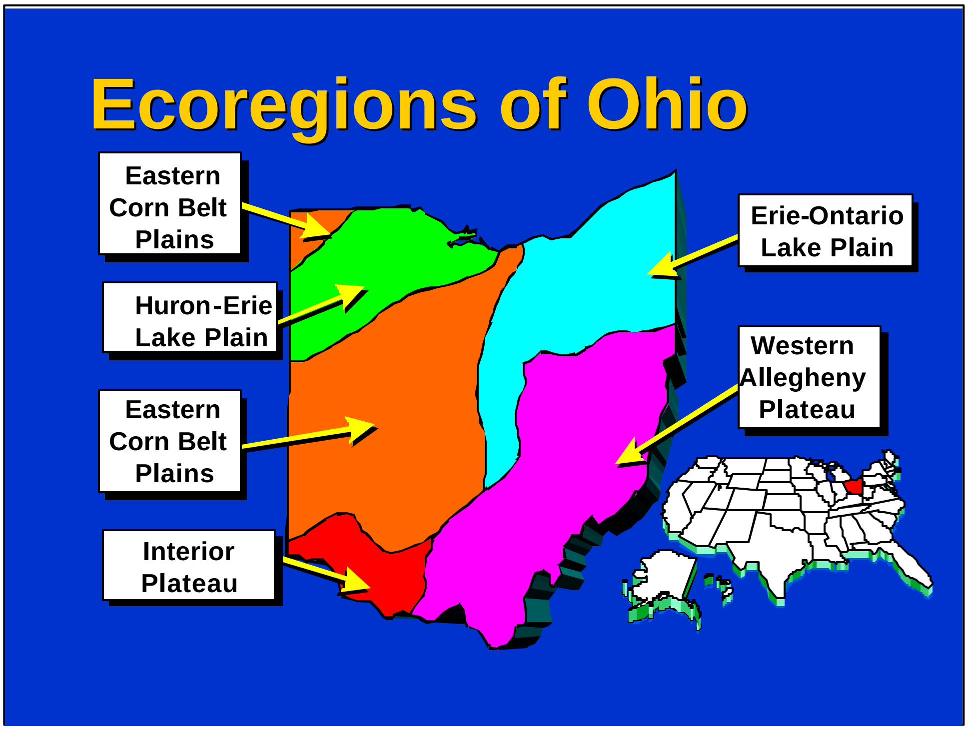
Parameter	Value	Units
Dissolved Oxygen	>4.0	mg/L
pH	6-9	standard units
Un-ionized Ammonia-N	0.05	mg/L
Fecal Coliforms	400	colonies/100ml
Temperature	30	degrees Celsius

- Above are examples of water quality criteria for one designated use: warm water aquatic life.
- Each waterbody will have a series of designated uses, and each designated use will have many water quality criteria. For each parameter, look for the most stringent WQC to determine the appropriate concentration.

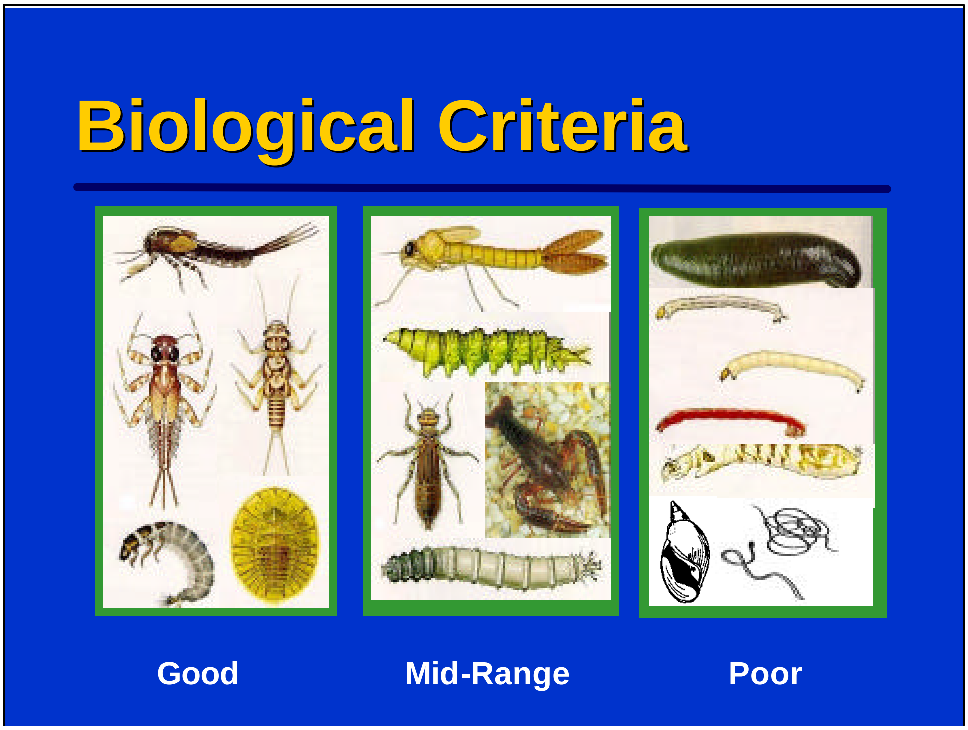




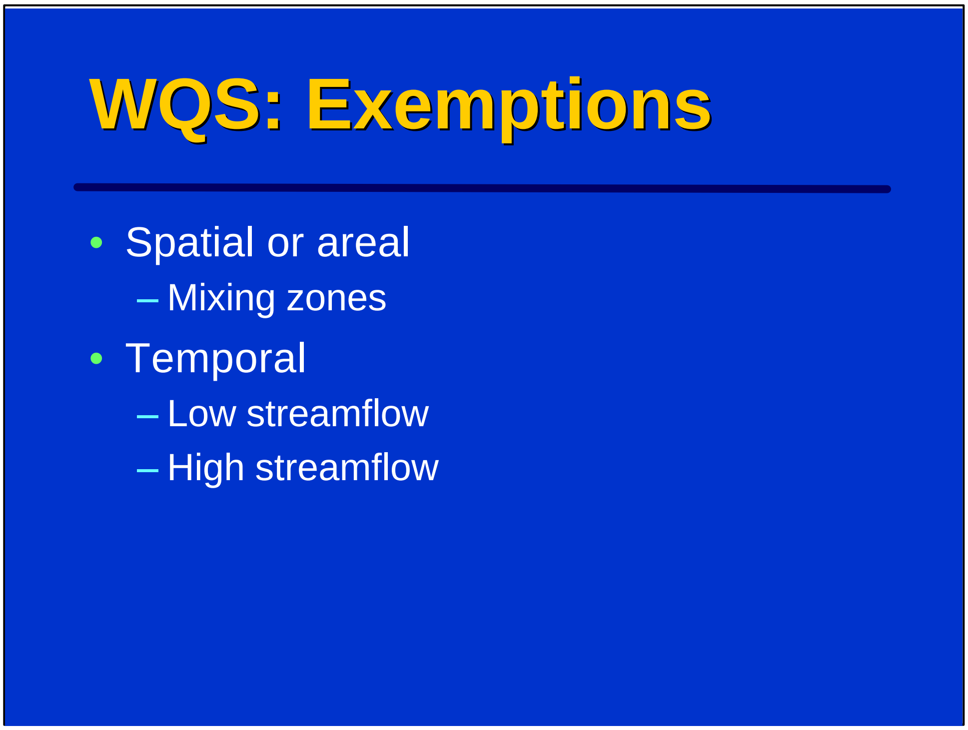
- Biological criteria apply only to aquatic life designated uses. The use of biological or ecological assessments require spending considerable time in the field collecting organisms and other data. Various techniques focus on different kinds of organisms, such as fish, large invertebrates, and/or plants. Once the target types of organisms have been collected, they are sorted into easily-identified groups, usually to the family level, rather than genus or species. These are then quantified according to a variety of measures, in metrics, each of which is used to indicate certain aspects of ecosystem health.
- Definitions:
  - ***Feeding guilds***—animals are grouped according to the feeding strategies they employ, whether they remain stationary and filter food out of water that passes over specialized body parts that serve as nets or sieves, dig in the bottom sediments, or chase after other animals.
  - ***Trophic levels***—in the simplistic concept of a food chain, organisms are put at different levels, starting with the lowest, which are primary producers or plants, moving up to herbivores or plant eating animals, primary carnivores or herbivore eating animals, secondary carnivores or primary carnivore eating animal, and so forth.
  - ***Generalists***—species with very wide habitat requirements and a broad range of survival strategies.
  - ***Specialists***—species with very narrow, specific habitat needs and unique survival strategies.
- As an example of how these metrics may be used as indicators of the health and integrity of an aquatic ecosystem, a waterbody that has mostly generalists is usually less healthy than one that has a substantial number of specialists. Likewise, a waterbody dominated by species that can tolerate very polluted conditions is generally less healthy than one dominated by pollution intolerant species.



- In order to compare apples to apples, you have to divide a geographic area into different ecoregions, find unimpacted waterbodies for measurement, and use them as the models.
- EPA has published guidance and provides grants to States to help them develop the capacity to do the studies and adopt WQC for their programs.



- There are increasing numbers of volunteer stream monitors who do “bug counts.” With little training, these volunteers can distinguish among types of organisms.



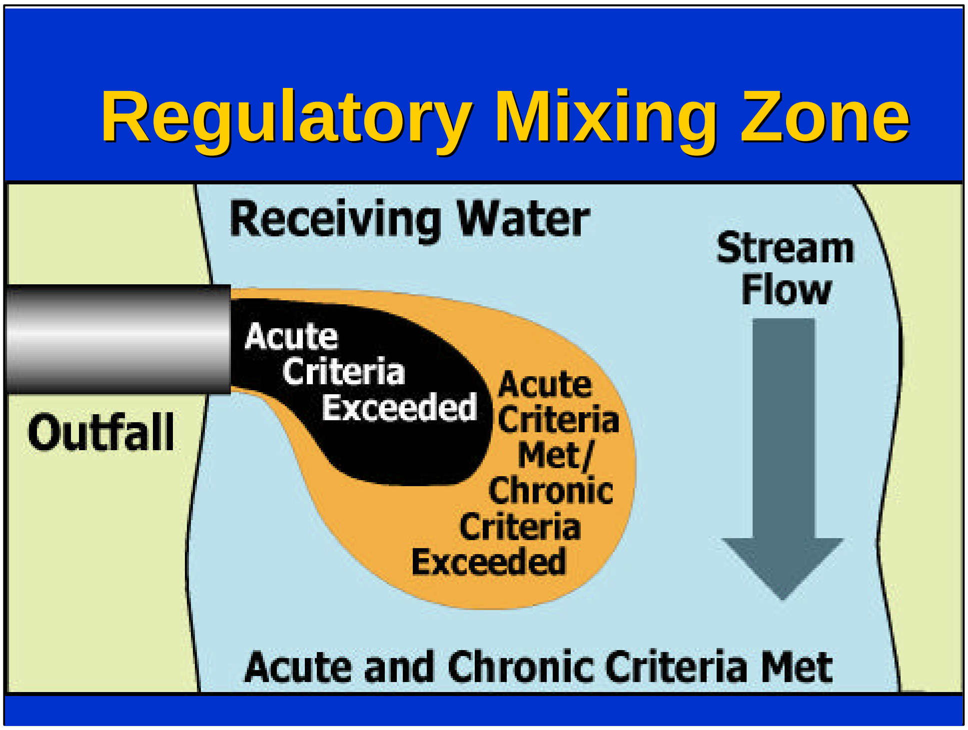
- Exemptions are established mostly through NPDES permits, rather than standards.

WQS Exemptions: Spatial

- Mixing zones
  - Limited portions of a waterbody where WQS are waived
  - Applies in outfall areas of some point sources
  - Chronic criteria waived, usually not acute
  - Size varies from site to site, but zone of passage for organisms usually required
  - Often prohibited in critical habitat areas

What do you know about limits on mixing zone size that have been used by States? What are critical areas where one might prohibit mixing zones?

- Limits on size may be expressed as an absolute limit on downstream length, such as 200 yards, or as a ratio of the stream, such as four times stream width. Mixing zone width is usually expressed as a percent of stream width, and usually provides for a "zone of passage," through which organisms can pass safely.

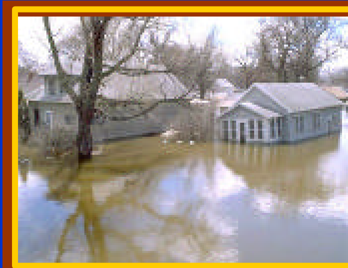


- This slide illustrates how a mixing zone for a particular point discharge might look.
- Note the smallest oval, in which both acute and chronic criteria can be exceeded, is called the Zone of Initial Dilution (ZID). Generally, these are areas where physical conditions make it hard for aquatic organisms to remain for more than a few moments. For example, this might be an area where rapid flow of effluent first enters the waterbody, or a highly bubbly area right around an air diffuser.
- ZIDs are sometimes controversial, as some question whether organisms that remain in them too long will be harmed.
- The large oval represents the main body of the mixing zone. In this area, water quality criteria are to be met, but criteria for long term exposure can be exceeded.
- Outside the discharge mixing zone, both acute and chronic criteria are to be met.
- Under no circumstances should a mixing zone extend from one side of a stream to another. A ***zone of passage*** for drifting and swimming life forms must be provided.

WQS Exemptions: Temporal

Design flows

- Allow WQS to be exceeded during rare events
- Extreme low flows: 7Q10, 1Q3
  - Usually applied to continuous dischargers, e.g.,municipal sewage plants, industrial facilities
- Exceptional high flows
  - Most relevant to storm-dependent discharges, e.g., municipal storm water

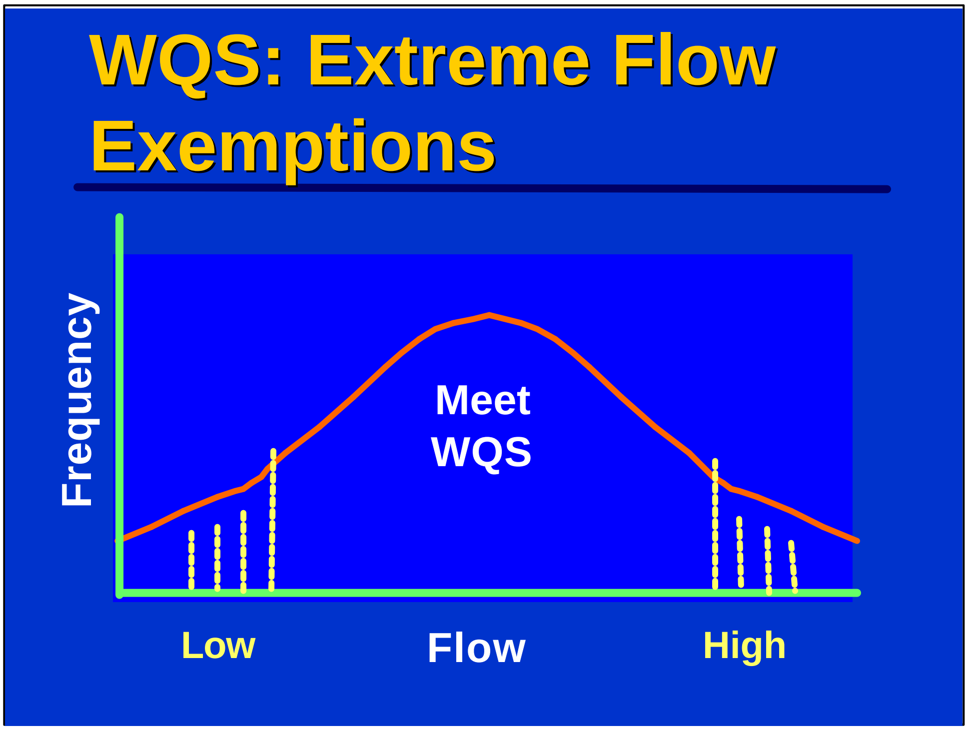


Are you aware of any temporal exemptions in your area?

- Critical flows are also used at times, rather than design flows, but the latter is probably less confusing. "Critical" may imply "critical biological conditions," but that is incorrect. These are unusually high and low flows, occurring only once every several years, during which time WQC are allowed to be exceeded. These exemptions are essentially economic variances, aimed at avoiding the need to spend extremely large amounts of public or private money to ensure that the criteria will be met absolutely 100 percent of the time.
- To illustrate this idea, when designing and building a flood control project, the Army Corps does not design the dam or other structure to protect life and property against the million-year storm, 100,000 year storm, or even the 1,000 year event. Usually they design for a storm event likely to occur once every 100 years to 200 years.
- Extreme low flow exemptions are most often applied to setting WQ-based effluent limits on continuous point source discharges. Extreme high flow exemptions are most often applied to storm-related discharges, such as combined sewer overflows (CSOs).

Extreme low flow: 1st number = duration; 2nd number = return interval

7Q10 = lowest 7-day average flow likely to occur in ten years (rolling ten-year period)
1Q3 = lowest one-day average flow likely to occur in three years (rolling three-years)



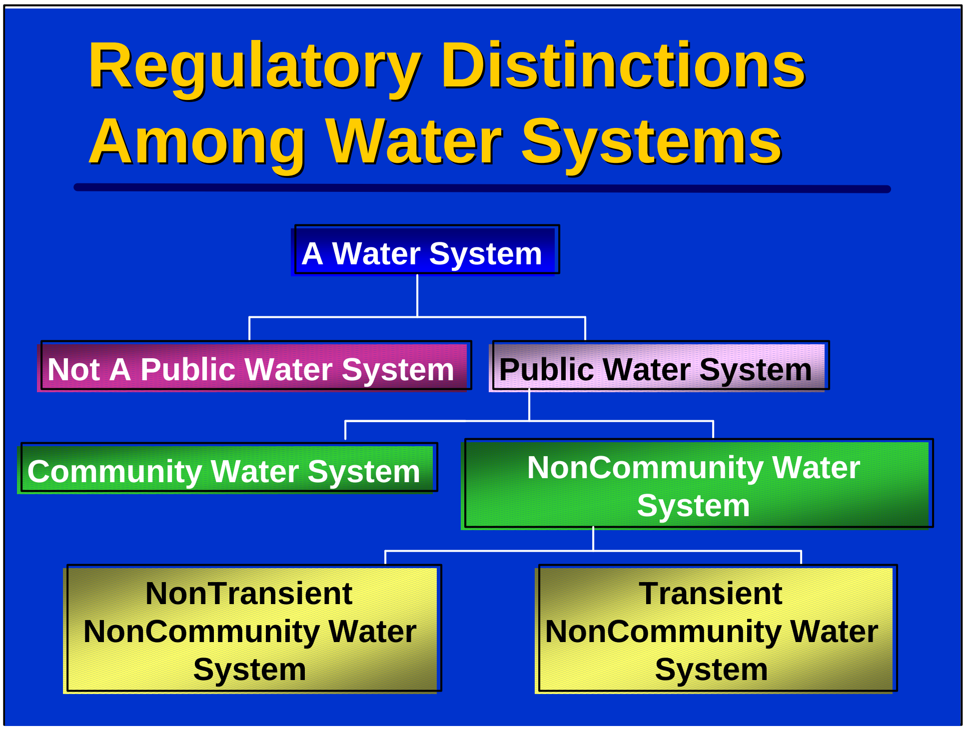
• Only in very unusual circumstances (for example, significant floods or droughts) are conditions in a waterbody knowingly allowed to be worse than those needed to provide relatively high levels of protection to humans and aquatic life. In the vast majority of streamflow conditions, CWA regulatory programs are designed so that WQS should be met.


The Safe Drinking
Water Act
Set Standards

What is a Water System?

- Provides water for domestic use, fire prevention, industrial use, irrigation
- Many variations of water systems:
  - May be regulated or unregulated by Federal or State governments
  - May be very simple or very complicated
  - May use a ground water source or a surface water source or a combination
  - May be small or large

- We talked earlier about type types of facilities covered by SDWA. This is important, so before we go any further, we'll review what a water system is and what types of water systems are covered under SDWA.
- ***Water systems deliver water*** to you. People use the water delivered from their water system for various uses.
  - o Home or ***domestic uses*** include drinking, cooking, washing, and flushing toilets;
  - o Industries use water for ***industrial purposes*** such as cooling equipment and rinsing; and
  - o Cities use water for ***fire protection***.
- In sum, there are many uses for the water delivered to you by a water system.
- Water systems are highly variable. They ***may be regulated or unregulated*** by Federal and State governments; they may be ***very simple or very complicated*** in construction and operation; they may use a ***ground water source, a surface water source, or a combination***; and they may be ***small or large***, ranging from one that serves a small trailer park to one that serves a major metropolitan area.



- A ***public water system (PWS)*** is defined by the ***Safe Drinking Water Act (SDWA)*** as "a system for the provision to the public of water for human consumption through pipes or other constructed conveyances, if such system has at least fifteen service connections, or regularly serves at least twenty-five individuals." [Section 1401(4)(a)]. Thus, individuals on wells and systems that serve fewer connections or people are not captured under Federal regulations, though some States regulate smaller systems. Federally regulated systems are called "public water systems" because they serve water to the public, not because they are publicly-owned. A public water system may be publicly owned (e.g., owned by a municipality) or privately owned (e.g., owned by an investor-owned utility or by the owner of a mobile home court).
- SDWA further divides public water systems into ***community water systems (CWSs)*** and ***non-community water systems (NCWSs)***.
  - o CWSs include public water systems that serve 25 people or 15 connections year-round. Examples of CWSs include municipal water systems or water systems that serve a mobile home park or other groups of residents.
  - o NCWSs are PWSs that do not serve a permanent resident population. This latter category is further defined, and includes two water system types.
    - – The first, ***non-transient, non-community (NTNCWSs)*** includes systems serving at least 25 people (the same people) at least six months of the year, such as some churches, schools, and factories.
    - – The second, ***transient non-community (TNCWSs)***, includes facilities such as roadside stops, commercial campgrounds, hotels, and restaurants that have their own water supplies and serve a transient population at least 60 days per year.
  - o Each of these types of PWSs can be publicly or privately owned.

Is This a PWS?

- Read each of the following descriptions and determine whether the system meets the definition of a public water system.
- If it does, is it a community water system or non-community water system?
- If it is a non-community water system, is it a:
  - Transient non-community water system?
  - Non-transient non-community water system?

Is This a PWS?

PWS
CWS
TNCWS
NTNCWS

Mountain View RV Park serves 150 RV slots. It includes a bath house, laundry and convenience store. It operates for only 4 months out of the year. It also maintains a dormitory for 26 employees.

This system is a PWS because it regularly serves at least 25 people. The system is not a CWS because is does not serve its customers year round. It is a TNCWS, because it serves at least 60 days, but not 6 months. If the facility operated for at least 6 months, then the 26 employees living in the dormitory would result in classification as a NTNCWS.

Is This a PWS?

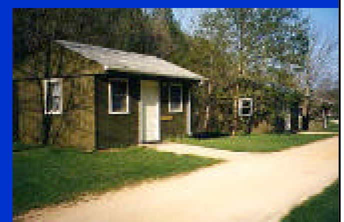
PWS
CWS
TNCWS
NTNCWS

The Seaforth is a bar and restaurant. The building has a maximum occupancy of 80 people and is open all year. Three employees live in apartments above the serving area. Twenty campsites without water, sewer or electricity are located outside the establishment.

This system is a PWS classified as a TNCWS, because it does not serve 25 of the same people for at least 6 months of the year.

Is This a PWS?

PWS
CWS
TNCWS
NTNCWS



Healing Waters operates a religious camp for the 4 summer months and is a residential religious school during 7 months of each year. There are 14 connections. The camp is closed during December each year for maintenance. The summer camp serves 70 campers for 7, 2-week sessions and the religious school provides classroom education for 45 residential students.

This system is a PWS classified as a NTNCWS, because the residential students are there more than 6 months. With only 12 employees, they do not qualify as a CWS.

Is This a PWS?

PWS
CWS
TNCWS
NTNCWS

Cherrywood is a wood products factory that employs 165 people. The facility works three, 8-hour shifts each day of the year. The plant manager and assistant manager are provided homes connected to the water system. The plant uses water for industrial water supply, a kitchen, bathroom, showers, and fire suppression purposes, in addition to domestic supply for all of the buildings.

This system is a PWS classified as a NTNCWS, because there are more than 25 people regularly served at least 6 months of the year. It is not a CWS because the 2 homes serving year-round residents don't serve 25 people.

Is This a PWS?

PWS
CWS
TNCWS
NTNCWS

Bethesda Gardens is a retirement home that serves 110 residents. The business employs 60 people.

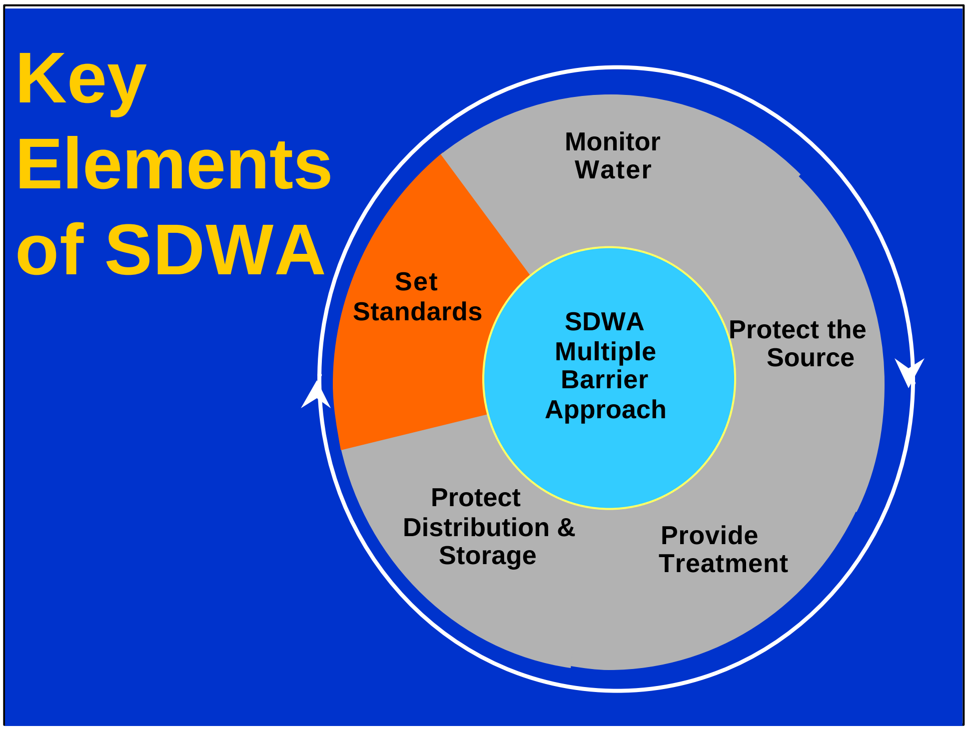
This system is a PWS. It is also a CWS because it serves at least 25 year-round residents.

Is This a PWS?

PWS
CWS
TNCWS
NTNCWS

The Walnut Creek Apartments are a fourplex. The units are 2-bedroom apartments. The typical census is 7 to 10 residents.

This system is not a PWS because it does not have 15 connections, nor does it serve at least 25 people, 60 days out of the year.



- One of the barriers that ensures safe drinking water is enforceable standards for drinking water contaminants.
- Many of these standards apply at the point where drinking water enters into the distribution system that carries water to consumers. Others apply at the entry point to the treatment system, and a very few apply either in the treatment system or at points within the distribution system.

Drinking Water Regulations

- National Primary Drinking Water Regulation
  - Legally enforceable standard
  - Limits levels of specific contaminants that can adversely affect public health
  - Maximum Contaminant Level or Treatment Technique
- National Secondary Drinking Water Regulation
  - Nonenforceable guideline
  - Covers contaminants that may cause cosmetic or aesthetic effects

- There are two categories of drinking water regulations:
  - ***National Primary Drinking Water Regulations*** (NPDWRs or primary standards) are legally enforceable standards that apply to public water systems. Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in water. They take the form of Maximum Contaminant Levels (MCLs) or Treatment Techniques (TTs).
    - These standards must be met at the discharge point from the distribution system or, in some cases, at various points throughout the distribution system.
  - ***National Secondary Drinking Water Regulations*** (NSDWRs or secondary standards) are nonenforceable guidelines regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or have aesthetic effects (such as affecting the taste, odor, or color of drinking water). EPA recommends secondary standards to water systems but does not require systems to comply. However, States may choose to adopt them as enforceable standards. NSDWRs are intended to protect "public welfare."
- This section of the course addresses NPDWRs.

Drinking Water Regulations: Key Terminology

- Maximum Contaminant Level Goal (MCLG)
  - § 1412(b)(4)(A): "…level at which no known or anticipated adverse effects…occur and which allows for an adequate margin of safety."
  - Not enforceable

- Once EPA has selected a contaminant for regulation, it examines the contaminant's health effects and sets a ***maximum contaminant level goal*** (MCLG). This is the maximum level of a contaminant in drinking water at which no known or anticipated adverse health effects would occur, and which allows an adequate margin of safety. MCLGs do not take cost and technologies into consideration.
- MCLGs are nonenforceable public health goals. In setting the MCLG, EPA examines the size and nature of the population exposed to the contaminant, and the length of time and concentration of the exposure.
- Since MCLGs consider only public health and not the limits of detection and treatment technology, they are sometimes set at a level that water systems cannot meet. For most carcinogens (contaminants that cause cancer) and microbiological contaminants, MCLGs are set at zero because a safe level often cannot be determined.

- EPA also establishes maximum contaminant levels (MCLs), which are enforceable limits that finished drinking water must meet. MCLs are set as close to the MCLG as feasible. SDWA defines "feasible" as the level that may be achieved with the use of the best available technology (BAT), treatment technique, or other means specified by EPA, after examination for efficacy under field conditions (that is, not solely under laboratory conditions) and taking cost into consideration.
- For some contaminants, especially microbiological contaminants, there is no reliable method that is economically and technically feasible to measure a contaminant at particularly low concentrations. In these cases, EPA establishes treatment techniques.
- A treatment technique is an enforceable procedure or level of technological performance that public water systems must follow to ensure control of a contaminant. Examples of rules with treatment techniques are the surface water treatment rule and the lead and copper rule.
- To support a rulemaking, EPA staff must perform a series of analyses:
  - Evaluate occurrence of the contaminant (number of systems affected by a specific contaminant and concentrations of the contaminant);
  - Evaluate the number of people exposed and the ingested dose; and
  - Characterize choices for water systems to meet regulatory standards (treatment technologies).
- In developing an MCL or treatment technique, EPA assesses multiple possible MCL or treatment technique alternatives in terms of costs (for example, the cost of installing new treatment equipment).
- EPA also assesses benefits resulting from the various regulatory alternatives. Some of the benefits can be quantified (for example, cost of illness avoided), but some are unquantifiable (for example, cost savings associated with the removal of other contaminants, gaining economies of scale by merging with other water systems).

Considerations for MCLs and TTs

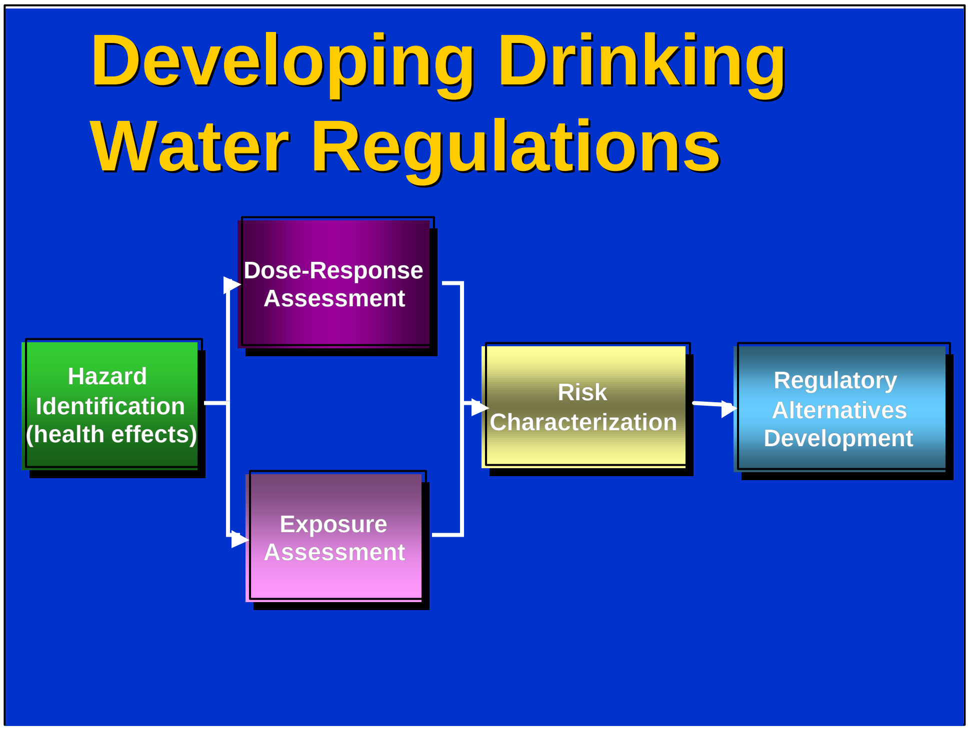
- Basis for setting MCLs and TTs
  - Acute or chronic exposures
  - Occurrence in drinking water systems
    - Number of water systems with contaminant
    - Concentration levels in those systems
- Basis for determining violations of MCLs or TTs could be:
  - One-time exceedance
  - Failure to follow procedures required for exceedance
  - Average exceedance over a specified period of time

- When thinking about how MCLs and TTs are established, it is important to keep in mind what we discussed earlier about how acute and chronic health effects are addressed under SDWA. EPA determines whether adverse health effects from a given contaminant are generally from acute or chronic exposures based on information about the occurrence of the contaminant in drinking water. MCLs are then set to protect humans from those exposures.
- There must be evidence of the presence of a contaminant at acute levels in order to set a standard at such a level. In addition, in meeting the levels for chronic concerns, drinking water would automatically be treated to a level that would prevent acute effects. Thus, unlike the WQC, duration of exposure is implicit in the MCL or TT and is not expressed as an explicit factor.
- It is also important to note that a one-time exceedance of an MCL is not necessarily considered a violation of the MCL. Some MCLs distinguish between an exceedance and a violation and others provide a method for calculating, over a period of time, whether a water system is in violation. We will discuss this in more detail in the monitoring section of the course.

Drinking Water Regulations: Key Terminology

- Maximum residual disinfectant level (MRDL)
  - Analogous to an MCL
  - Sets enforceable limits on residual disinfectants in the distribution system
- Maximum residual disinfectant level goal (MRDLG)
  - Analogous to an MCLG

- A ***maximum residual disinfectant level (MRDL)*** is similar in concept to an MCL. It sets enforceable limits on the levels of residual disinfectants in the distribution system. This term was not specifically defined in the 1996 SDWA Amendments, but has come into use as an indicator of the level of disinfection applied.
- EPA sets a nonenforceable ***maximum residual disinfectant level goal (MRDLG)*** for residual disinfectants. This is analogous to setting an MCLG.



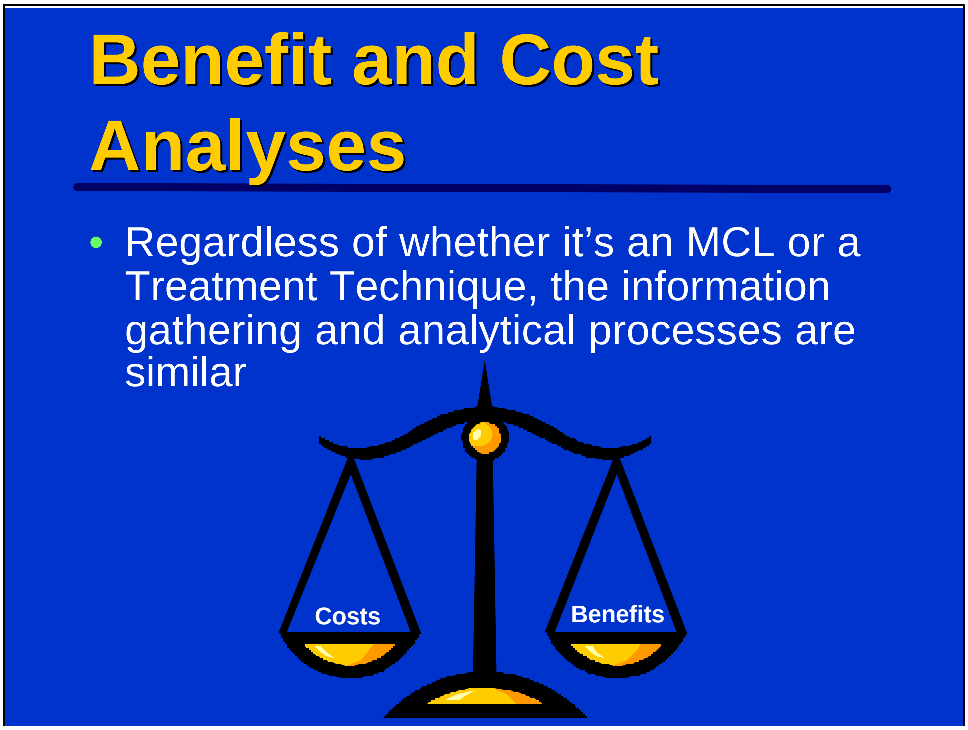
- This slide provides a graphical overview of EPA's risk-based rulemaking process.
- ***Hazard Identification*** - Determine if a contaminant is causally linked to particular health effects (e.g., cancer or birth defects), usually using data from other animals or test organisms.
- ***Dose-Response Assessment*** - Characterize the relationship between the dose of a contaminant and incidence of an adverse health effect. There can be many different relationships depending on varying responses (cancer, acute illness).
- ***Exposure Assessment*** - Determine the size and nature of the population exposed to the contaminant, and the length of time and concentration of the contaminant (need to consider age and health of the exposed population, and other factors).
- ***Risk Characterization*** – Integrate the first three components, resulting in an estimate of the magnitude of the public health problem.
- ***Regulatory Alternative Development*** – Formulate options to achieve compliance by evaluating multiple MCLs or TTs, comparing costs and benefits, and developing the regulatory structure.

Drinking Water Regulations: Key Steps

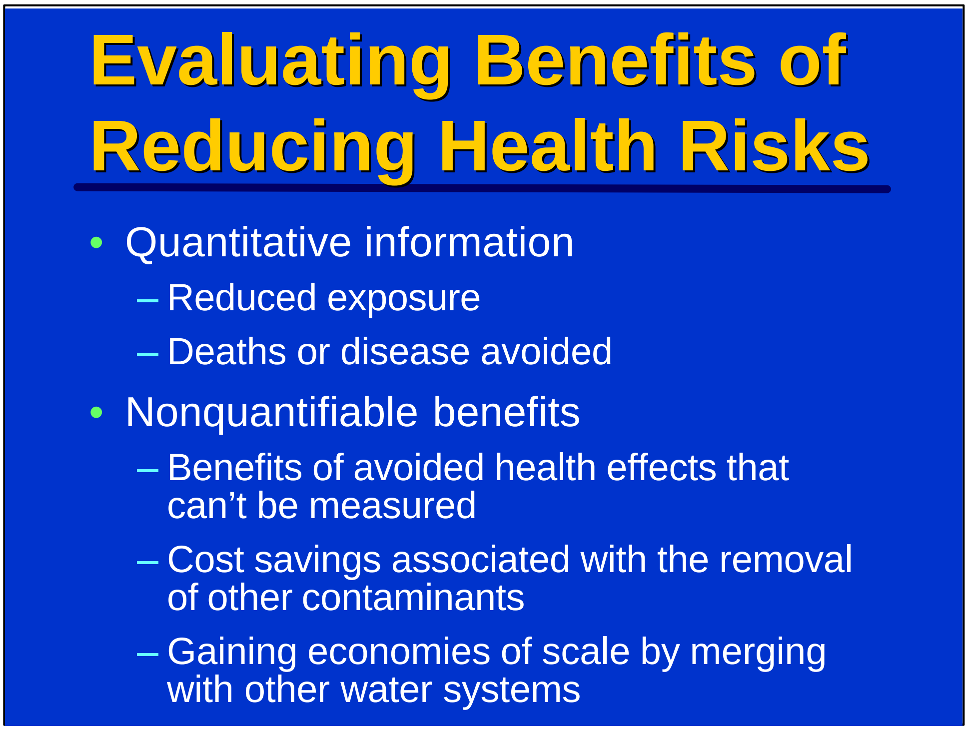
- Setting the MCLG
  - Health effects information
  - Exposure information
  - Relevant information and procedures developed by EPA for risk assessment and characterization

- In concept, the MCLG precedes the MCL, though both are usually proposed and finalized at the same time.
- In developing the MCLG, EPA:
  - o Evaluates the health effects of the contaminant (i.e., hazardous identification and dose-response assessment); and
  - o Examines the size and nature of the population exposed to the contaminant, and the length of time and concentration of the exposure.
- A key assumption for noncarcinogens is there is an exposure threshold; that is, a level below which exposures would be expected to show no increase in adverse health effects.
- In evaluating threshold noncarcinogens, EPA assumes a drinking water intake of two liters per day and a body weight of 70 kilograms (≅ 154 pounds).
- Ambient water quality criteria (WQC) were derived to calculate the impact of waterborne pollutants on aquatic organisms and on human health. EPA uses a "subtraction" approach to account for non-water sources of exposure.
- The drinking water program commonly uses a "percentage" method in deriving MCLGs. That is, the percentage of total exposure accounted for by drinking water is applied to the RfD to determine the maximum amount of the RfD "allocated" to drinking water. A ceiling level of 80 percent of the RfD and a floor level of 20 percent of the RfD are used as upper and lower bounds. In other words, the MCLG cannot account for more than 80 percent of the RfD, nor less than 20 percent of the RfD.

- These are the steps from the MCLG to the MCL. Depending on the risk characteristics, EPA:
  - o Assesses the appropriateness of setting a MCL or TT standard;
  - o Identifies and evaluates the costs and effectiveness of treatment technologies; and
  - o Specifies Best Available Technology (BAT) to ensure that systems can, in most cases, treat to meet the standard. Note that water systems do not have to use the technology specified in BAT.



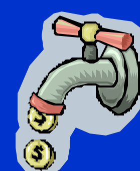
- The 1996 SDWA Amendments added section 1412(b)(6), Additional Health Risk Reduction and Cost Considerations, which states, ". . . if the Administrator determines. . . that the ***benefits*** of a maximum contaminant level . . . ***would not justify the costs*** of complying with the level, the Administrator may, after notice and opportunity for public comment, promulgate a maximum contaminant level that ***maximizes health risk reduction benefits at a cost that is justified by the benefits***."
- This was a significant change from the previous language as it allows the cost of compliance to be an explicit consideration is setting MCLs. EPA used this rationale when promulgating the arsenic rule (January 22, 2001, 66 FR 6975-7066).
- EPA set the standard at a level that "maximizes health risk reduction benefits at a cost that is justified by the benefits." In other words, although technology would allow lower levels of arsenic to be reached, EPA determined that the potential health benefits did not justify the added cost.
- Prior to the 1996 Amendments, benefit-cost analysis did not enter into rule development explicitly, although it was still done to help inform the decision.



- ***Benefits estimation*** uses ***occurrence*** and ***exposure*** information to determine how many people currently exposed above some critical threshold would have their exposure reduced below it as a result of the rule.
- Where dose-response information is available, estimates are made of the number of cases of disease or death avoided. These ***estimates are monetized***.
- SDWA section 1412(3)(C)(1) requires EPA to ***consider benefits that can't be quantified***.
- EPA assesses benefits resulting from the various regulatory alternatives. Some of the benefits are nonquantifiable, for example:
  - o Cost savings associated with the removal of other contaminants; or
  - o Gaining economies of scale by merging with other water systems.

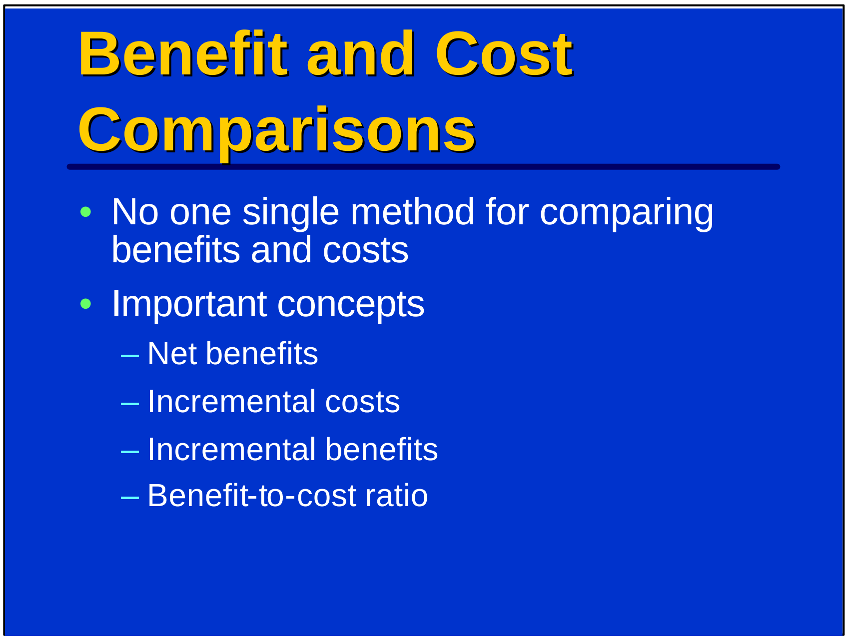
Costs

- Costs of drinking water rules
  - Capital costs for installing treatment
  - O & M costs for operating the treatment
  - Monitoring costs
  - Administrative costs to systems, States and EPA



- In developing the costs of a drinking water rule, EPA must consider:
  - ***Capital costs*** for installing treatment equipment, and other costs such as acquiring land and construction of new buildings. Capital costs are based on the design flow of a water system (that is, the capacity of the system in producing potable water).
  - ***Operational and maintenance*** (O&M) costs are for the ongoing operation and maintenance of the treatment system. O&M costs are based on the average daily flow rate to more closely capture the day-to-day operation of the water system.
  - ***Monitoring costs*** of the specific contaminant according to a specified schedule and analytical method.
  - ***Recordkeeping and reporting costs to the systems*** for reading the rule, understanding the monitoring procedure, submitting monitoring results to States or EPA, maintaining records, and responding to inquiries.
  - ***Recordkeeping and reporting costs to the States*** to review monitoring results from system, maintain records, submit summaries to EPA, and respond to inquiries.
  - ***Costs to EPA*** to review summaries from States, maintain records, and respond to inquiries.

- Contaminant occurrence information is combined with treatment cost information to build up the ***national cost estimates***.
- Occurrence assessment -- how many systems are affected?
- Generally, occurrence is described as national probability distributions, usually lognormal. (Note: The lognormal distribution is commonly used to model environmental data. A random variable is lognormally distributed if the logarithm of the random variable is normally distributed, that is, the distribution forms a normal bell curve.)
- The integration of the occurrence data and the treatment costs through the decision tree or matrix produces the national cost estimates for each of the regulatory alternatives:
    - o Annual national costs;
    - o System level costs; and
    - o Household costs (costs passed down from the system to individual households served by the system, generally as a part of the water bill).



- To ***compare costs and benefits***, EPA may use a number of methods:
  - ***Net benefits*** – benefits minus costs for specific alternatives;
  - ***Incremental costs*** – increase of costs between two end points (for example, from no action to a MCL alternative, or from a MCL alternative to another MCL alternative);
  - ***Incremental benefits*** – increase of benefits between two end points (for example, from no action to a MCL alternative, or from a MCL alternative to another MCL alternative); or
  - Also, ***benefits-to-cost ratio*** (if over 1, benefits are greater than costs).
- As an example, below is a brief summary of EPA's analysis in setting the arsenic MCL.

Summary of National Annual Net Benefits and Benefit-Cost Ratios,

Combined Bladder and Lung Cancer Cases, ($ millions)

Arsenic Level (µg/L)		**3**	**5**	**10**	**20**
Lower Bound	**Net Benefits**	($484.0)-($578.3)	($223.7) - ($280.6)	($40.8) - ($66.0)	($0.6) -($10.3)
	B/C Ratio	0.3	0.5 - 0.4	0.8 - 0.7	1.0 - 0.9
Upper Bound	**Net Benefits**	($206.8) - ($301.1)	($59.2) - ($116.1)	$17.3 - $0.7	$8.5 - $0.9
	B/C Ratio	0.7 - 0.6	0.9 - 0.8	1.1 - 1.0	1.1 - 1.0

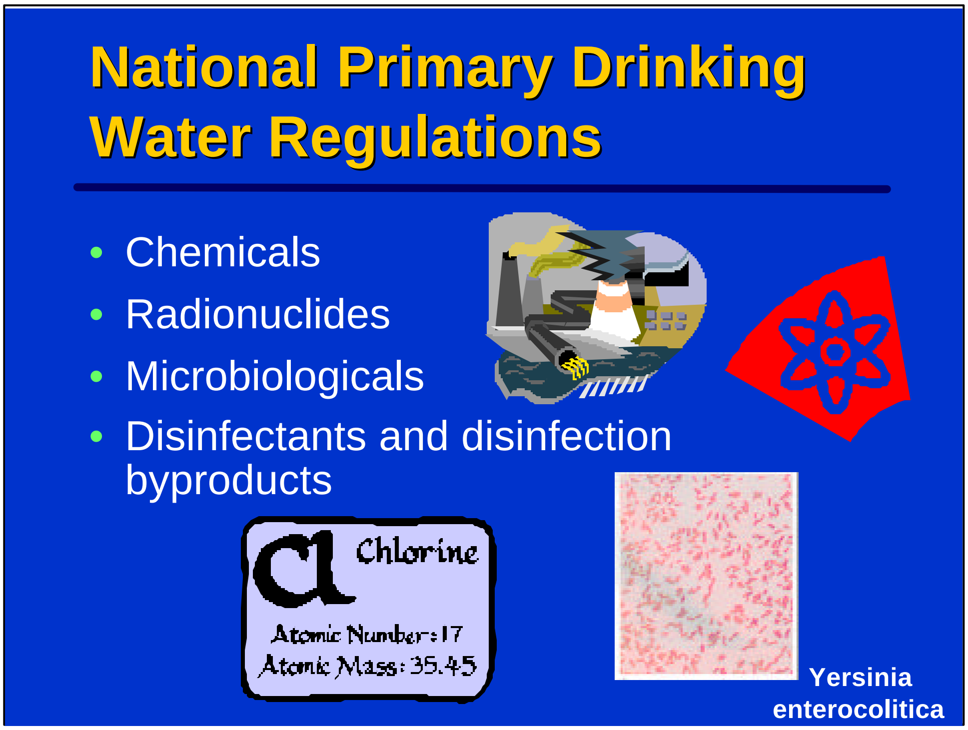
The table above shows the quantifiable net benefits and the benefit-cost ratios under various regulatory levels at three percent and seven percent discount rates. As shown under both the lower- and upper-bound estimates of avoided lung and bladder cancer cases, the net benefits decrease as the arsenic rule MCL options become increasingly more stringent. Similarly, the benefit-cost ratios decrease with each more stringent MCL option. Costs, however, outweigh the quantified benefits for the lower-bound benefits estimates under all four MCL options. Benefit-cost ratios are equal to or greater than 1.0 for the upper-bound benefits for arsenic levels of 10 µg/L and 20 µg/L. Progressively more stringent regulatory options become considerably more expensive, from a cost standpoint, than the corresponding increases in benefits, as reflected in decreasing net benefits. The MCL must be set as close as feasible to the MCLG, unless EPA invokes its authority to set an alternative MCL that maximizes health risk reduction benefits at a cost that is justified by the benefits.
The MCLG for arsenic is zero and the feasible level is 3 µg/L. EPA determined that the feasible level has the highest projected national costs, relative to other MCL options, while both the net benefits and the benefit-cost disparity at the feasible level are the least favorable of the regulatory options considered. Based on all the factors considered above, EPA believed that the monetized benefits of a regulatory level of 10 µg/L best justify the costs.

Drinking Water Regulations: Key Steps

- Evaluate contaminant occurrence (number of systems affected and to what degree)
- Evaluate contaminant exposure (number of people affected and to what degree)
- Characterize compliance choices for regulatory alternatives

- To support a rulemaking, EPA staff must perform a series of analyses:
  - ***Evaluate occurrence*** of the contaminant (number of systems affected by a specific contaminant and concentrations of the contaminant);
  - ***Evaluate the number of people exposed*** and the ingested dose; and
  - ***Characterize choices for water systems*** to meet regulatory standards (treatment technologies).

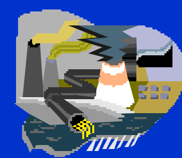
- EPA compares benefits and costs associated with the proposed MCL or TT alternatives, and address uncertainty of the data and estimation procedures.
- EPA develops detailed documents on the data and methodologies used in the analyses:
  - o Economic Analysis;
  - o Health Criteria Document;
  - o Occurrence and Exposure Document; and
  - o Cost and Technology Document.



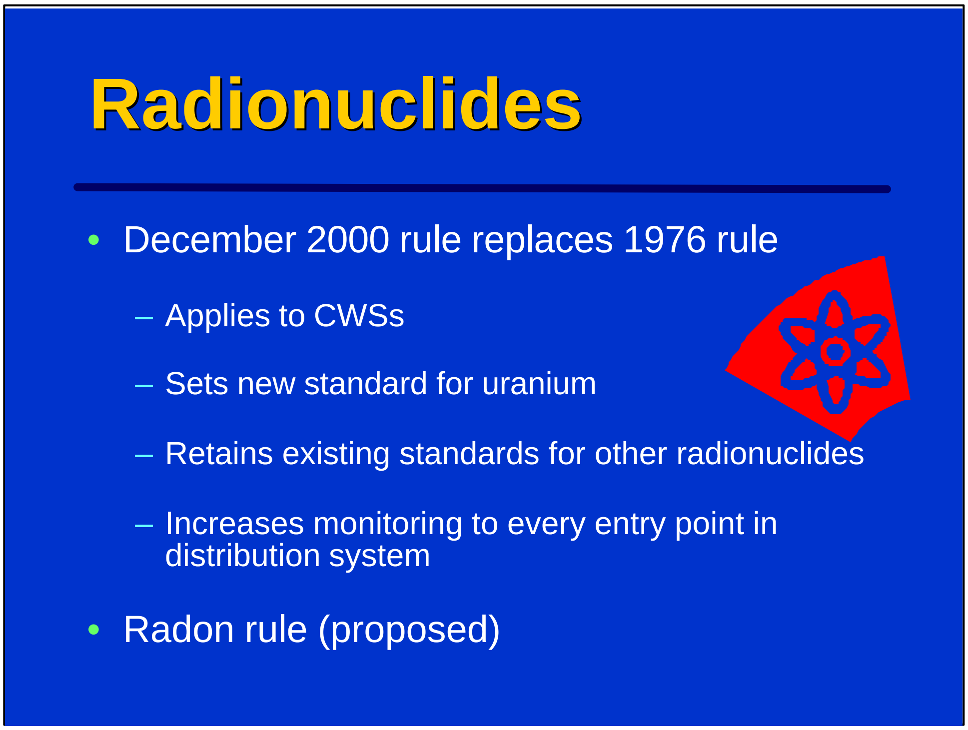
- EPA has set MCLs or treatment techniques for more than 90 contaminants:
  - Chemicals;
  - Radionuclides;
  - Microbiologicals; and
  - Disinfectants and disinfection byproducts.
- The next few slides discuss these standards.

Chemical Standards

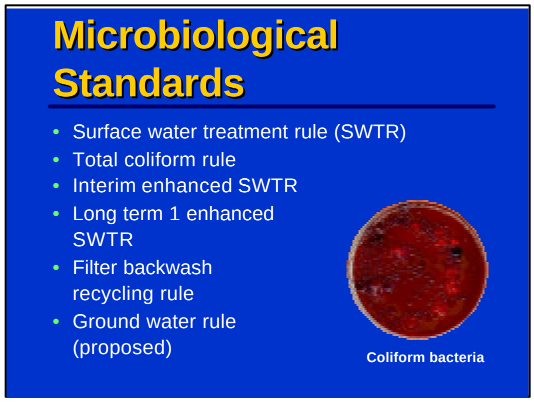
- Phases I, II, IIb, and V
- Total trihalomethanes
- Lead and copper
- Arsenic



- EPA regulates most chemical contaminants through the rules known as Phase I, II, IIb, and V. These regulations are found in 40 CFR 141.61-.62.
- The ***Phase I Rule*** (published in 1987) limits exposure to eight volatile organic chemicals (VOCs) that industries use in manufacturing. The Phase II and IIb Rules (both published in 1991) updated or created MCLs for 38 contaminants. The Phase V Rule (published in 1992) set standards for 23 more contaminants.
- ***Phases II, IIb, and V*** included inorganic chemicals (IOCs) such as heavy metals that are present naturally in some water, though only at trace levels. Industrial activity accounts for the potentially harmful levels of IOCs; synthetic organic chemicals (SOCs) such as pesticides. These chemicals enter water supplies through run-off from fields where farmers have applied them or by leaching through the soil into ground water; and additional VOCs.
- ***Trihalomethanes*** (THMs) are a group of byproducts that form as a result of disinfection. Since 1979, standards and monitoring requirements have been in place for community water systems that serve at least 10,000 people and use disinfection in the water purification process (40 CFR 141.12). The 1996 Amendments required EPA to develop rules to balance the risks between microbial pathogens and disinfection byproducts, which resulted in the Stage 1 Disinfectants/ Disinfection Byproducts Rule, explained in a later slide.
- Promulgated in 1992 and amended on January 12, 2000 (65 *FR* 1949-2015), the ***lead and copper rule*** differs substantially from the rest of the rules under the PWSS program (40 CFR 141.80-.91). Other rules require water systems to treat water so that when it leaves their facilities it is clean and safe to drink. The lead and copper rule regulates two contaminants that nearly always taint drinking water after it leaves the treatment plant.
- Under the lead and copper rule, EPA established ***action levels*** for lead and copper — levels of lead and copper that are well below levels that could cause health problems. An action level is different from a MCL. While an MCL is a legal limit on a contaminant, an action level, as the name suggests, is a trigger for additional prevention or removal steps.
- EPA promulgated a final rule for ***arsenic*** on January 22, 2001 (66 FR 6976-7066). This rule revised the existing standard set in 1975 from 50 parts per billion (ppb) to 10 ppb.
- In setting the new standard, EPA used its discretionary authority under the 1996 SDWA Amendments to set the standard at a level that "maximizes health risk reduction benefits at a cost that is justified by the benefits." In other words, although technology will allow lower levels of arsenic to be reached, EPA determined that the potential health benefits did not justify the added cost.



- Standards for combined radium-226/radium-228, gross alpha particle activity (not including uranium), and beta emitters have been in effect since 1977. These standards apply to community water systems only and appear in 40 CFR 141.15.
- On December 7, 2000, EPA promulgated revised (non-radon) ***radionuclide standards*** (65 FR 76707-76753). This rule:
  - o Includes requirements for uranium, not regulated under the 1976 rule;
  - o Revises the monitoring requirements for combined radium-226 and radium-228, gross alpha particle radioactivity, and beta particle and photon radioactivity (requires monitoring at each entry point to the distribution system);
  - o Retains the current MCL for combined radium-226/228 and gross alpha particle radioactivity; and
  - o Retains the current MCL for beta particle and photon radioactivity, but promises further review in the near future.
- EPA is developing new regulations to protect people from exposure to ***radon***. The framework for this proposal is set out in the 1996 SDWA Amendments, which provide for a multimedia approach to address the public health risks from radon in drinking water and radon in indoor air from soil. SDWA directs EPA to promulgate an MCL for radon in drinking water, but also to make available an alternative approach: a higher alternative maximum contaminant level accompanied by a multimedia mitigation program to address radon risks in indoor air. This framework reflects the unique characteristics of radon: in most cases, radon released to indoor air from soil under homes and buildings is the main source of exposure and radon released from tap water is a much smaller source of radon in indoor air. It is more cost-effective to reduce risk from radon exposure from indoor air, than from drinking water. EPA proposed the radon rule on November 2, 1999 (64 *FR* 59246).



- Promulgated in 1989, the ***surface water treatment rule*** seeks to prevent waterborne diseases caused by viruses, Legionella, and *Giardia lamblia* (40 CFR 141.70-.75). The rule sets MCLGs for Legionella, *Giardia*, and viruses at zero because any amount of exposure to these contaminants represents some health risk. The rule also sets ***treatment technique*** requirements to control these contaminants.

- The total coliform rule, promulgated in 1990, sets the MCL for microbiological contaminants based on the presence or absence of total coliforms (40 CFR 141.63). ***Coliforms*** are a group of bacteria, most of which are harmless. However, the presence of any coliforms in drinking water suggests that there may be disease-causing agents in the water. Coliforms are used as “indicator organisms” for microbiological contaminants because they are found in warm-blooded animals, they are “heartier” than typhoid or cholera bacteria, and they are easy to test for.

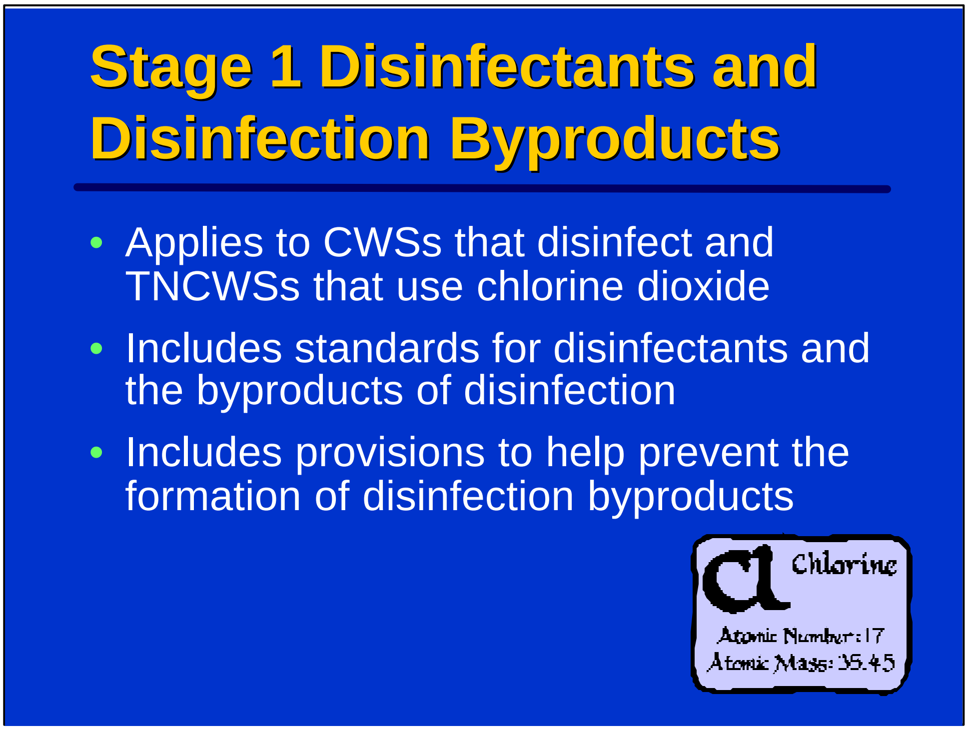
- The presence of coliform bacteria in tap water suggests that the treatment system is not working properly or that there is a problem in the distribution system. Published in 1989 as a complement to the surface water treatment rule, the ***total coliform rule*** sets both MCLGs and MCLs for total coliform levels in drinking water. The rule also details the type and frequency of testing by water systems.

- The ***interim enhanced surface water treatment rule (IESWTR)*** was promulgated on December 16, 1998 (63 *FR* 69477-69521). It updates the requirements of the surface water treatment rule. A major challenge for water suppliers is how to balance the risks from microbial pathogens and ***disinfection byproducts (DBPs),*** which form when disinfectants react with organic compounds present in drinking water. It is important to provide protection from these microbia l pathogens while simultaneously ensuring decreasing health risks to the population from DBPs.

- The ***long term 1 ESWTR*** improves control of microbial pathogens, specifically the protozoan Cryptosporidium, in drinking water and address risk trade- offs with disinfection byproducts. The rule requires systems to meet strengthened filtration requirements as well as to calculate levels of microbial inactivation to ensure that microbial protection is not jeopardized if systems make changes to comply with disinfection requirements of the stage 1 disinfection and disinfection byproducts rule (DBPR). The LT1ESWTR applies to public water systems that use surface water or ground water under the direct influence of surface water and serve fewer than 10,000 persons. EPA plans to finalize a long term 2 rule at the same time the stage 2 DBP rule (see next slide) is promulgated in order to ensure a proper balance between microbial and DBP risks.

- The ***filter backwash recycling rule*** requires that water treatment recycle streams pass through all of the processes of a system’s existing conventional or direct filtration system, or through an alternative location approved by the State. The rule addresses possible disruption of the treatment process by hydraulic surges through the facility, creation of a coagulation chemistry imbalance or return of concentrated amounts of disinfection–resistant pathogens (such as *Cryptosporidium*) through the plant.

- EPA has also proposed a ***ground water rule*** that specifies the appropriate use of disinfection and addresses other components of ground water systems to ensure public health protection (May 10, 2000, 65 *FR* 30193-30274).



- EPA promulgated the Stage 1 DBPR on December 16, 1998 (63 *FR* 69389-69476). It applies to all CWSs that apply a chemical disinfectant or an oxidant for either ***primary*** or ***residual disinfection*** (i.e., maintaining detectable levels of disinfectant in distribution pipes). In addition, ***certain requirements apply to transient noncommunity water systems that use chlorine dioxide***. The Stage 1 DBPR establishes:

  - o Revised MCL for total trihalomethanes (40 CFR 141.12);
  - o New MCLGs (40 CFR 141.53) and MCLs (40 CFR 141.64) for disinfection byproducts;
  - o Maximum Residual Disinfectant Goals (MRDGs) for disinfectants (40 CFR 141.54); and
  - o New Maximum Residual Disinfectant Levels (MRDLs) (40 CFR 141.65) for disinfectants.

- To limit disinfection byproducts (DBPs) without compromising microbial protection, the rule includes a ***treatment technique*** requirement that all systems using surface water or GWUDI and that use conventional treatment remove total organic carbon, a precursor of DBPs (40 CFR 141.130-.135).

- Systems will conduct monitoring based on the type of system and population served, the treatment employed, and the disinfectant used. Surface water and GWUDI systems serving at least 10,000 people must be in compliance with the rule by January 1, 2002. Surface water and GWUDI systems serving fewer than 10,000 people and all ground water systems must be in compliance by January 1, 2004.

- EPA is currently working with stakeholder workgroups to develop the ***Stage 2 Disinfectant/ Disinfection Byproducts Rule.*** The efforts will continue to focus on addressing the chronic health effects associated with DBPs, as well as acute reproductive threats that have been identified.

Comparison: MCLs and WQC

Contaminant	MCL - SDWA	Eat Fish	DW + Eat Fish	FW AL- Chronic
		Designated Use		
Mercury	2 µ g/L	0.051 µg/L	0.050 µg/L	0.77 µg/L
Cadmium	10µg/L			2.2 µg/L
Nickel		4,600 µg/L	610 µg/L	52 µg/L

* Aquatic life criteria for metals listed in chart are for hardness $CaCO_3$ of 100 mg/L

* NOTE: In January 2001, EPA published a new criterion for mercury (Hg): methylmercury in fish tissue=0.3 mg/kg

- This slide illustrates the relationships among WQC designed to protect humans from various exposure routes, as well as the relationship between human health criteria and chronic aquatic life criteria.
- Across the top of the chart are four uses or exposure patterns:
  - ***Drinking Water* (DW)**—Acceptable levels in public drinking water supplies. These are actually criteria from the Safe Drinking Water Act (SDWA) program, called Maximum Contaminant Levels (MCLs). Unlike the WQC generated under the CWA, these standards reflect economic and technical feasibility.
  - ***Eat Fish***—This CWA criterion is aimed at protecting those who consume fish, at national average rates, taken from the waterbody.
  - ***DW and Eat Fish***—This CWA criterion is aimed at protecting those who use the waterbody as a drinking water supply (and the water is untreated) and also consume fish from the waterbody.
- Interesting comparisons:
  - The CWA human health criteria for mercury are more stringent than the SDWA MCL, because:
    - Mercury is highly bioaccumulative, so levels in fish will be far higher than in the water column. This means that in order to protect those that eat the fish, water column levels must be very low.
    - Economics and technical feasibility are factored into the SDWA MCL, but are not in the CWA WQC.
    - The MCLG is the SDWA equivalent of WQC because both are based strictly on science.
  - The AL-chronic criteria for cadmium is more stringent than the human health criteria. At first, this may seem counterintuitive, until one realizes that the "critters" in the waterbody are, in essence, breathing the water continuously. By contrast, humans' exposure through drinking water and fish consumption is much more intermittent.

Variances from MCLs

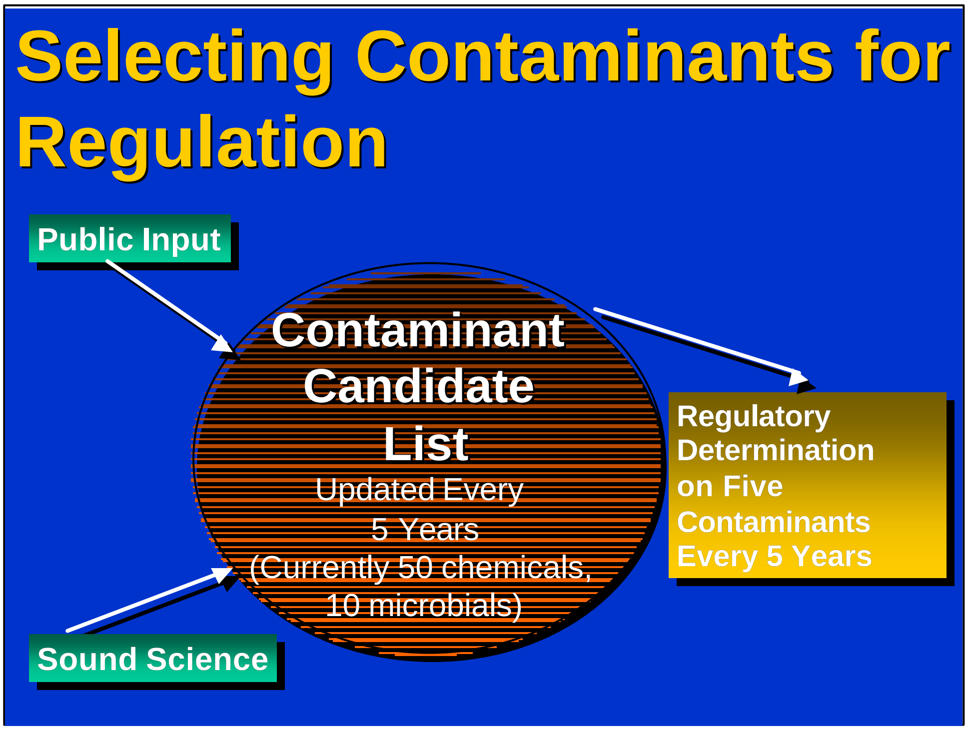
- Variances are for systems that cannot comply because of source water characteristics
- Include a compliance schedule
- Issued for up to three years, with possible two-year extension
- May not allow an unreasonable risk to public health

- EPA and primacy States are authorized under SDWA to grant variances from standards to systems that cannot comply because of the characteristics of their water sources. (Primacy States do not have to offer variances.) A variance allows higher contaminant levels to be present. To receive a variance, a system must install an EPA-approved variance technology.
- Variances may be issued for up to three years, with the possibility of an additional two-year extension.
- The 1996 Amendments added a new section 1415(e), which specifically addresses variances for small systems. EPA promulgated regulations (63 FR 157, August 14, 1998) that address this section.
    - The revised regulations create a new affordability-based small systems variance which may be granted by a State to a public water system serving fewer than 3,300 people or, with the approval of EPA's Administrator, to a system serving 3,301-10,000 people.
    - A variance may be granted only if the State finds that the small public water system cannot afford to comply with a NPDWR through treatment; by developing an alternative source of water; or by implementing restructuring changes or consolidation.
    - The State may grant a variance on the condition that the system install,operate, and maintain a nationally listed variance technology.
- Variances must include a schedule for complying with MCLs and implementing any additional control measures the State requires.

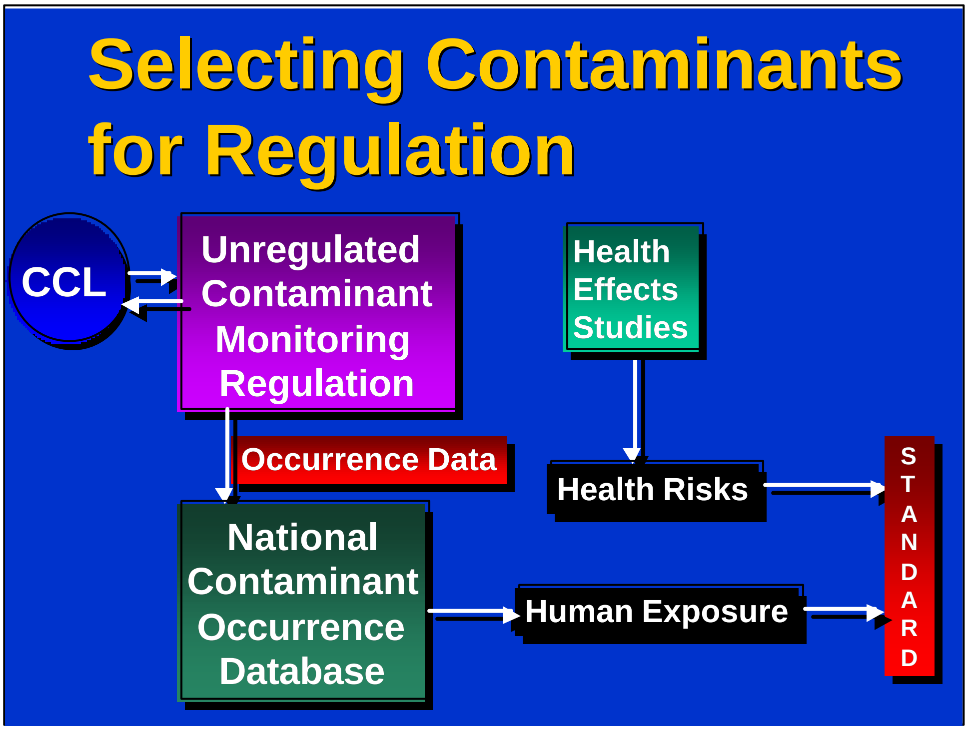
Exemptions from MCLs

- Exemptions can be issued to PWSs for “compelling reasons”
  - Including financial
- Up to three years
  - As many as three, 2-year extensions for systems serving fewer than 3,300 people

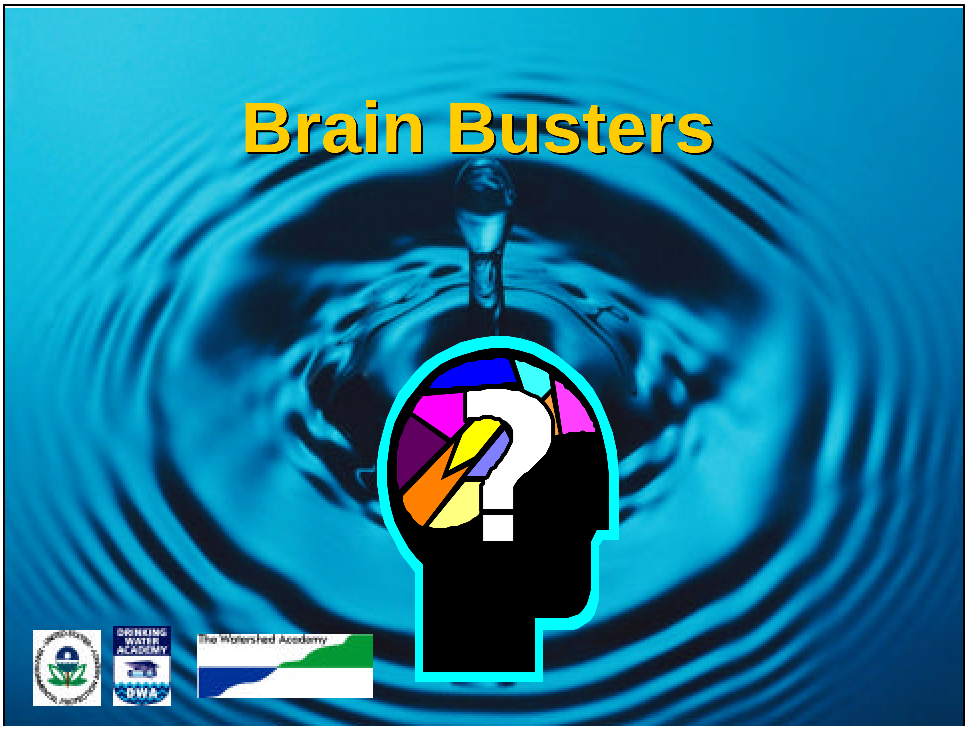
- SDWA section 1416 authorizes EPA and primacy States to exempt a PWS from any MCL or treatment technique if there are compelling reasons (including economic factors) demonstrating that the water system is unable to comply with the standard or to implement measures to develop an alternative source of water supply. As with variances, a primacy State may choose not to offer exemptions.
- Exemptions must include a schedule for complying with MCLs, including measures to develop an alternative water source, and may require the PWS to implement additional control measures.
- Exemptions may be granted for up to three years. Systems serving fewer than 3,300 people may receive two-year renewals, not to exceed a total of six years.
- A system may not receive both an exemption and a variance.



- The 1986 SDWA Amendments required EPA to draw contaminants for regulation from an existing list of contaminants with known health effects. However, this approach did not take into account how often a contaminant occurred in drinking water, and it did not provide a means to prioritize contaminants for regulation.
- The approach outlined in the 1996 Amendments for developing new standards requires ***broad public and scientific input*** to ensure that contaminants posing the greatest risk to public health will be selected for future regulation. A contaminant's presence in drinking water and public health risks associated with a contaminant must be considered in order to determine whether a public health risk is evident. In addition, the new contaminant selection approach explicitly takes into account the needs of sensitive populations such as children and pregnant women.
- Under the 1996 Amendments, the ***Contaminant Candidate List (CCL)*** will guide scientific evaluation of new contaminants. Contaminants on the CCL are prioritized for regulatory development, drinking water research (including studies of health effects, treatment effects, and analytical methods), and occurrence monitoring. EPA published the initial CCL on March 2, 1998, consisting of 50 chemicals and 10 microbials. EPA must make a ***determination for regulatory action for five contaminants by 2001***. The CCL must be ***updated every five years***, providing a continuing process to identify contaminants for future regulations or standards and prevention activities.



- To prioritize contaminants for regulation, EPA considers peer-reviewed science and data to support an "***intensive technological evaluation***," which includes many factors: occurrence in the environment; human exposure and risks of adverse health effects in the general population and sensitive subpopulations; analytical methods of detection; technical feasibility; and impacts of regulation on water systems, the economy and public health.
- EPA has developed several programs to improve the regulatory process in the drinking water program.
    - o EPA promulgated the ***Unregulated Contaminant Monitoring Regulation (UCMR)*** on September 17, 1999 (64 *FR* 50555-50620). The rule contains a list of contaminants for which PWSs must monitor, requirements to submit the monitoring results to EPA and the States for inclusion in the NCOD, and requirements to notify consumers of monitoring results. The contaminant list must be updated every five years.
    - o EPA also established the ***National Drinking Water Contaminant Occurrence Database*** (NCOD). NCOD is a collection of drinking water contaminant occurrence data (non-detections and detections) representing finished, untreated and source waters associated with PWSs across the U.S. It includes data on regulated and unregulated contaminants. NCOD is accessible to the public through the Internet (http://www.epa.gov/ncod).
- The CCL occurrence priorities list is the primary source of contaminants to be selected for this monitoring. The UCMR will provide data to guide regulatory determinations and other prioritization for future CCLs. Linked with the CCL on a five-year cycle, the UCMR will provide a continuing source of needed data.
- The monitoring data from the UCMR will be stored in NCOD, along with other data on the occurrence of both regulated and unregulated contaminants. These data will provide additional information to identify contaminants for future CCLs, regulations, and review of existing regulations.

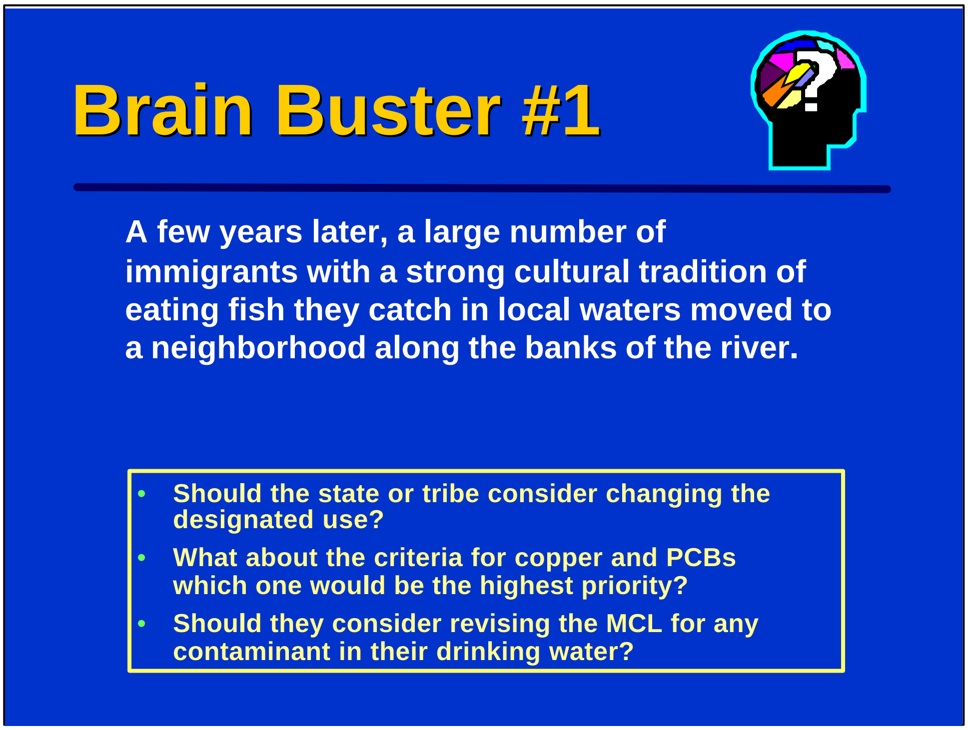

Brain Busters
DRINKING WATER ACADEMY
DWA
The Watershed Academy

Brain Buster #1

For 50 years a river in a city was heavily polluted, including high levels of pathogens, copper, and PCBs. Virtually no fish or other aquatic life were present. Kayakers ran the rapids and wind surfers used the flatwater. In 1982, after years of cleanup effort, plenty of perch and bass lived in the river, and pathogen levels dropped below the WQC for swimming.

- **What were the existing uses before the cleanup: fishable, swimmable, public water supply?**
- **Could the water have been designated “fishable/ swimmable” before the cleanup? Neither fishable nor swimmable? Just fishable? Just swimmable? Public water supply?**
- **What about existing and designated uses after cleanup?**

- **Existing uses before cleanup:** Aquatic life (AL) did not exist and one can’t determine the other uses based on info provided.
- **Existing uses after cleanup:** There is now AL and probably recreational fishing. One can’t determine the other uses based on the information provided.
- **Designated uses before cleanup:** Could include AL, but if a use attainability analysis and downgrading process had been completed, AL might not be a DU. Should have a designated use consistent with “swimmable”, unless downgrading was completed.
- **Designated uses after cleanup:** The DU probably includes AL and recreational fishing because these uses are now existing.
- **Changing the WQC:** If AL wasn’t a DU before, and it became a DU after November 1975, then the State would need to re-examine both the copper and PCB criteria for AL. The State should also revisit the human health criteria for PCB, because fish consumption probably has increased significantly, creating a different exposure scenario.



- **Changing the DU**: The State should revisit the designated use and also might need to change the designated use from recreational fishery to subsistence fishing.
- **Changing the WQC**: The State should definitely look at the human health criteria for PCBs, because they bioaccumulate in fish tissues.

Brain Buster #2

At the time of passage of the CWA, a waterbody is in excellent condition. However, in the 1980s major development takes place in the watershed, resulting in very low dissolved oxygen and other factors that eliminate all species of game fish and shellfish. Toxic metals also build up in the waterbody, including significant levels of mercury.

- What were the existing uses in 1978? What should the DUs have been?
- What were the existing uses in 1992? What should the DUs have been?
- Answer each question for aquatic life, primary contact recreation, public water supply.

- **Protective criteria**: The criteria would not be protective of primary recreation. A criterion for fecal coliform that was perhaps an orders of magnitude higher than those currently suggested by EPA would not be protective of people involved in primary and/or secondary contact recreation during these periods. For example, white water kayakers love high flow conditions. WQCs are expressed as concentrations and durations, therefore, the volume of water from which a sample is drawn is irrelevant. If the concentration of a pollutant in a cup of water is high enough to make you sick, it doesn't matter whether the water was taken from a washbasin, bathtub, swimming pool, major river, or a Great Lake.
- **Alternative**: Do a temporal exemption from the WQS for the period of time when the exceptional high flows occur. This would avoid the expenditure of enormous amounts of money to control CSOs to the degree that none would occur, even in the biggest storms. Of course, the waters should be posted during these times, warning the public that water contact sports are not safe.

Brain Buster #3

A waterbody has been designated for several uses. The corresponding WQC for each of the pollutants “x” and “y” is listed below, in mg/L

Use	Criterion x	Criterion y
Aquatic life	5	13
Ag water supply	19	16
HH-Fish consumption	8	7
Industrial water supply	50	10

Monitoring indicates that the instream concentration of “x” is 12 mg/L and “y” is 3 mg/L

Brain Buster #3 (Bonus)

- Is the waterbody meeting all its DUs? If not, which are not attained?
- Which of the DUs is the "most sensitive" for "x"? For "y"?
- What instream concentrations of "x" and "y" must be achieved to be in full attainment of WQS?
- Would a TMDL be required for this waterbody for "x"? For "y"?
- Does antidegradation apply to this watershed?

Brain Buster #3 (Bonus)

A few years after the state deals successfully with the previous situation, a nearby community decides it soon wants to start using the waterbody as a water source for its public water supply (PWS). The WQC for PWS for “x” is 9 mg/L and for “y” is 2 mg/L.

- Could PWS be added to the list of DUs for this waterbody? Must it?
- If PWS were added, what would be the most sensitive use for “x”? For “y”?
- Would the waterbody be meeting all of its DUs?

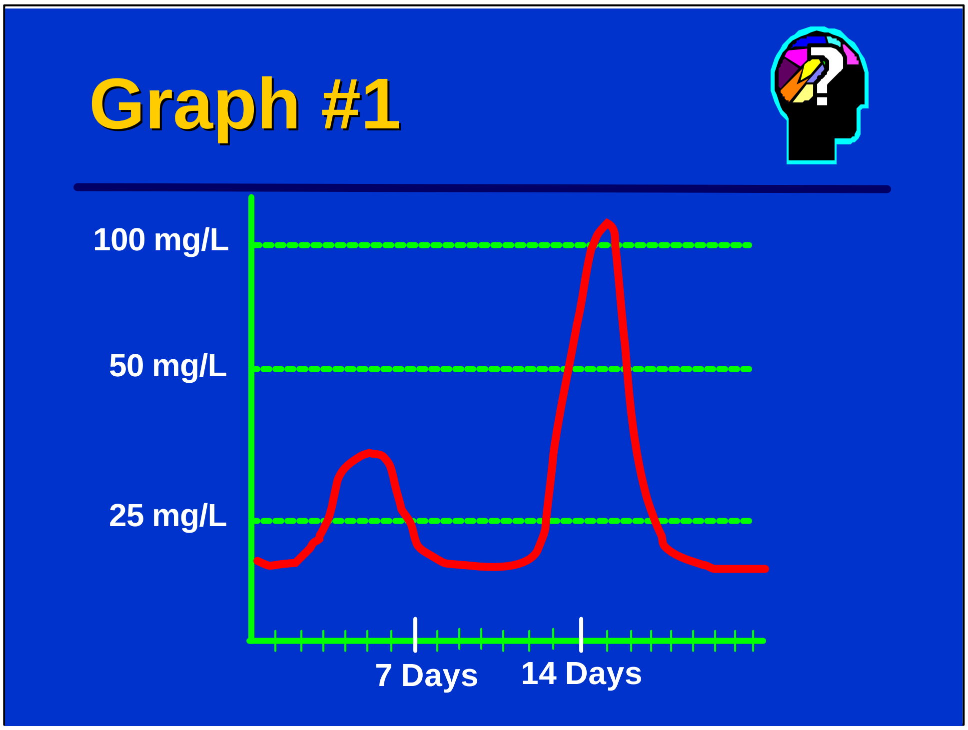
Brain Buster #4

A State or Tribe has adopted the following water quality criteria for pollutant "X"

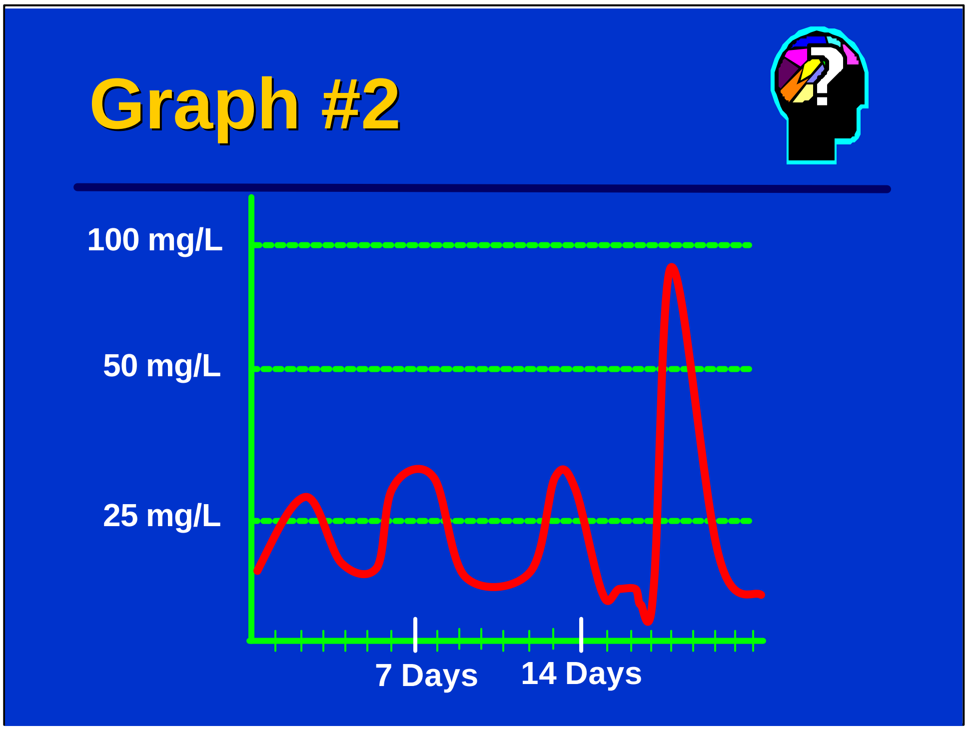
Not to exceed	**100 mg/L**
1-day average	**50 mg/L**
7-day average	**25 mg/L**

In which of the situations graphed below is one or more of the above criteria exceeded? Which ones, for each graph?

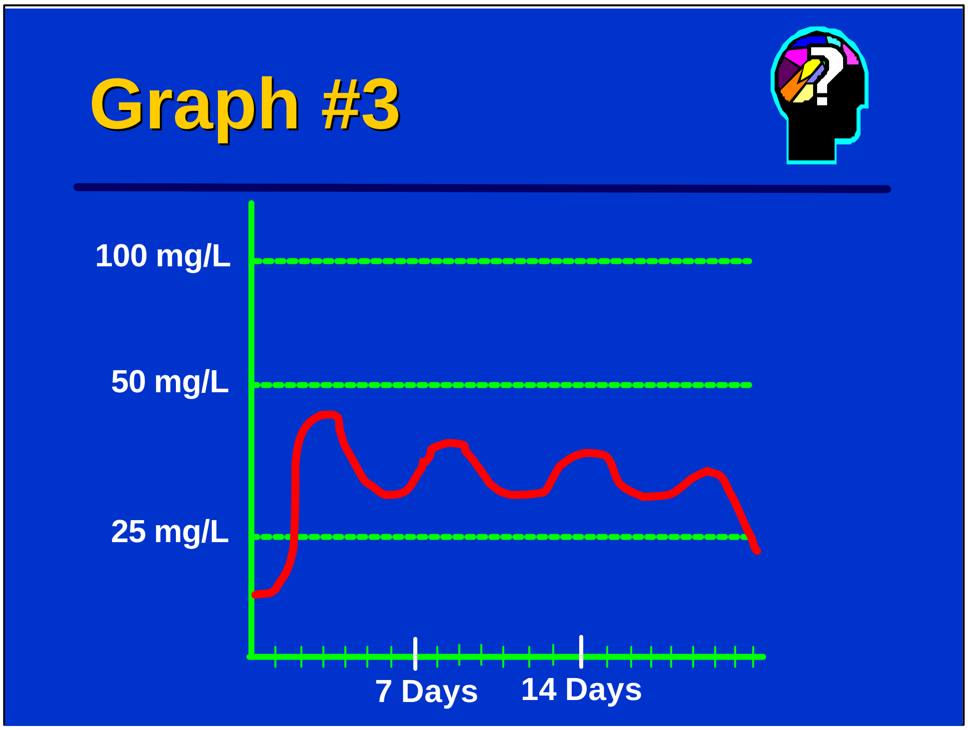
- The primary purpose of this exercise is to reinforce the fact that one must look at not only the concentration of a parameter, but also the duration of time during which the concentration specified in a WQC is exceeded. This is not necessary when the criterion is expressed as Instantaneous or Never to Exceed.



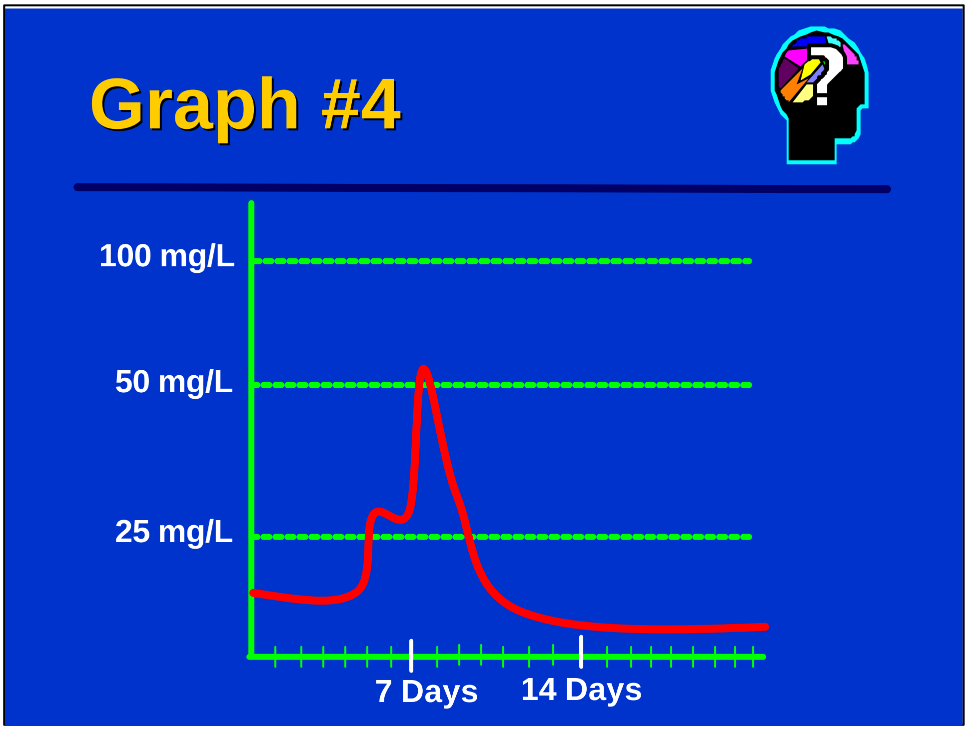
- **Graph #1:** Instant-Yes; 1 day-probably; 7 day-probably not



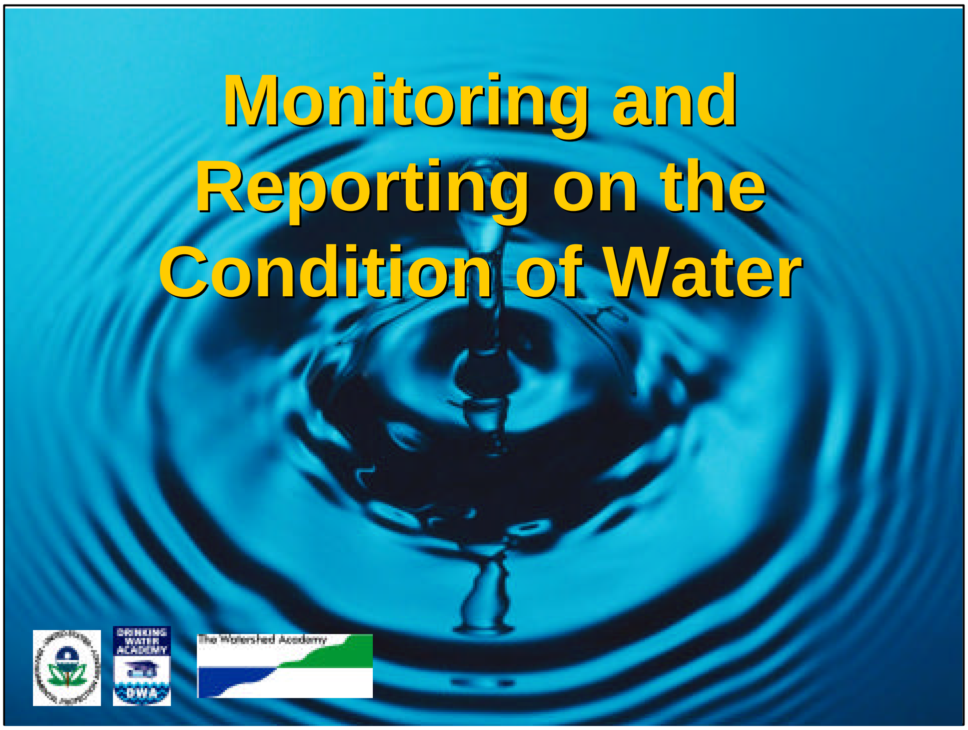
- **Graph #2**: Instant-No; 1 day-probably; 7 day-maybe, it's a close call

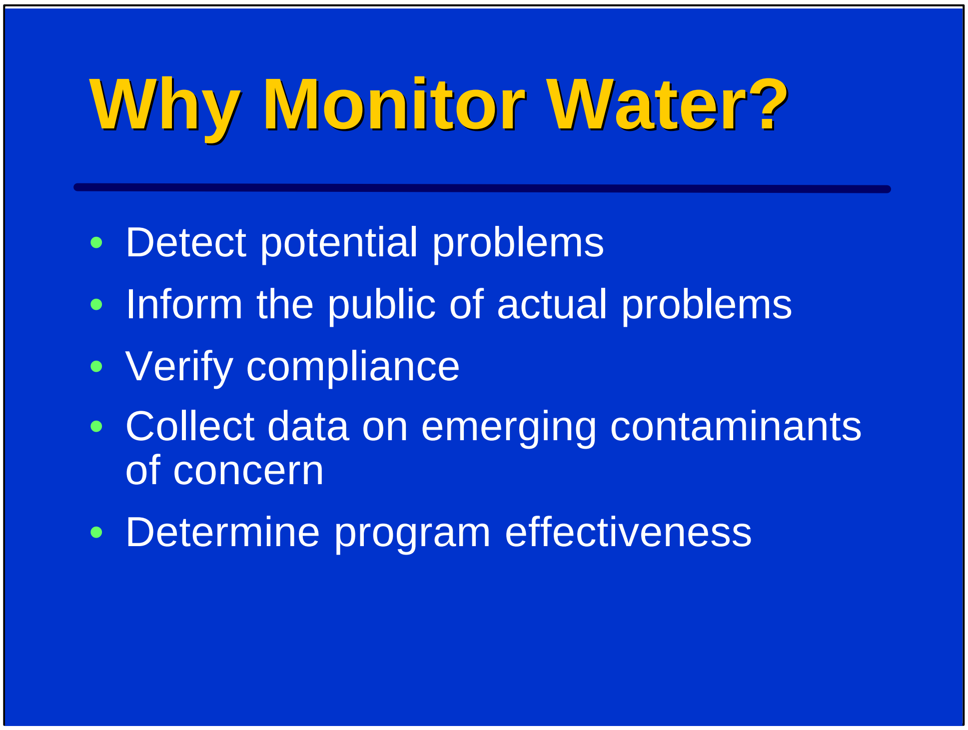


- **Graph #3**: Instant-No; 1 day-No; 7 day-Yes



- **Graph #4**: Instant-No; 1 day-Probably not; 7 day-Maybe, it’s a close call

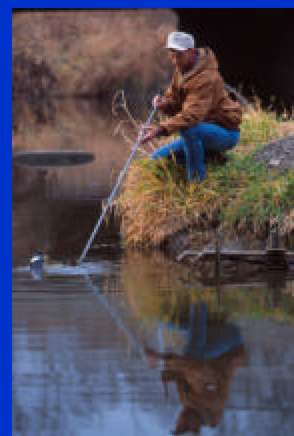

Monitoring and Reporting on the Condition of Water
DRINKING WATER ACADEMY
DWA
The Watershed Academy



- Both statutes require monitoring of water for a number of reasons.
    - Monitoring can identify potential problems. For example, increasing levels of a contaminant may signal a need to take some action to ensure that a water treatment facility or industrial discharger remains in compliance.
    - In cases where violations are detected, the public can be notified to ensure that they do not drink or otherwise come in contact with water that may present a health hazard.
    - Monitoring provides information to regulatory agencies to ensure that facilities are complying with applicable regulations and permits.
    - In the SDWA program, monitoring is also used to collect information on the occurrence of emerging contaminants of concern in order to help determine whether regulation is necessary.

Where Is Water Monitored?

- End of treatment processes
- Ambient monitoring
- Within treatment processes or distribution system

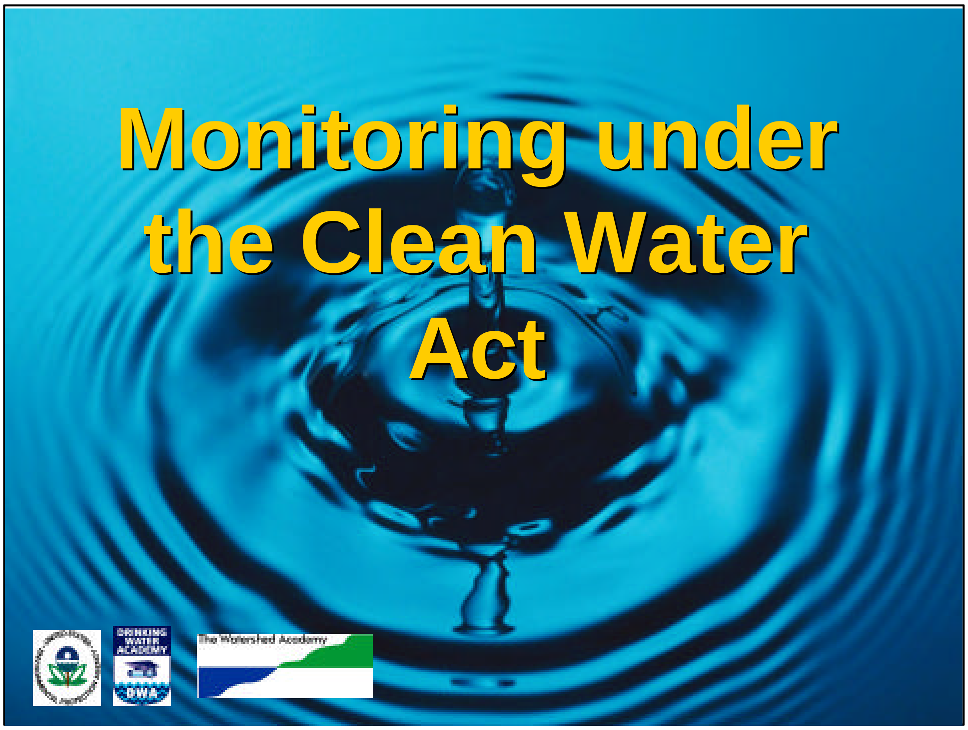


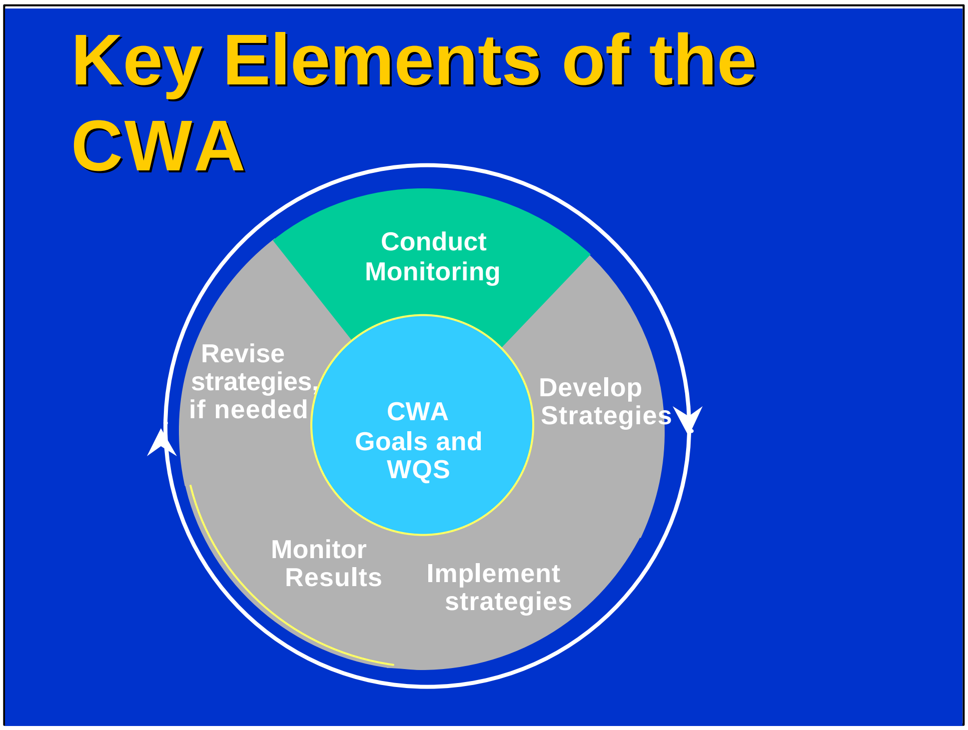
Sampling in Iowa to study the effects of farming practices on water quality

- Both statutes require two types of monitoring: ***monitoring at the end of a treatment process*** (i.e., at the point of discharge or distribution), and ***ambient water quality monitoring***.
- The water at the end of treatment processes is monitored to ensure that the treatment is adequately providing barriers to specific types of contamination.
  - For example, industrial dischargers under the NPDES program monitor to ensure that their discharges meet the levels specified in their permits.
  - Turbidity monitoring at drinking water treatment plants that use surface water sources provides information to assess whether particle removal barriers are working properly.
- Ambient water quality monitoring involves direct measurement of the concentration of contaminants and other conditions in water bodies.
- Both statutes have historically placed more emphasis on end of treatment monitoring than on ambient monitoring.
- In addition to these common requirements, SDWA also requires, for certain contaminants, monitoring ***within the treatment system*** or ***within distribution systems***.

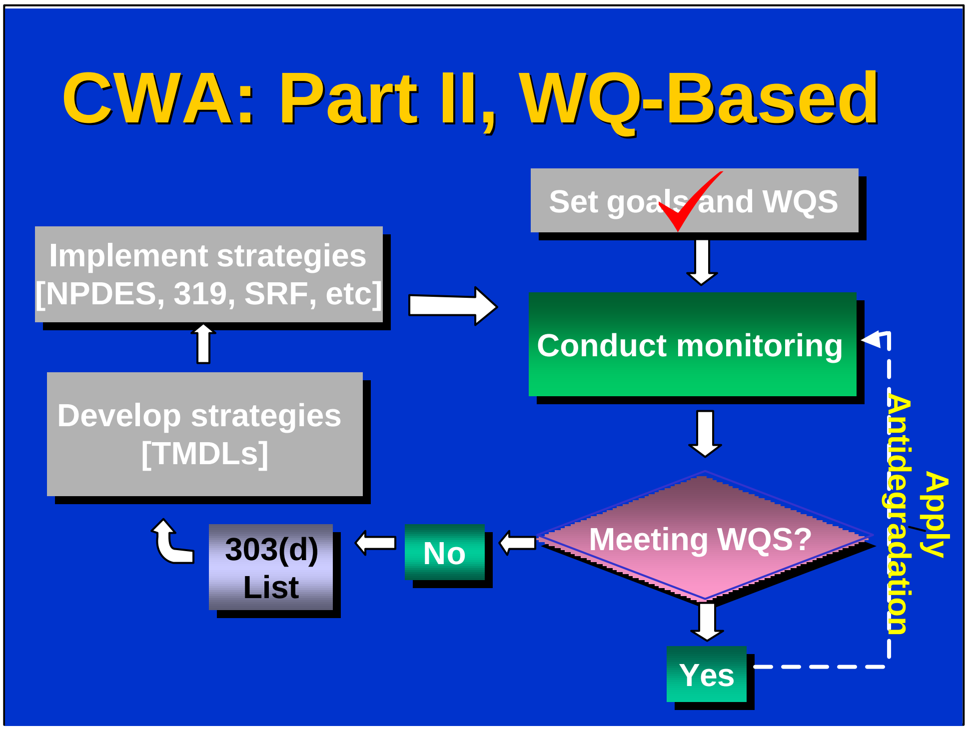
What Parameters Are Monitored?

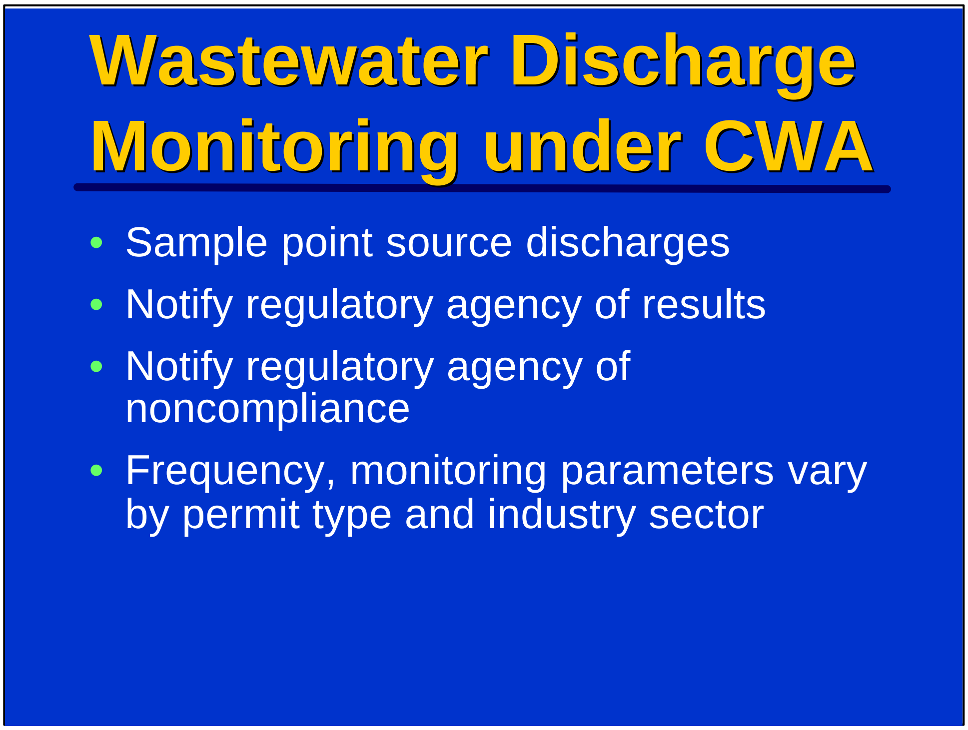
- Chemical
  - Mostly numeric standards for contaminants or other parameters
- Physical
  - Numeric (flow, temperature, habitat structure) or narrative (objectionable color, aquatic habitat)
- Biological
  - Numeric (indices of biological integrity, fecal coliform concentrations, chlorophyll *a*) or narrative (support populations of fish and shellfish)


Monitoring under the Clean Water Act
DRINKING WATER ACADEMY
DWA
The Watershed Academy



- Now we go into a brief section on monitoring and reporting regarding waterbody conditions. The focus of this section is water quality monitoring.


CWA: Part II, WQ-Based
Set goals and WQS
Implement strategies [NPDES, 319, SRF, etc]
Conduct monitoring
Develop strategies [TMDLs]
Meeting WQS?
303(d) List
No
Yes
Apply Antidegradation

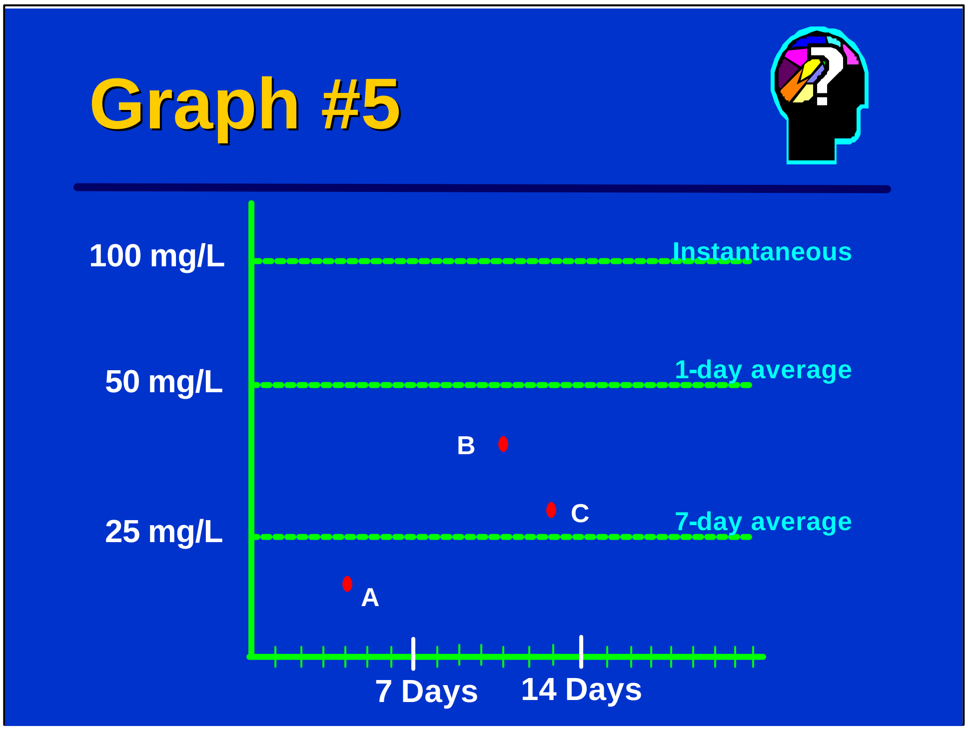


- Monitoring and reporting requirements under the NPDES program are used to evaluate wastewater treatment efficiency, and determine compliance with permit conditions.
- There are various methods used to monitor NPDES permit conditions. The permit will require the facility to sample its discharges and notify EPA and the State regulatory agency of these results. In addition, the permit will require the facility to notify EPA and the State regulatory agency when the facility determines it is not in compliance with the requirements of a permit. EPA and State regulatory agencies also will send inspectors to companies in order to determine if they are in compliance with the conditions imposed under their permits.
- Not all NPDES permittees are required to monitor their discharges. As a general rule, wet weather point sources (e.g., municipal storm sewers, combined sewer outfalls, storm water associated with industrial activities, construction-related storm water) are *not* required to monitor their discharges on a regular basis.

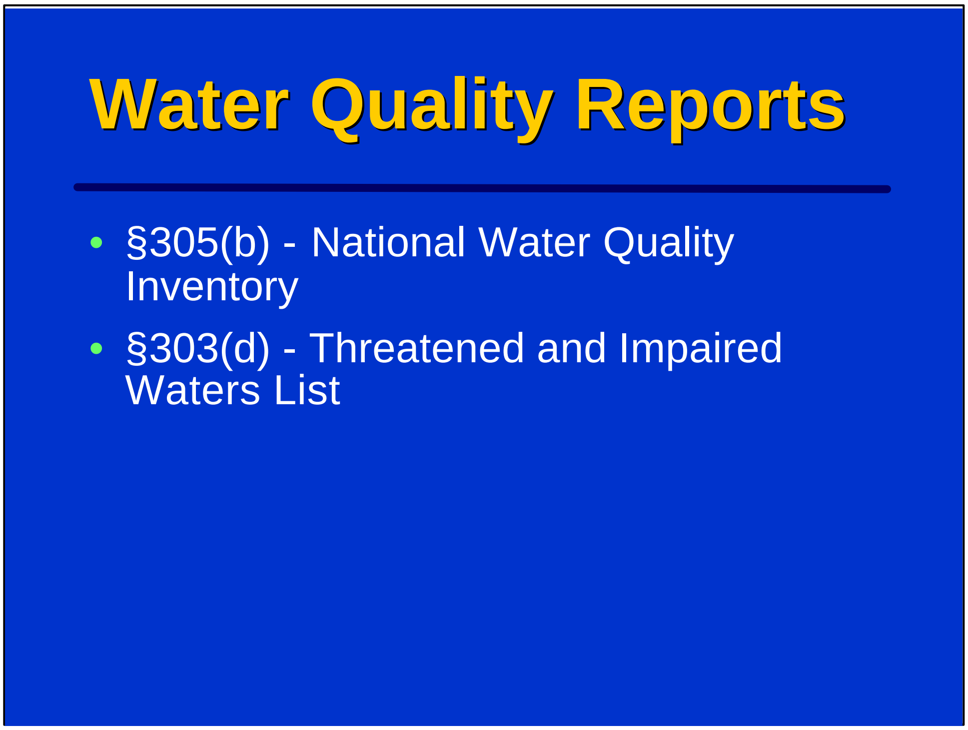
Ambient Monitoring Eligible Under CWA Section 106

- Development of monitoring strategies and plans
  - Where and when to monitor
  - What to monitor for
- Fixed station networks and intensive surveys
- Chemical, physical, and biological analyses
- Laboratories and data storage systems
- Reporting, including §305(b)
- Training

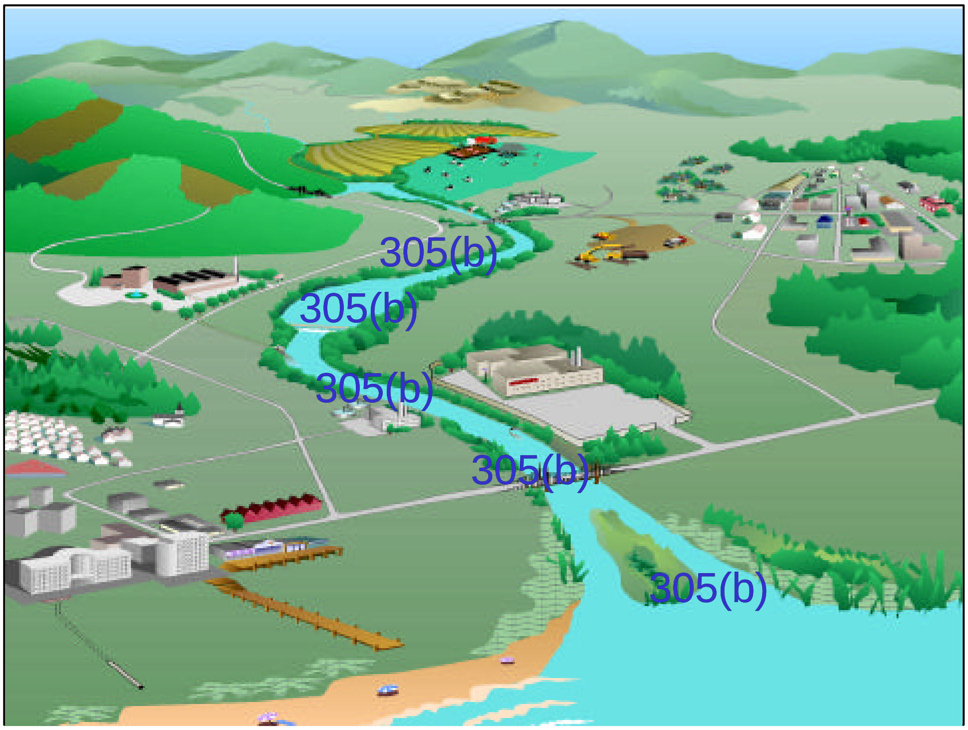
- Virtually any kind of ambient monitoring operation can be funded under section 106.
- Section 106 grants cover not only ambient monitoring but also other aspects of CWA implementation. In the past, this has often resulted in ambient monitoring receiving relatively small amounts of money, even though it is a costly process if done widely and accurately. This was not much of a problem during the technology-based phase of CWA implementation, but has become a serious problem as we've moved into the WQ-based phase.
- There are no clear requirements in the CWA regarding what, where, how, or how often EPA and States should perform ambient monitoring.



- Remember this graph from the earlier exercise. The purpose of this slide is to present a common real-world situation. The lines on the graphs in the earlier exercise would only be available if continuous monitoring and analysis were available. This is usually not the case with regard to ambient monitoring, and depending on the contaminant, not for end of treatment monitoring either. This slide is more typical, and in fact, often there are even fewer data points.
- With these three data points, what can you say regarding each of the three criteria given:
  - o Definitely exceeded?
  - o Highly uncertain?
  - o Fairly uncertain?
  - o Definitely not exceeded?
- How much, if any, would you answer be changed if you had only the following points:
  - o A and B?
  - o B and C?
  - o A?
  - o B?

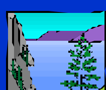
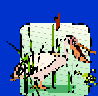


- These are two different sections of the CWA that require reports in which States provide results of monitoring they and others have performed.



- States and tribes submit biennially to EPA §305(b) National Water Quality Inventory reports. These reports include:
  - o Condition of all waterbodies;
  - o Key causes of impairment, including:
    - – Pollutants and other stressors; and
    - – Sources; and
  - o Progress toward CWA goals.
- EPA provides an overview in a Report to Congress.
- This illustrates the notion that in the ideal world, States will include monitoring results from throughout a watershed in their §305(b) reports. Unfortunately, this is often not the case. In fact, some watersheds may not have been monitored for years or even decades.

Percent of Waters Assessed

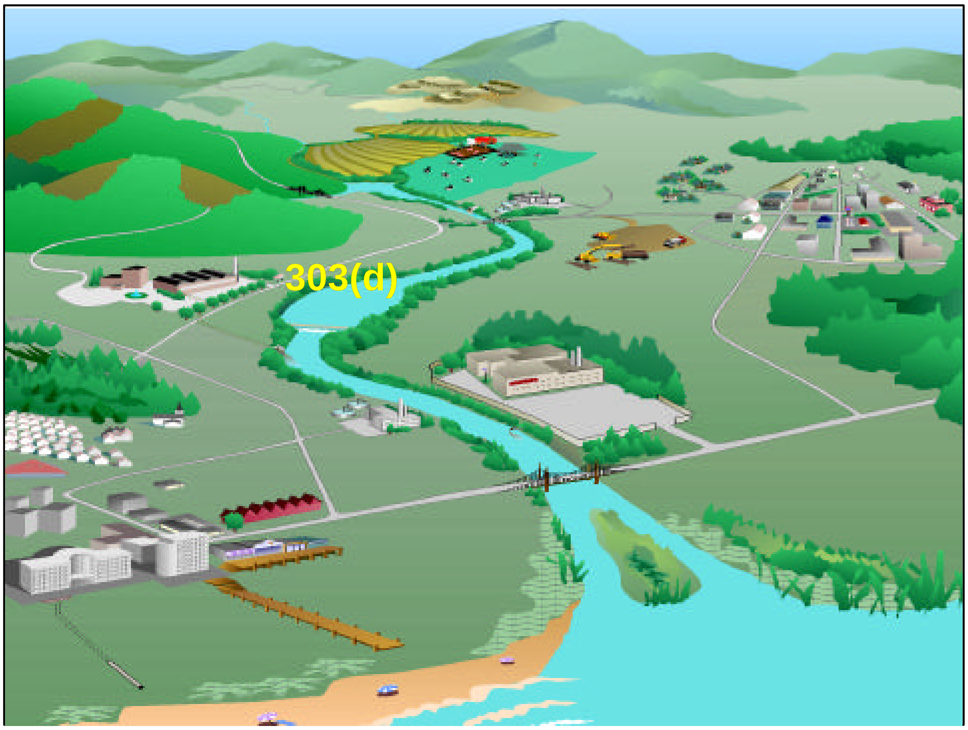
Waterbody Type	Total Size	Amount Assessed (% of total)
 Rivers (miles)	3,692,830	699,946 19%
 Lakes (acres)	40,603,893	17,339,0808 43%
 Estuaries (sq. miles)	87,369	31,072 36%

- The *National Water Quality Inventory: 2000 Report* summarizes findings from State, territorial and other jurisdictional assessments of water quality.
- In their 200 reports, approximately 700,000 miles of rivers and 17.34 million acres of lakes, slightly less area that in the 1998 reports, were assessed. This decrease is largely due to the States' growing reluctance to use older qualitative data when making water quality assessments.

Waterbody Conditions

Waterbody Type	Good (% of Assessed)	Good but Threatened (% of Assessed)	Polluted (% of Assessed)
Rivers (miles)	367,129 53%	59,504 8%	269,258 39%
Lakes (acres)	8,026,988 47%	1,348,903 8%	7,702,370 45%
Estuaries (sq. miles)	13,850 45%	1,023 <4%	15,676 51%

- In 2000, mercury was described as a leading cause of impairment in the nation's estuaries and lakes. Increasing, States are moving toward more comprehensive examination of fish tissue and are issuing statewide advisories that restrict the consumption of some fish, especially for vulnerable segments of the population.
- Of the assessed ocean shoreline miles, 14 percent are impaired, primarily because of bacteria, oxygen depletion, and turbidity. Primary sources of pollution include urban runoff, storm sewers, nonpoint source runoff, and land disposal of wastes. States assessed only 6 percent of the nation's ocean shoreline.
- States also found that 78 percent of assessed Great Lakes shoreline miles are impaired, primarily due to pollutants in fish tissue at levels that exceed standards to protect human health. States assessed 92 percent of Great Lakes shoreline miles.
- The average annual loss of wetlands has decreased over the past 40 years to a current estimated loss of 58,500 acres per year.
- Overall, the States found that ground water quality is good and can support many different uses. However, measurable negative impacts have been detected in some areas and are commonly traced to sources such as leaking underground storage tanks, septic systems, and landfills.



- States and Tribes also submit biennially to EPA for review and approval a list of threatened and impaired waters (§303(d) list). This list includes waters:
  - o Not currently meeting WQS even if all tech-based controls on point sources have been implemented; and
  - o Waters currently meeting WQS but expected to exceed WQS by the date of the next §303(d) list.
- Note that "§303(d)" appears in only one location in the schematic watershed. This reflects the fact that the §303(d) list includes only impaired waterbodies or those not meeting all WQS and WQC.
- In an effort to improve the consistency and comprehensiveness of water quality reporting and to streamline the reporting process, EPA is providing States and Tribes with guidance that recommends they submit a *2002 Integrated Water Quality Monitoring and Assessment Report* to satisfy the requirements for both sections 305(b) and 303(d) of the CWA.

§303(d): Threatened and Impaired Waters List

- 21,000 waters in 1998 §303(d) report
- Listing of priorities for TMDL development
  - Approximately 40,000 TMDLs needed
    - ~40% of listed waters have more than one cause
    - Most stressors for any water = 30

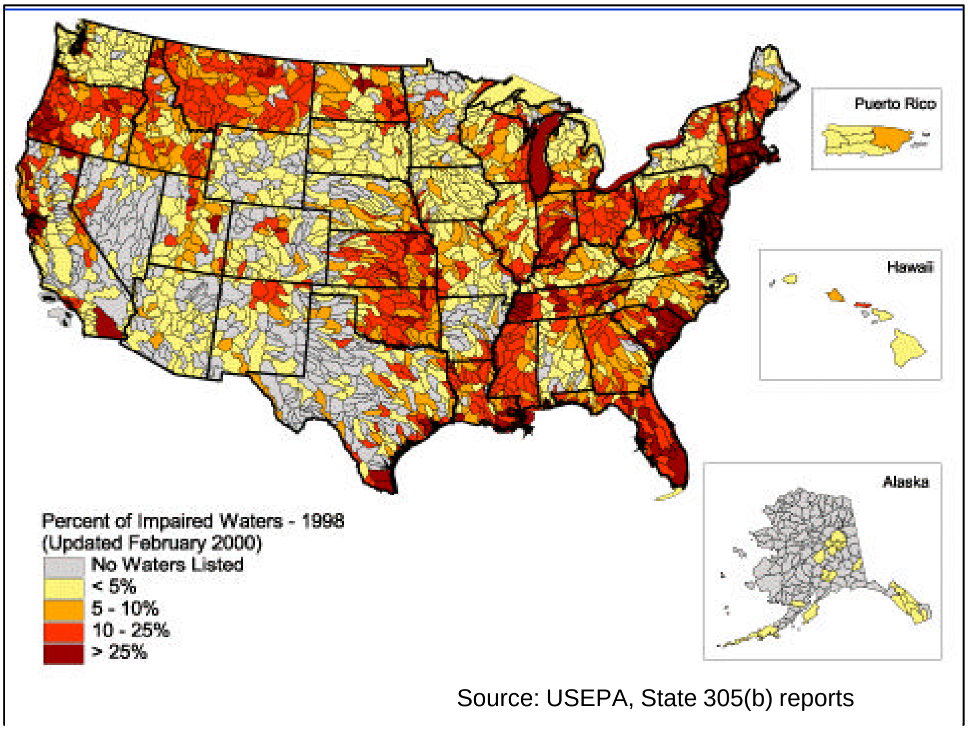
- There are more TMDLs than impaired waters because some waters are impaired for more than one pollutant.

§303(d) Listed Waters

- 300,000 miles of rivers and coastal shoreline
  – 75% of segments 1-20 miles long
- 5 million acres of lakes
- Equals ~1/3 of length/acreage of assessed waters
  – Around 10% assessed in past several years
- 210 million people live within 10 miles of at least one impaired water

Examples of Existing and Available Information

- Numeric criterion exceedances
- Direct evidence of use impairment
- Evidence of not meeting a narrative criterion
- Technical analysis (e.g., WQ modeling)
- Other information sources (e.g., volunteer monitoring, university research and studies, data from other agencies, public participation process)



- Section 303(d) waters show current water quality standard impairments or threats to the future attainment of WQC or failure to implement anti-degradation provisions. This map is a representation of threatened and impaired streams, rivers, coastlines, estuaries, lakes and wetlands within an 8-digit Hydrologic Unit Code (HUC), divided by the total number of water miles within the HUC.

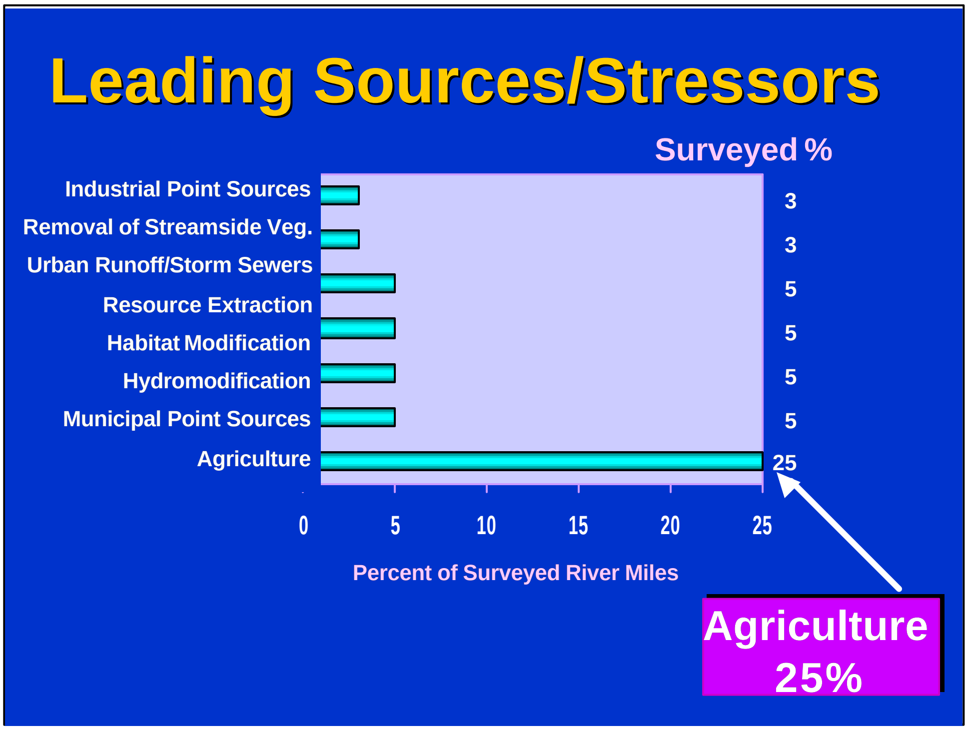
Causes of Impairment

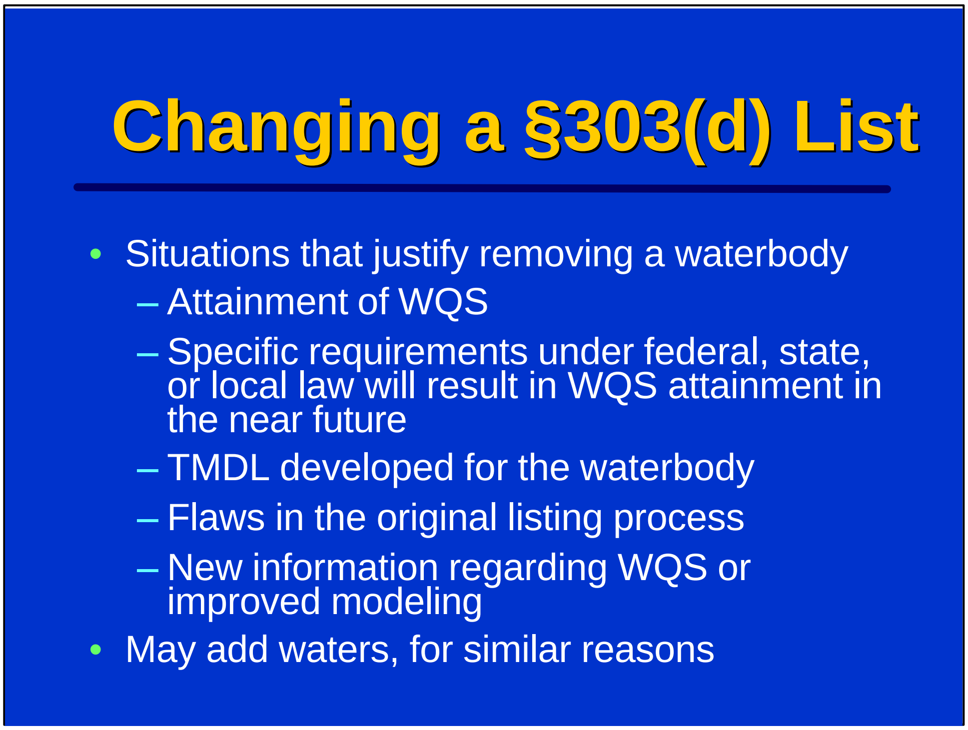
Pollutant	Number of Times Named as Cause
Sediments	6502
Nutrients	5730
Pathogens	4884
Metals	4022
Dissolved Oxygen	3889
Other Habitat Alterations	2163
pH	1774
Temperature	1752
Biologic Impairment	1331
Fish Consumption Advisories	1247
Flow Alterations	1240
Pesticides	1097
Ammonia	781
Legacy	546
Unknown	527
Organics	464

- ***Sediment***—Clean sediment and silt; not toxics-laden bottom sediments.
- ***Other habitat alterations***—dams, channelization, but not flow alteration
- ***Legacy***—pollutants no longer being discharged into the waterbody, but still have unacceptable levels in bottom sediments or the bodies of aquatic organisms (e.g., PCBs)
- ***Organics***—synthetic organics
- Note that the two most common cause of impairments—nutrients (N and P) and clean sediments—are parameters for which EPA, and most States, do not currently have numeric WQC. As mentioned earlier, EPA plans to issue criteria guidance for these within the next couple years.
- The three most commonly cited causes—nutrients, pathogens and sediments—are frequently associated with nonpoint sources of pollution. One could think of NPS as standing for **N**utrients, **P**athogens, and **S**ediments.
- This list has some "oranges" as well as "apples." Biological impairment is a condition that could result from any of a number of the stressors listed in the table. Fish consumption advisories could be caused by pesticides, metals, or organics.

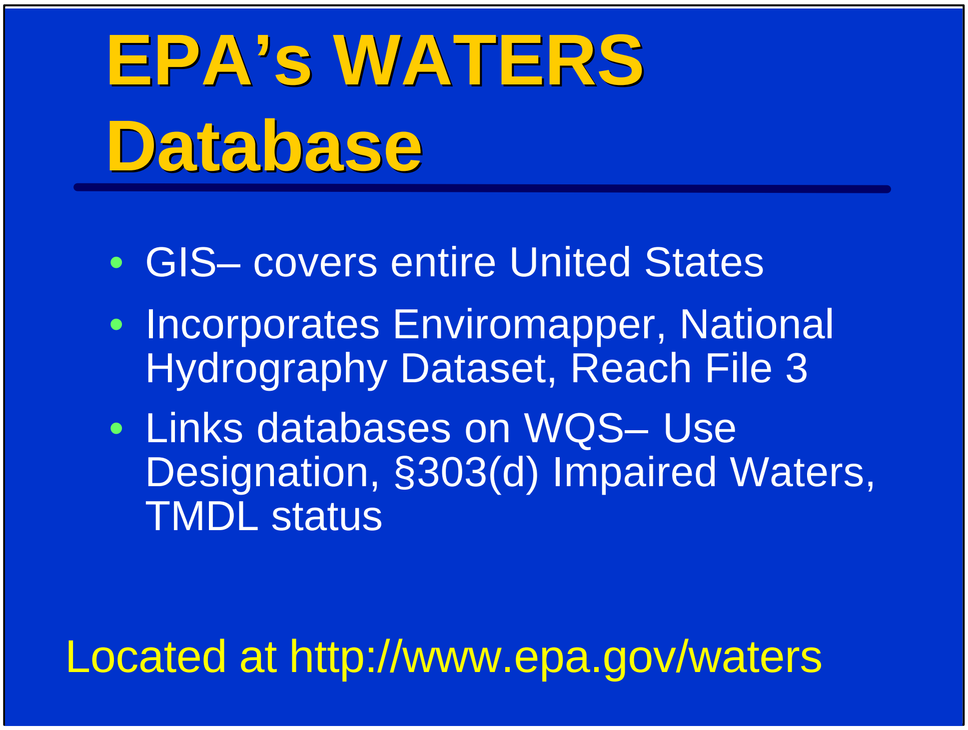
Sources of Impairment by Category - 1998 §303(d) List

- 47% combination of point and nonpoint sources
- 43% nonpoint sources only
- 10% point sources only


Leading Sources/Stressors
Surveyed %
Industrial Point Sources
Removal of Streamside Veg.
Urban Runoff/Storm Sewers
Resource Extraction
Habitat Modification
Hydromodification
Municipal Point Sources
Agriculture
3
3
5
5
5
5
25
0
5
10
15
20
25
Percent of Surveyed River Miles
Agriculture
25%



- Situations that justify removing a waterbody:
  - o Attainment of WQS
    - – Due to reduction of loads
    - – Due to changing a WQS
    - – Downgrade DU and/or site-specific WQC
  - o Specific requirements under federal, state, or local law will result in WQS attainment in the near future
  - o TMDL developed for the waterbody
  - o Flaws in the original listing process
  - o New information regarding WQS or improved modeling
- May add waters, for similar reasons



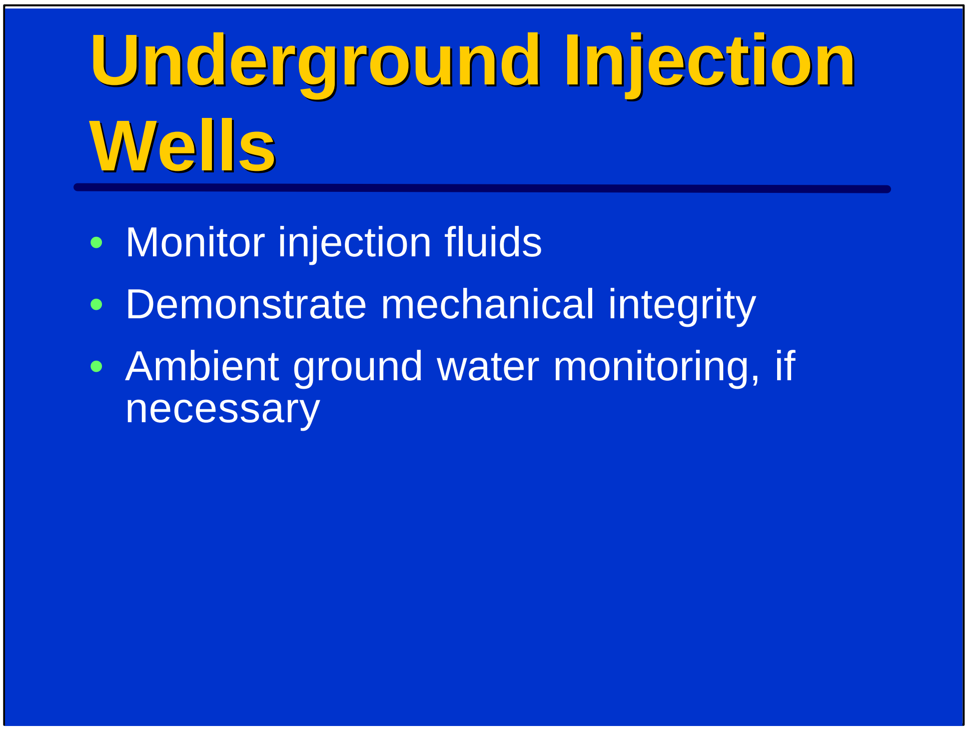
- EPA, in partnership with States, territories and tribes, is working to improved communication with the regulated community and the public about the quality of the nation's surface waters through the use of the Watershed Assessment, Tracking and Environmental Results (WATERS) information system. WATERS unifies geography-specific water quality information previously available only on various individual state web sites and several different EPA Web sites.
- WATERS contains information about the quality of the nation's surface water, designated use of a waterbody (e.g., drinking water supply, recreation, fish protection), and a list of waters identified by the state as being impaired.
- The Web site uses EPA's standard mapping application, Enviromapper, to display water quality information about local waters.
- WATERS also uses the National Hydrography Dataset (NHD) maintained by the U.S. Geological Survey, as the common language to connect and display surface water information. Users can find local water quality information for a particular body of water by clicking on an interactive map.
- More detailed ambient monitoring data is available from the STORET database at http://www.epa.gov/storet.


Monitoring under
the Safe Drinking
Water Act

Monitoring Under SDWA

- Underground injection wells
- Public water systems
  - – Finished water monitoring
  - – PWS treatment process monitoring

- SDWA requires monitoring in both the UIC program and the PWS program.
- UIC monitoring includes the quality of the wastes injected, the mechanical integrity of the injection well equipment and the ground water of the aquifer into which the well penetrates.
- The monitoring required of public water systems includes monitoring of the water supplied to consumers, both at the source and within the distribution system. It also includes certain monitoring conducted to assess the operation and effectiveness of water treatment processes.



- Monitoring in the underground injection control program is different from the other monitoring done under SDWA, in that generally the water resource (ground water) is not directly monitored.
  - The fluids to be injected must be monitored to yield data representative of their characteristics.
  - Wells must demonstrate mechanical integrity; i.e., they must show that there is no significant leak into the structure of the well or fluid movement into an underground source of drinking water.
  - Other monitoring of the injection zone may be required, such as monitoring for pressure changes in the injection zone or an aquifer, monitoring ground water quality, or monitoring to determine the position of the waste front.
- Actual monitoring of the ground water in association with the operation of an underground injection well is not routine, but rather accomplished if circumstances necessitate it.

Public Water System Monitoring

- Finished water monitoring
  - (MCLs and MRDLs)
  - Water receiving no treatment
  - Water with disinfection
  - Water receiving treatment and disinfection
- Raw water monitoring
- Water treatment process monitoring
  - Treatment techniques

- We will discuss finished water monitoring (water ready to be served to consumers), raw water monitoring and water treatment process water monitoring.
- Finished water monitoring will generally be accomplished to assess compliance with MCLs or MRDLs specified in the Federal rules.
- Raw water monitoring and water treatment process monitoring is generally accomplished in order to assess compliance with a treatment technique expressed in the rules.
- The following slides will look at several general descriptions of PWSs and discuss the monitoring required for that type of system.
- Actual monitoring parameters, monitoring frequencies and monitoring initiation dates depend on a variety of factors, such as system population served, system source, system type and specific system configurations.

Finished Water Monitoring Requirements Vary

- Source water type
- System type
- Contaminant group
- System size
- Sampling locations

- Requirements for finished water quality monitoring under SDWA vary from rule to rule for a number of reasons.
- Contaminant occurrence and the associated risk can vary due to source water type. The variability of water quality is different in surface and ground water sources. That is, surface water quality typically varies much more, and much more quickly, than does the quality of ground water.
- The type of system also affects monitoring requirements. Community and nontransient, noncommunity water systems have to be worried about contaminants with both acute and chronic health effects. However, transient, noncommunity water systems only need to be concerned about contaminants with acute health effects.
- The contaminant group (i.e., whether the contaminant is a VOC, SOC, IOC, microbiological or disinfection byproduct) also affects monitoring requirements because of public health goals and occurrence.
  - Contaminants likely to cause acute health effects require more frequent monitoring and those likely to cause chronic effects, conversely, require less frequent monitoring.
  - In addition, EPA may not be able to justify the cost of regulating contaminants that are widespread but not prevalent in drinking water.
- System size can also be a variable affecting sampling frequency and analytical methods.
- Sampling locations also vary. Sampling may be required at the entry point to the distribution system, at a “representative” point, or at the point of entry or point of use.

How Often Must a System Monitor under SDWA?

- Bacteriological quality (coliform bacteria)
  - Ranges from daily to quarterly
- Turbidity
  - Ranges from daily or less to continuous
- Chemicals and radiologicals
  - Quarterly (less or more)
- Disinfectant residuals
  - Ranges from daily to monthly
- Disinfection byproducts (DBPs)
  - Ranges from 4 samples per quarter to 1 per quarter

- Monitoring under SDWA varies in frequency considerably, depending on the parameter considered, the source of the water used, the water treatment processes used, the type of water system, and the population served by the water system.
- Water samples to determine ***bacteriological quality*** (coliform) must be collected according to a schedule and at locations within water systems, based on the type of system and the size of the population served, ranging from one sample per month to nearly 500 samples per month for the largest systems.
- Water samples to measure ***turbidity*** must be collected and analyzed to determine compliance with both MCLs and treatment techniques. The frequency is generally daily, but can be less, and can be required on a continuous basis.
- Water samples to be analyzed for ***chemical and radiological*** contaminants must generally be collected and analyzed quarterly, however, circumstances can increase or decrease that frequency.
- Water samples to measure ***disinfectant residuals*** must be collected and analyzed on frequencies that range from daily to monthly.
- Water samples to measure ***disinfection byproducts*** must be collected and analyzed on frequencies that range form four samples per quarter to quarterly.

PWS-Finished Water, No Treatment

Microbials

- At ground water systems
  - Coliforms
- At unfiltered surface water systems
  - Coliforms
  - Turbidity

PWS-Finished Water, No Treatment

Chemicals and Radionuclides

- IOCs
- SOCs
- VOCs
- Radionuclides
- Lead and copper

PWS-Finished Water, Treated

Microbials

- Coliform at selected taps in the distribution system

- At specific sites – Stage 1D/DBP rule
  - Residual disinfectant monitoring
  - Disinfectant byproduct monitoring
- DBP precursors
  - Raw water
  - Finished water

PWS-Finished Water, Treated

Chemicals and Radionuclides

- At each entry point to the distribution system
  - IOCs
  - SOCs
  - VOCs
  - Radionuclides
- At selected taps
  - Lead and copper

Public Water Systems-Treatment Process Monitoring

Microbials

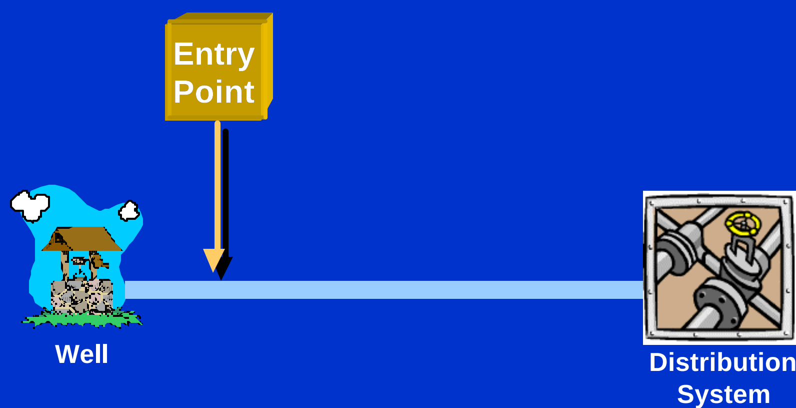
- Surface water treatment rule
  - CT calculations
  - Turbidity
- IESWTR and LT1ESWTR
  - IFE turbidity monitoring
  - CFE turbidity monitoring
  - Filter profiles, filter self-assessments and CPEs
  - Disinfection profiling and benchmarking

Public Water Systems- Treatment Process Monitoring

Chemicals and Radionuclides

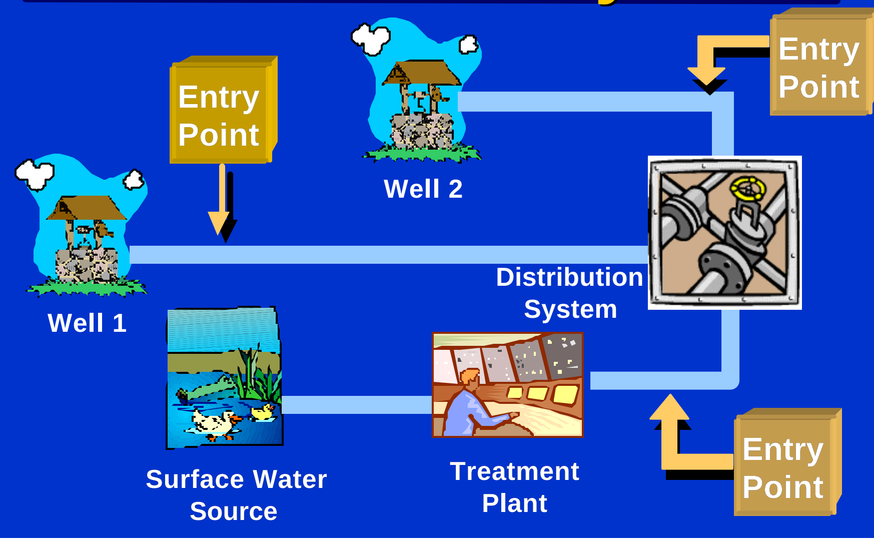
- None

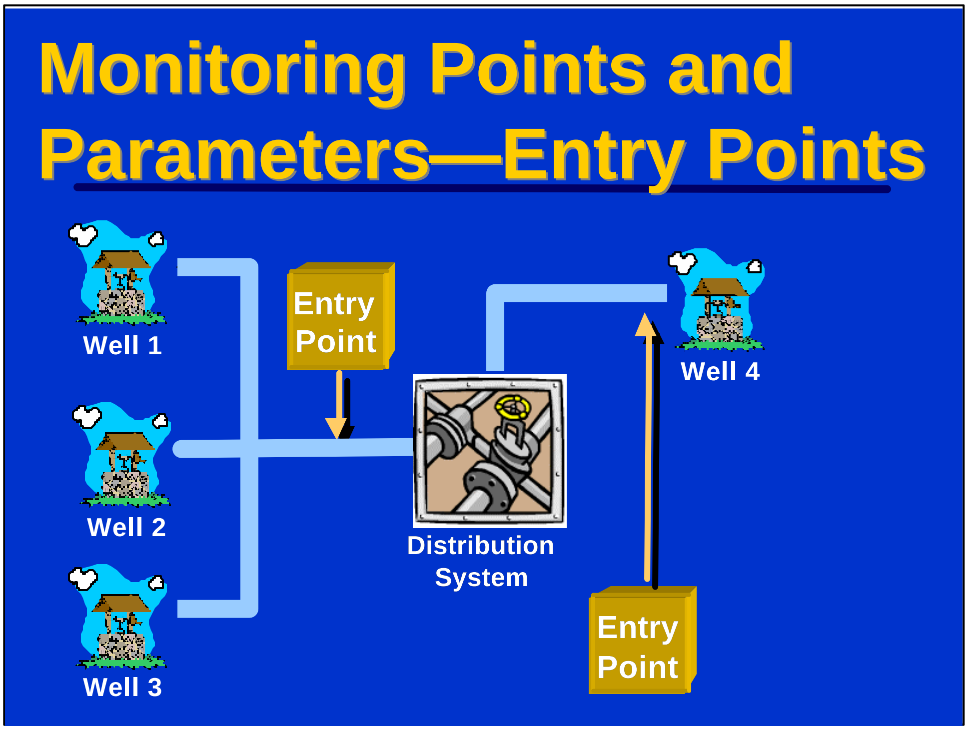
Monitoring Points and Parameters—Entry Points

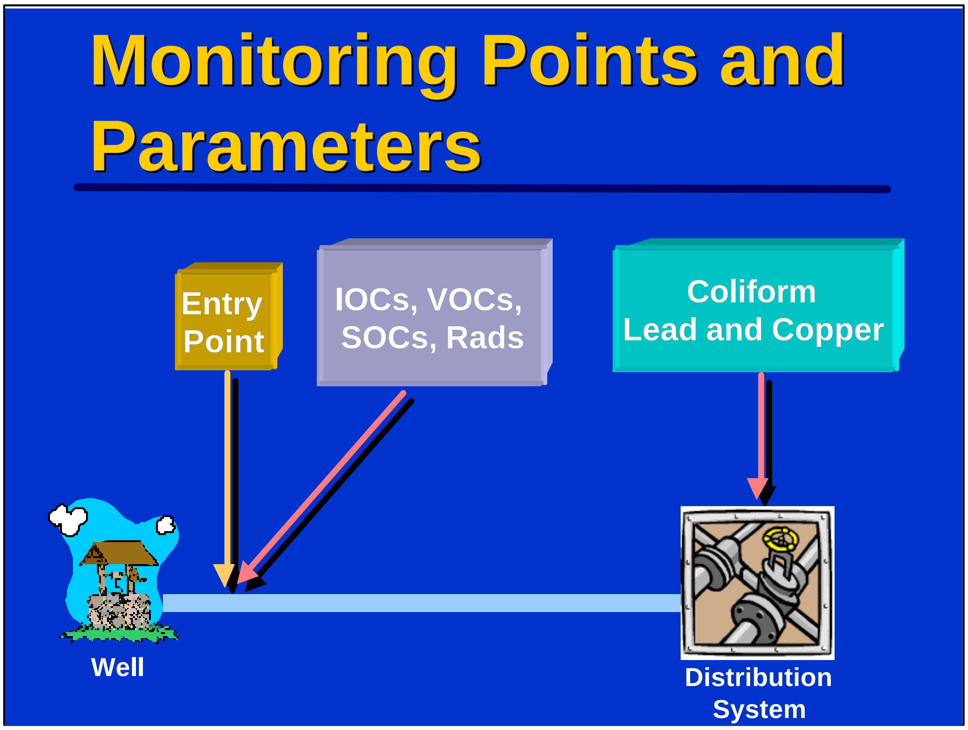


- The entry point to the distribution system (EP) is that location where the source water, after any water treatment applied to it, is introduced into the distribution system for consumption by any water system user.
- In this case, there is no water treatment process applied, therefore, the EP is just downstream of the wellhead, but before any tap can provide water to any user.

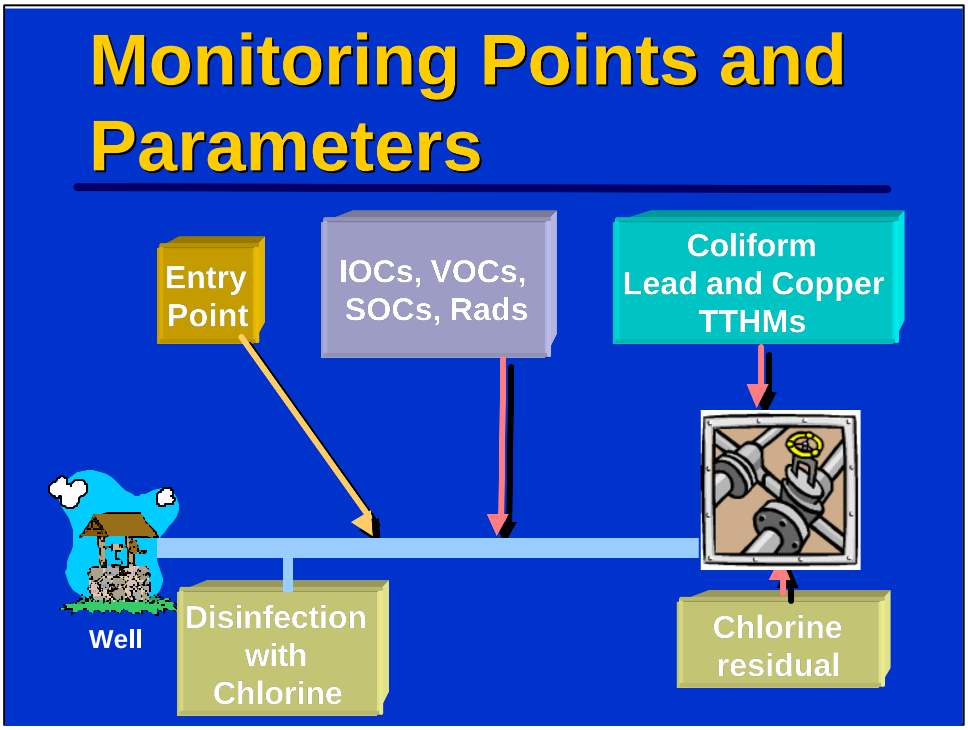
Monitoring Points and Parameters—Entry Points



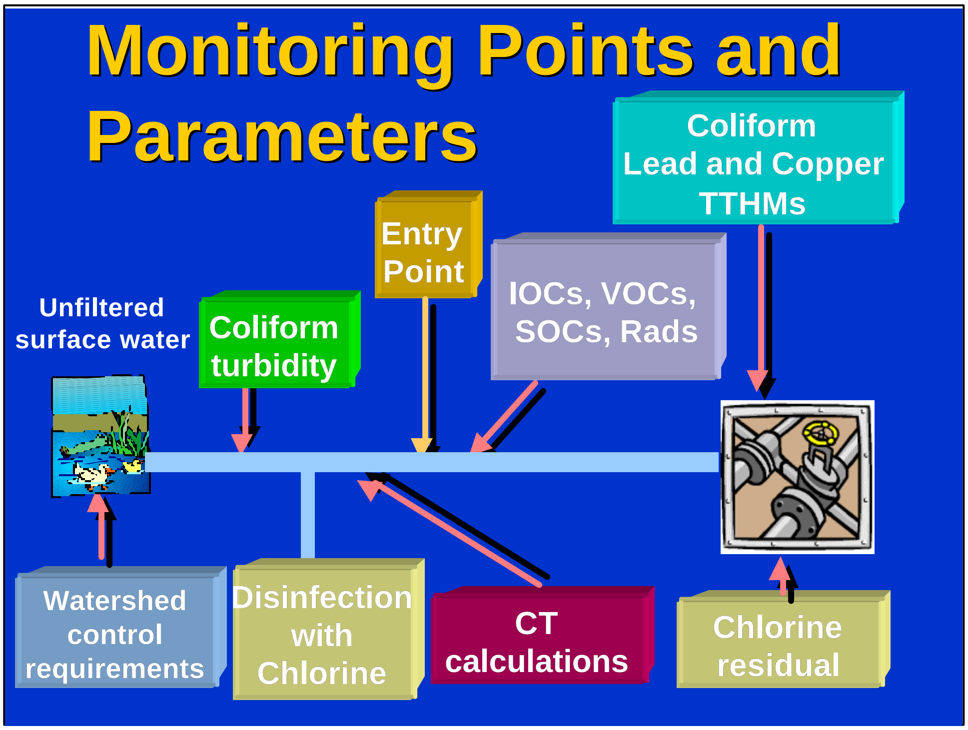

Monitoring Points and Parameters—Entry Points
Well 1
Well 2
Well 3
Well 4
Entry Point
Entry Point
Distribution System

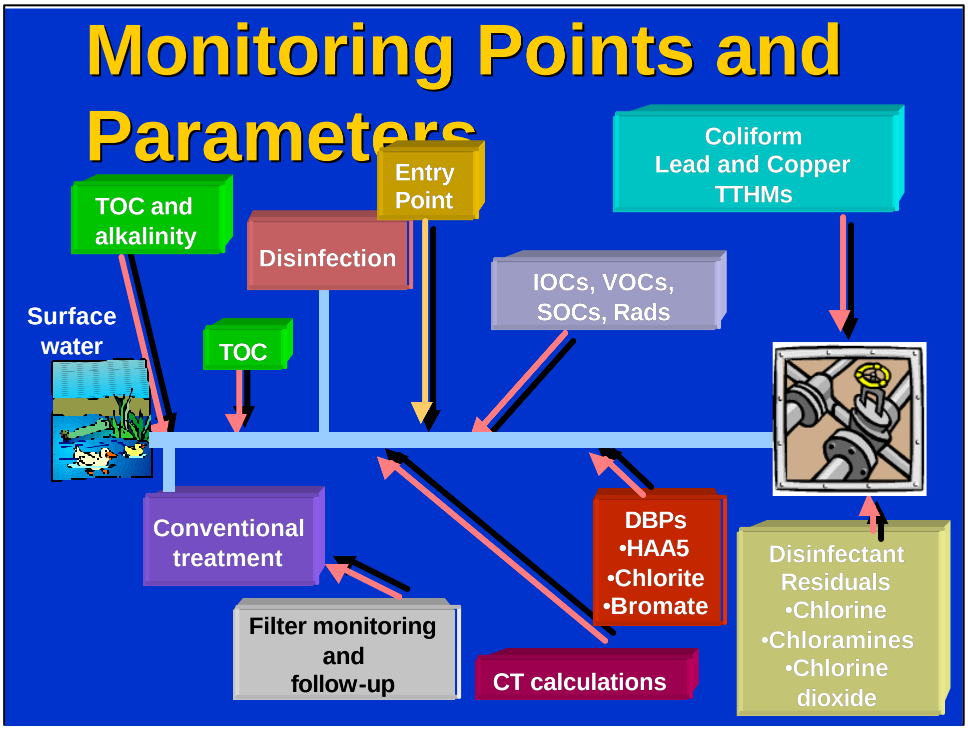


- This is simple system comprised of a well source and a distribution system.
- The system may need to complete monitoring at each entry point to the distribution system (EP) for IOCs (inorganic chemicals or inorganic contaminants), VOCs (volatile organic chemicals or volatile organic contaminants), SOCs (synthetic organic chemicals or synthetic organic contaminants) and radionuclides.
- The system may need to complete total coliform and lead and copper monitoring at selected service taps within the distribution system.



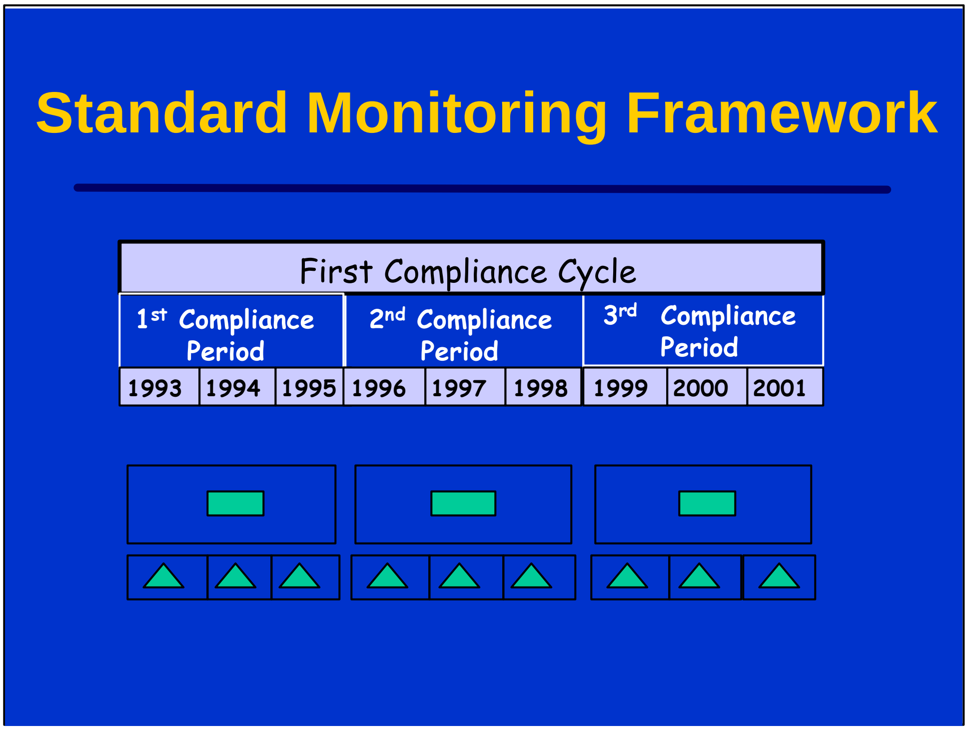
- This water system is similar to the previous slide, however, it includes a disinfection system using chlorine.
- In addition to the monitoring described for the earlier slide, this system will need to monitor for total trihalomethanes (TTHMs) and chlorine residual in the distribution system.


Monitoring Points and Parameters
Coliform
Lead and Copper
TTHMs
Entry Point
IOCs, VOCs, SOCs, Rads
Unfiltered surface water
Coliform turbidity
Watershed control requirements
Disinfection with Chlorine
CT calculations
Chlorine residual

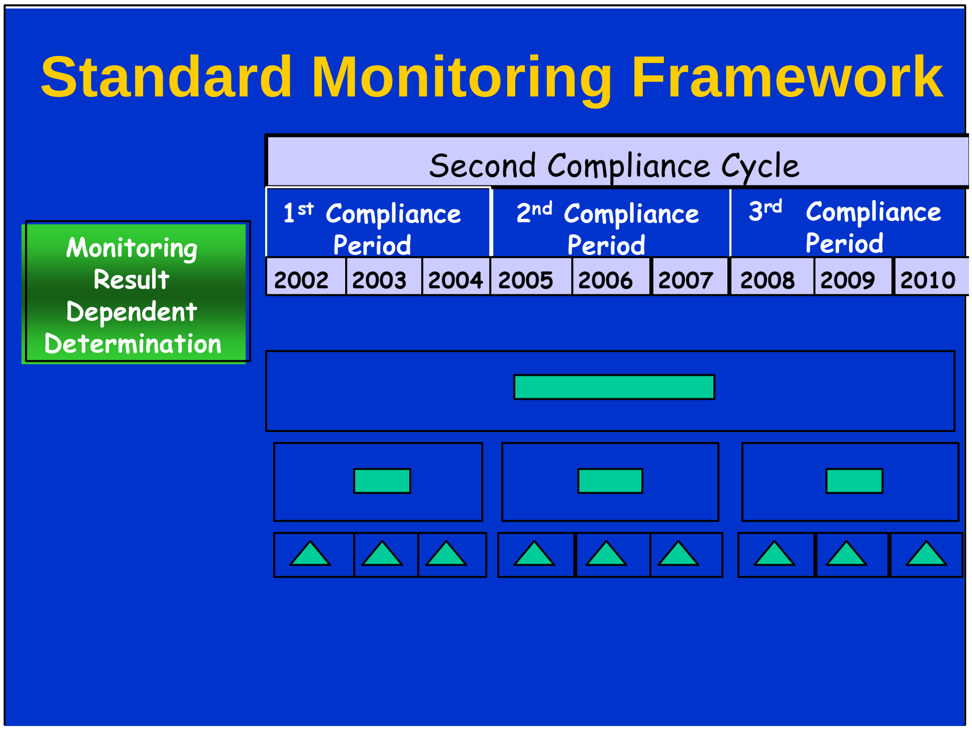

Monitoring Points and Parameters
Coliform
Lead and Copper
TTHMs
Entry Point
TOC and alkalinity
Disinfection
IOCs, VOCs, SOCs, Rads
Surface water
TOC
Conventional treatment
DBPs
•HAA5
•Chlorite
•Bromate
Disinfectant Residuals
•Chlorine
•Chloramines
•Chlorine dioxide
Filter monitoring and follow-up
CT calculations

Monitoring Schedules

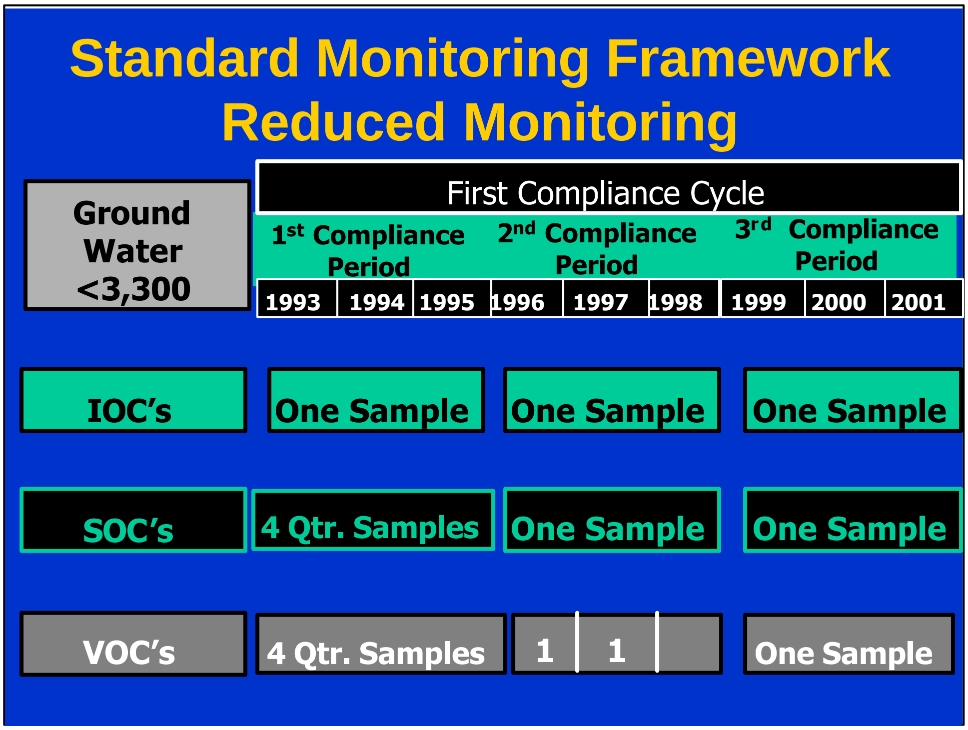
- Initial monitoring period
- Grandfathered data
- Standard monitoring framework
- Increased monitoring
- “Reliably and consistently” determinations
- Waivers



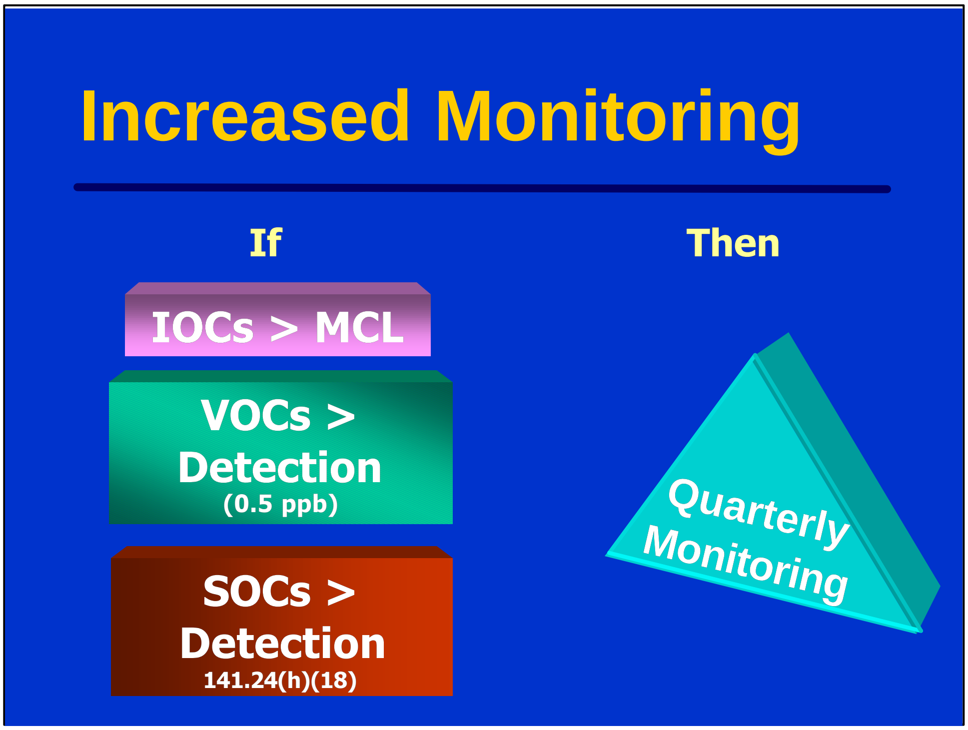
- Each drinking water rule includes unique monitoring requirements related to each contaminant's health effects, occurrence, and other characteristics. However, there is an important ***standard monitoring framework*** that serves as the basis for chemical and radiological contaminant compliance monitoring.
- The framework describes nine year compliance cycles starting in 1993, that are composed of three compliance periods of a 3-year duration. The initial monitoring required under SDWA, based on a variety of factors, is typically expressed as a frequency of monitoring within a quarter year, a one-year period, a 3-year compliance period, or a 9-year compliance cycle.
- Logically, a particular contaminant's monitoring frequency is specified for an initial period, after which the frequency may increase or decrease based on the data results during the initial period. The process remains dynamic over time, so that appropriate monitoring can respond to the observed changes in water quality. Surface water source systems typically must monitor more frequently than ground water source systems, owing to the general likelihood that surface water will be less stable in quality. **Monitoring for acute contaminants will be at a higher frequency than monitoring for chronic contaminants, because of the higher likelihood that illness will result from short term exposure to acute contaminants.**
- Generally, under EPA's drinking water regulations, failure to meet an MCL or treatment technique constitutes a violation. Some rules, however, distinguish between a numerical ***exceedance*** of an MCL or MRDL and a ***violation*** of that MCL or MRDL.
  - The lead and copper rule establishes ***action levels***. An exceedance of an action level triggers the implementation of applicable source water treatment and public education requirements. Under this rule, failure to comply with the applicable requirements is a violation.
  - Systems monitoring annually or less frequently for organic chemicals (other than TTHM's) whose sample result exceeds the MCL must begin quarterly sampling. The system will not be considered in violation of the MCL until it has completed one year of quarterly sampling.
  - For systems monitoring for chemical contaminants more than once a year, compliance is determined by calculating a ***running annual average*** of all samples taken at each sampling point. If the running annual average at any sampling point is greater than the MCL, then the system is out of compliance. If any one sample would cause the running annual average to be exceeded, then the system is out of compliance immediately.



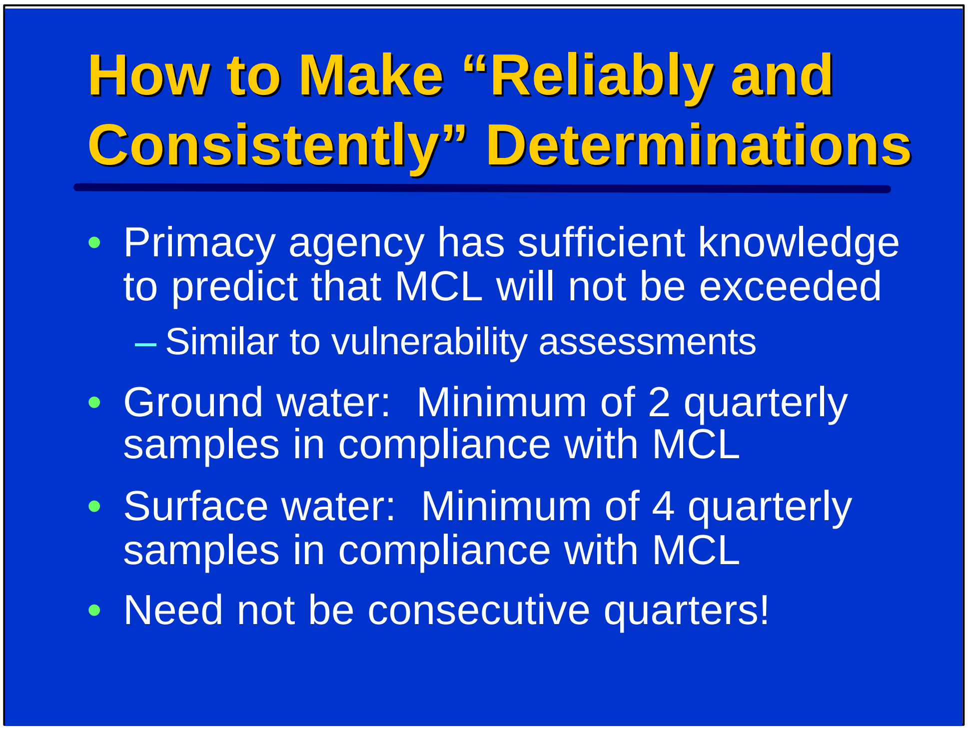
- The Second Compliance Cycle is the nine year period of time including the years 2002 to 2010.
- As systems move into the second compliance cycle, starting in 2002, their results from the first compliance cycle will dictate the monitoring frequency they continue. Some may sample as infrequently as once in nine years and others will be required to continue annual or quarterly monitoring.



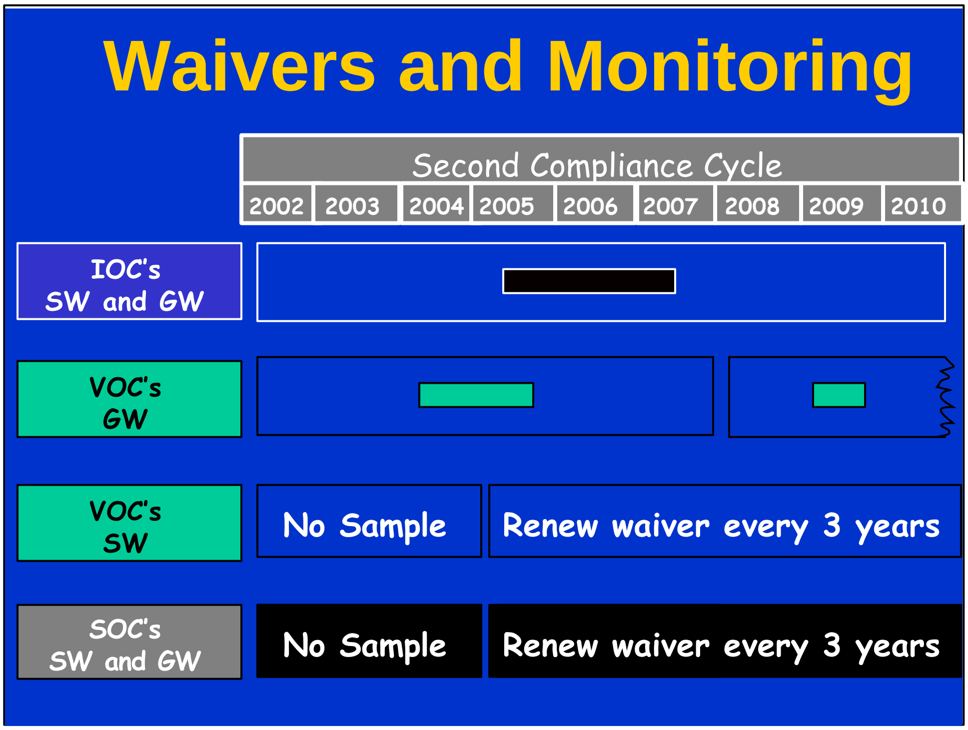
- Some systems can reduce their monitoring frequency for some contaminants under certain specified circumstances. These reduced monitoring requirements also vary by contaminant group, previous sampling results, system size, and source water type.
  - For example, after a minimum of three years of annual sampling, a State may allow ground water systems with no previous detection of any organic contaminant (SOCs and VOCs) for which an MCL has been established to take one sample during each three-year compliance period.
  - For nitrate sampling, a State may allow community and nontransient, noncommunity water systems that use a surface water source to reduce the sampling frequency to annually if all analytical results from four consecutive quarters are "less than 50 percent of the MCL," and those using ground water sources after four consecutive quarterly samples that are "reliably and consistently less than the MCL."



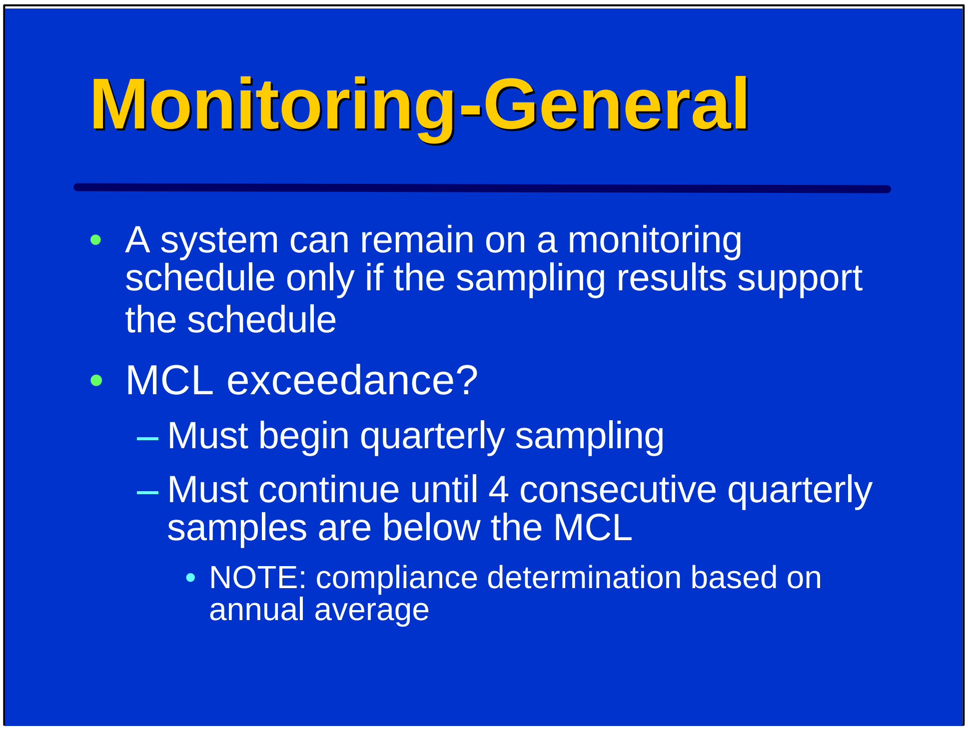
- Systems monitoring for chemical contaminants annually or less frequently that observe the occurrence of certain, specific triggering values in their monitoring, must begin quarterly monitoring in the next calendar quarter after the trigger observance (an exceedance of an MCL or an exceedance of some other triggering level such as a fraction of the MCL or the analytical detection limit).
- In this slide, the triggering values or the legal references to those triggering values are provided for VOCs and SOCs. Regarding IOCs, for example, the triggering value used for arsenic is the MCL. When a value greater than the MCL is observed in annual or less frequent monitoring, the system must adjust to quarterly monitoring, and then calculate compliance with the MCL, based on those monitoring results.



- If the primacy agency determines that a system is "reliably and consistently below the MCL," it may allow the system to monitor less frequently. "Reliably and consistently" (R & C) determinations are made regarding systems that have been required to increase their monitoring frequency because of sampling results, and then desire to justify, through an R & C determination, that they can return to less frequent monitoring (reduce monitoring).
- To make a "reliably and consistently determination," States/Primacy Agencies should examine, among other things:
  - The quality of data;
  - The amount of data;
  - The length of time covered by the data;
  - Whether there are wide variations in the data; and
  - Whether there are wide variations in results.
- The primacy agency can allow a system to take the minimum number of quarterly samples in non-consecutive quarters.
- **NOTE:** This differs from the requirement for a compliance determination because compliance is based on the total number of samples collected.



- States may grant monitoring frequency waivers under certain conditions. In determining whether to grant a waiver, a State must consider:
  - o Knowledge of the previous use (including transport, storage or disposal) of the contaminant in the watershed or zone of influence of the system.
  - o If previous use of the contaminant is unknown or it has been used, then the State must consider specified factors such as previous analytical results, proximity of the system to a potential point or nonpoint source of contamination, the environmental persistence and transport of the contaminant, number of people served by the water system, and how well the water source is protected against contamination.
- Specific waiver criteria for IOCs appears at 40 CFR 141.23(c); for VOCs at 40 CFR 141.24(f), and for SOCs at 40 CFR 141.24(h)



- A system can stay on a reduced monitoring schedule as long as the results support the schedule.
- A result above the MCL means quarterly monitoring for a system. The system must continue taking samples every quarter until four consecutive quarterly samples are below the MCL. This is a specifically stated requirement for organics, and inferred for inorganics
- Systems are only required to conduct quarterly monitoring at the entry point to the distribution system at which the sample was collected and for the specific contaminant that triggered the system into the increased monitoring frequency.

Unregulated Contaminant Monitoring Rule

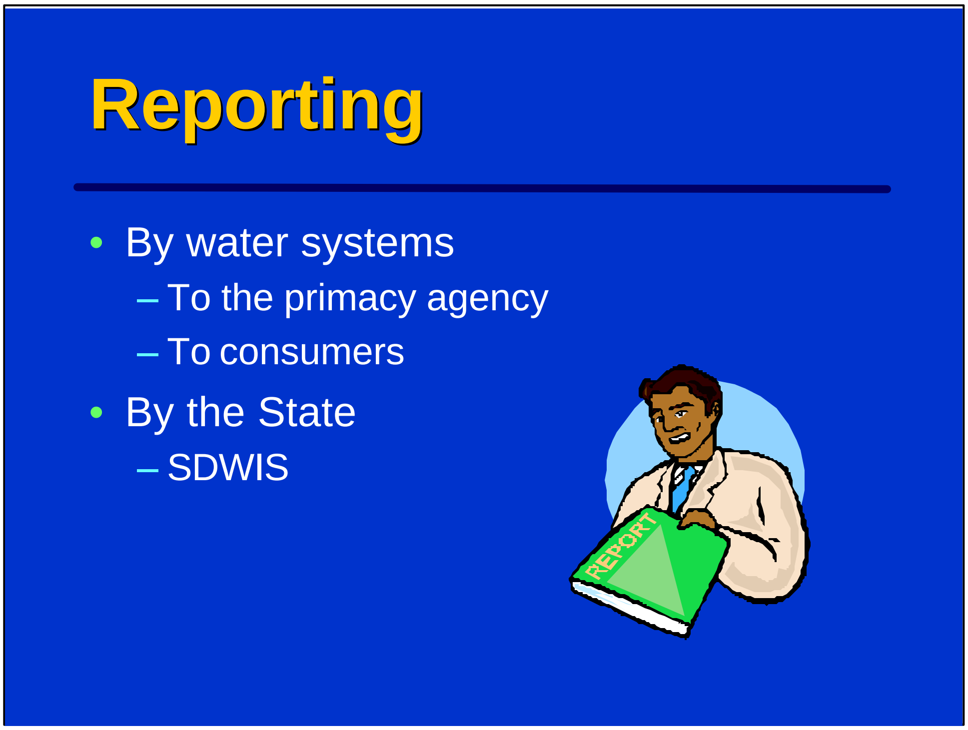
- List of contaminants to monitor
- A schedule for sampling
- Analytical methods
- Reporting requirements
  - To regulatory agencies
  - To the public

- In addition to monitoring for contaminants for which MCLs and TTs have been set, certain, selected public water systems must monitor for unregulated contaminants that are emerging contaminants of concern.
- The 1996 Amendments to the Safe Drinking Water Act require EPA to establish criteria for a monitoring program for unregulated contaminants and to publish a list of contaminants to be monitored: the ***Unregulated Contaminant Monitoring Rule*** (UCMR). The data generated by the UCMR will be used to evaluate and prioritize contaminants that EPA is considering for possible new drinking water standards. This data will help to ensure that future decisions on drinking water standards are based on sound science.
- The rule is designed to have a small economic impact. UCMR monitoring is required only for large systems (>10,000 population), who presumably can afford some incremental monitoring and by a statistically selected, nationally representative sample of less than 1,000 small and medium-sized systems. The rule includes:
  - A list of contaminants for which public water systems must monitor;
  - A sampling schedule;
  - Analytical methods for the contaminants;
  - Requirements for all large public water systems and a representative sample of small public water systems to monitor for those contaminants on the list for which methods have been promulgated;
  - Requirements to submit the monitoring data to EPA and the States for inclusion in the National Drinking Water Contaminant Occurrence Database; and
  - Requirements to notify consumers of the results of monitoring.
- The list of contaminants must be updated every five years.
- Most of the sampling is required in the years 2001 thru 2003.
- The current rule does not require systems to repeat the monitoring schedule specified in the rule.
- The rule provides that EPA will pay for some of the analytical work done under the UCMR.

Analytical Methods

- Promulgated by OGWDW
- Specific requirements
  - Composite samples
  - Detection limits
  - Multi-analyte methods

- An ***analytical method*** is a procedure used to analyze a sample in order to determine the identity and concentration of a specific sample component. Analytical methods generally include information on the collection, transport, and storage of samples; define procedures to concentrate, separate, identify, and quantify components contained in samples; specify quality control criteria the analytical data must meet; and designate how to report the results of the analyses.
- Many government agencies, universities, and consensus methods organizations develop analytical methods. The Office of Ground Water and Drinking Water is responsible for evaluating analytical methods developed for drinking water by these organizations. The Office then promulgates, as approved, those methods that it determines meet Agency requirements for monitoring organic, inorganic, radionuclide and microbiological contaminants. **Consistent with the CWA, only approved analytical methods published in the *Federal Register* can be used for compliance-related monitoring of drinking water under SDWA.**
- Some rules allow ***composite samples***, that is, samples that are combined or mixed. For example, in sampling for organic chemicals, composite samples from a maximum of five sampling locations are allowed, provided that the detection limit (the lowest concentration at which a contaminant can be detected using available technology) of the method used for analysis is less than one-fifth of the MCL. Monitoring for residual disinfectants must be done by analysis of ***grab samples*** (a single sample taken at a particular time and place) or continuous monitoring.
- Some analytical methods can be used to detect numerous contaminants (***multi-analyte methods***). For example, EPA Method 505, Organohalide Pesticides and PCBs by Microextraction and Gas Chromatograph, can be used to detect pesticides and PCBs.



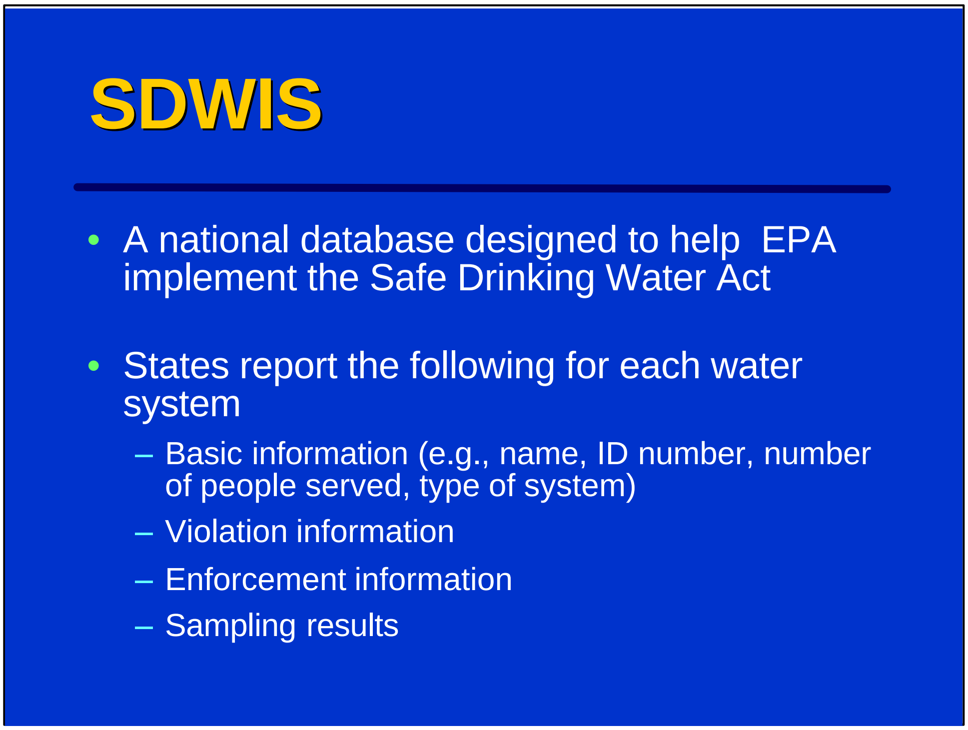
- If a numerical result in excess of an MCL or other trigger value is detected during monitoring, there are immediate retesting requirements, referred to as confirmation sample requirements, that go into effect and strict instructions for how the system informs the public and the primacy agency about the sampling and analysis result. Confirmation samples are required to help determine the accuracy of data that indicate a violation of the MCL, on a very short term basis, often 24 hours or less. They are not the same and cannot be substituted for samples required when a system must begin increased frequency monitoring.
- Systems must report the results of their monitoring in their annual Consumer Confidence Report (CCR) and may need to notify the public in accordance with the Public Notification Rule if a violation or an exceedance occurs.
- EPA regulations also require public water systems to maintain certain records and make them available to the public.
- States are required to enter information in a national database, the Safe Drinking Water Information System (SDWIS).

Consumer Confidence Reports and Public Notification

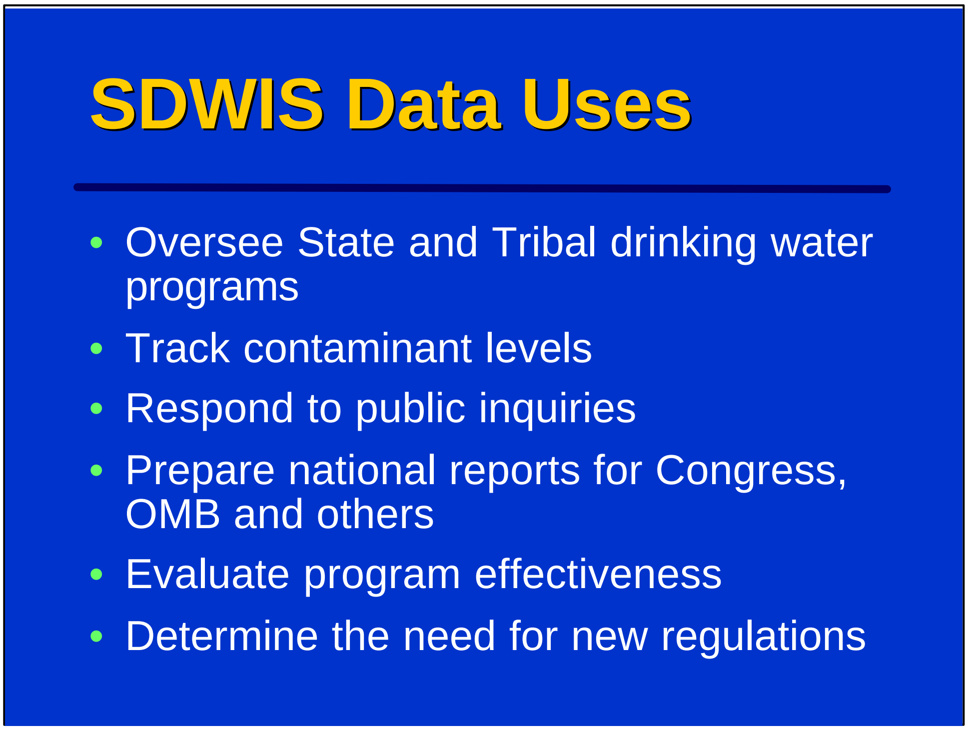
- Easy-to-understand explanations of drinking water standards and health effects
- Information on the quality of the water system's source and monitoring results
- Health effects information on any contaminant in violation of an EPA health standard
- Hotline number to address questions

- Consumer awareness and right-to-know was a major theme of the 1996 Safe Drinking Water Act Amendments. Beginning in 1999, water systems must provide their customers annual reports, called ***Consumer Confidence Reports (CCRs),*** that provide information about the quality of their drinking water.
  - o The CCRs must provide easy-to-understand explanations of drinking water standards and health effects.
  - o The CCRs also provide customers with information on the water system's source, monitoring results and health effects of any contaminants detected.
  - o CCRs must include the telephone number of a Safe Drinking Water Hotline so that consumers have another source of information on contaminants and other issues.
- ***Public notification***, which predates the 1996 Amendments, requires public water systems to notify the public in the event of a violation of drinking water standards. Methods of notification and deadlines are delineated in the rule.

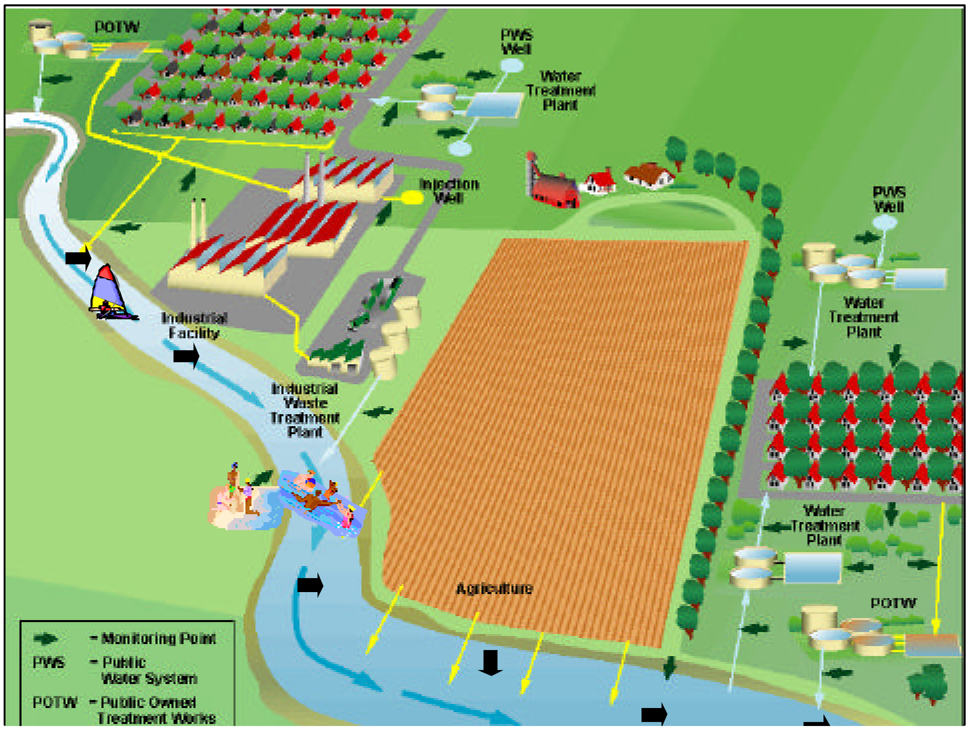
> Contrast the aggressive public notice requirements under SDWA with the lack of them under the CWA. There is no comparable CWA program to notify consumers of water impairment.



- The ***Safe Drinking Water Information System (SDWIS)*** database was designed and implemented by EPA to meet its needs in the oversight and management of the Safe Drinking Water Act. The database contains data submitted by States and EPA Regions in conformance with reporting requirements established by statute, regulation and guidance.
- A "sister" system, SDWIS/STATE (State version) was designed by EPA and States to help States and EPA Regions run their drinking water programs and fulfill EPA reporting requirements.
- SDWIS is an EPA national database storing routine information about the nation's drinking water. SDWIS stores the information EPA needs to monitor approximately 162,000 public water systems.
- States report the following information to EPA:
  - o Basic information on each water system, including: name, ID number, number of people served, type of system (year-round or seasonal), and source of water (ground water or surface water);
  - o Violation information for each water system: whether it has followed established monitoring and reporting schedules, complied with mandated treatment techniques, or violated any Maximum Contaminant Levels (MCLs);
  - o Enforcement information: what actions States have taken to ensure that drinking water systems return to compliance if they are in violation of a drinking water regulation; and
  - o Sampling results for unregulated contaminants and for regulated contaminants when the monitoring results exceed the MCL.



- Currently, EPA is in the process of determining additional information States may be required to report in the future, such as the city and county where the system is located (most States already report this information), and the latitude and longitude of the source water intake.
- EPA uses this information to oversee State drinking water programs, track contaminant levels, respond to public inquiries, and prepare national reports for Congress, OMB and others. EPA also uses this information to evaluate the effectiveness of its programs and regulations, and to determine whether new regulations are needed to further protect public health.



Class Discussion

- In this diagram, where would you have monitoring points to assess the effectiveness of treatment processes and where would you monitor ambient water quality?
- Where would you monitor to determine impacts of point source discharges on aquatic life? Agricultural runoff? Urban stormwater runoff?
- Where would be the most important points at which to monitor to determine risks to humans from pathogens? Carcinogens?

Group Exercise

- Monitoring and Reporting Requirements —Compliance Determinations
- See your binder for the exercise