BASIC WATER AND WASTEWATER FOR THE COMMUNITY

Presenter:

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ENTECH ENGINEERING

READING | LITITZ | POTTSVILLE | MOUNTAINTOP | PITTSBURGH

Outline

- Section 1: Potable Water
- Section 2: Wastewater
- Section 3: Financing & Community Involvement

Goals – Potable Water

- Overall safeness and sources of drinking water.
- The distribution system.
- Identification of the roles of the government agencies and a brief overview of major regulations.
- Treatment techniques.

QUIZ – SECTION 1

Goals – Wastewater

- Characteristics of wastewater.
- The collection and conveyance system.
- Planning, permitting, and reporting requirements.
- Treatment techniques.

QUIZ – SECTION 2

Goals – Financing and Community Involvement

- Basic understanding of the reason for financing and upkeep of the potable water / wastewater system.
- Identification of the importance of community involvement and techniques to obtain involvement.

QUIZ – SECTION 3

Section 1

DRINKING WATER

References

- *Water of Tap: What You Need to Know*. United States Environmental Protection Agency (USEPA), December 2009. Print. www.epa.gov/safewater

- *Drinking Water Operator Certification Training Modules*. Pennsylvania Department of Environmental Protection (PADEP, Revised April 2013. Print.
  www.portal.state.pa.us/portal/server.pt/community/training/21408/dep_training_modules/1522737#dw

- PADEP - Bureau of Safe Drinking Water
  http://www.portal.state.pa.us/portal/server.pt/community/Bureau_of_Safe_Drinking_Water/20891

Drinking Water is Essential to Life

- USS Indianapolis
  - Attacked and sank July 30, 1945 by a Japanese torpedo
- 900 made it into the water
  - After 5 days at sea
    - shark attacks
    - starvation
    - dehydration
    - Exposure
- 317 survived


EUROPE
NORTH
ATLANTIC OCEAN
ALGERIA
MAURITANIA
MALI
Caribbean Sea
CENTRAL
AMERICA
SOUTH
AMERICA
BRAZIL
SOUTH
ATLANTIC OCEAN

Drinking Water Questions

- How safe is my drinking water?
- Where does my drinking water come from?
- How does it get to my house?
- How is my drinking water treated?
- What is being done to improve security?

Is it safe?

- It is contaminated; FOR REAL?
- Some people may be more vulnerable to contaminants than the general population.
  - People undergoing chemotherapy
  - Living with HIV/AIDS
  - Transplant patients
  - Children and infants
  - Elderly
  - Pregnant women and their fetuses

Pollutants

- Naturally Occurring:
  - Microorganisms
  - Radionuclides
  - Nitrates and Nitrites in the Soil
  - Heavy Metals
    - Arsenic, Cadmium, Chromium, Lead, and Selenium
  - Fluoride

http://water.epa.gov/drink/contaminants/basicinformation/fluoride.cfm

USEPA – Water on Tap what you need to know

Pollutants

- Human Activities:
  - Bacteria / Nitrates
  - Heavy Metals
  - Fertilizers and Pesticides
  - Industrial Products and Wastes
  - Household Wastes
  - Lead and Copper
  - Water/Wastewater Treatment Chemicals

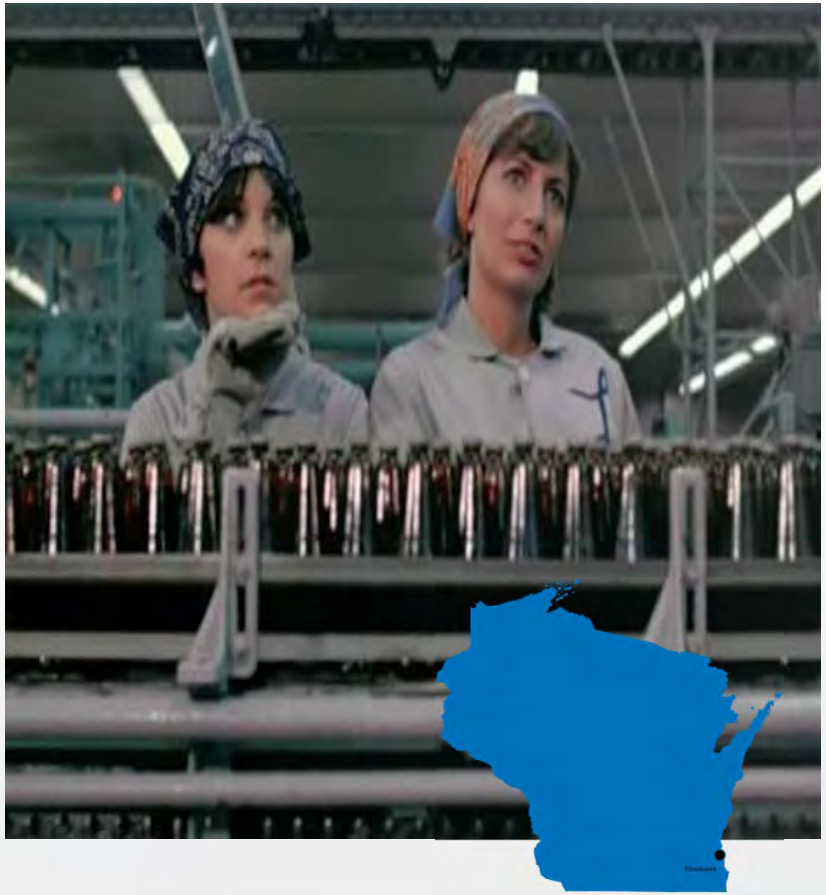
USEPA – Water on Tap what you need to know

Microbial Contamination

- The potential for health problems from microbial contaminated drinking water is demonstrated by localized outbreaks of waterborne disease.

Microbial Contamination

- Certain pathogens, such as Cryptosporidium, may occasionally pass through water filtration and disinfection processes in numbers high enough to cause health problems.



USEPA – Water on Tap what you need to know

Chemical Contamination

- Nitrate, a chemical most commonly used as a fertilizer, poses an immediate threat to infants at levels above the national standard.
  - Nitrates are converted to nitrites in the intestines. Once absorbed into the bloodstream, nitrites prevent hemoglobin from transporting oxygen.
    - Blue Baby Syndrome

Lead

- Lead can cause a variety of adverse health effects.
  - In children, exposure to lead in drinking water above the action level of lead (**0.015 mg/L**) can result in delays in physical and mental development.
- Congress enacted the “Reduction of Lead in Drinking Water Act” (2011), regarding the use and introduction into commerce of lead pipes, plumbing fittings or fixtures, solder and flux.
  - The Act established a prospective effective date of January 4, 2014.

mg/L

- Standard BB
  - .3408 g = 340.8mg
- 15x4’ pool
  - 20,000 L

Waterborne Disease Outbreaks Associated with Drinking Water

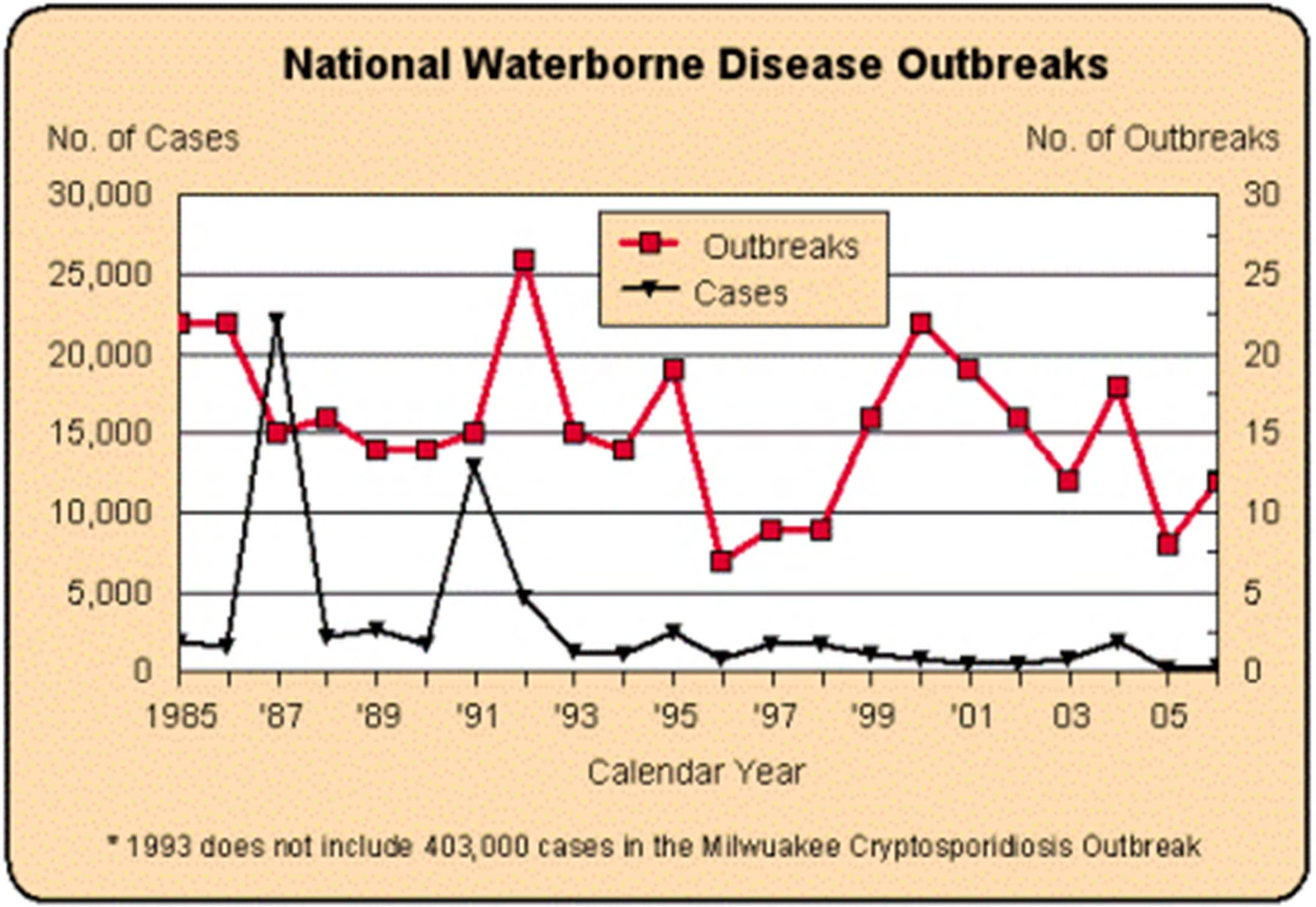
- During 2009–2010, the most recent years for which finalized data are available:
  - 33 outbreaks reported
  - 1,040 cases of illness
  - 85 hospitalizations
  - 9 deaths

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6235a3.htm

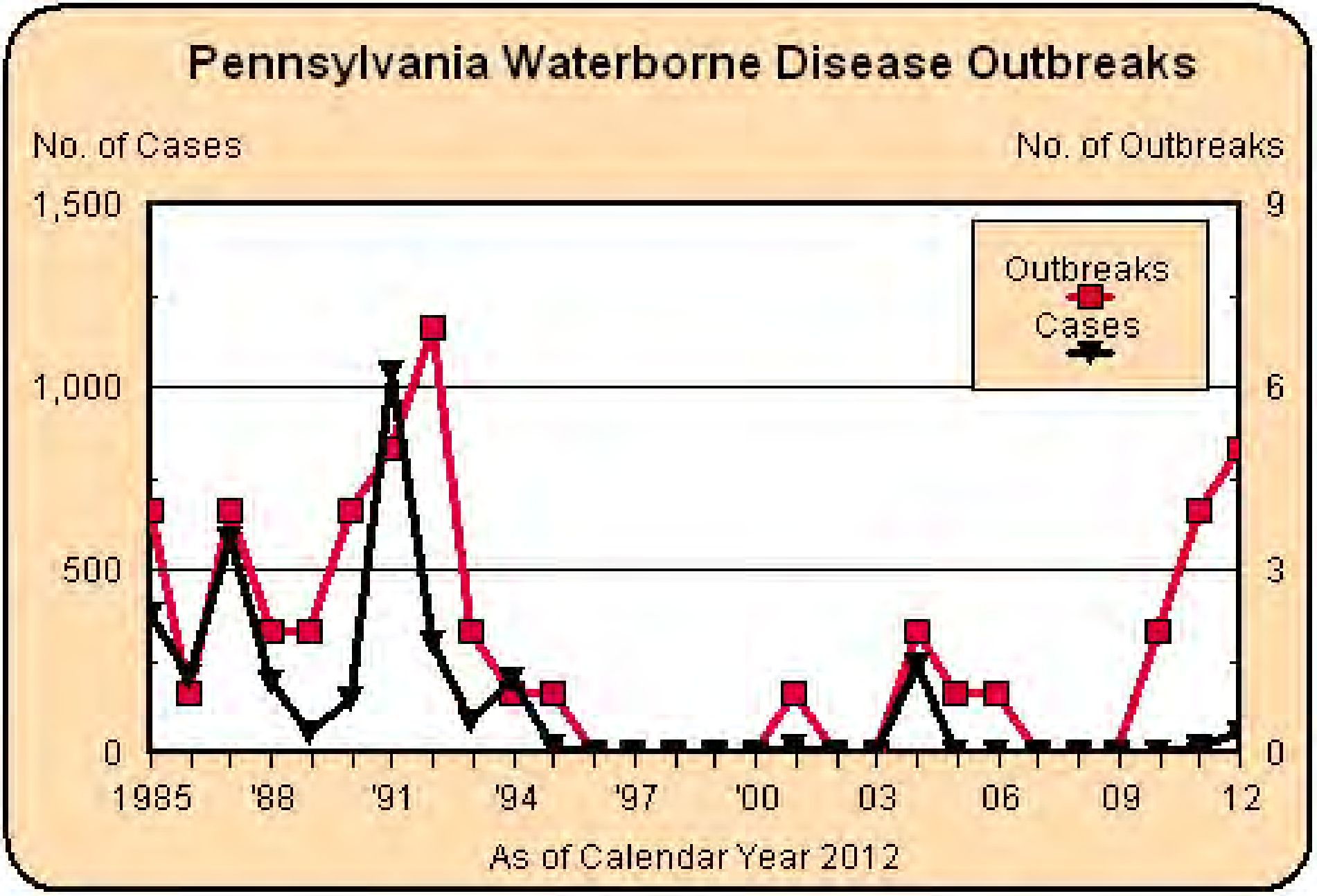
Disease Outbreaks

- *Legionella* accounted for 58% of outbreaks and 7% of illnesses, and *Campylobacter* accounted for 12% of outbreaks and 78% of illnesses.
  - The most commonly identified outbreak deficiencies (legionella) were:
    - Plumbing systems (57.6%)
    - Untreated ground water (24.2%)
    - Distribution system deficiencies (12.1%)

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6235a3.htm



http://www.portal.state.pa.us/portal/server.pt/community/waterborne_diseases/21164/waterborne_diseases_reach_all-time_low_in_pennsylvania/1259358



http://www.portal.state.pa.us/portal/server.pt/community/waterborne_diseases/21164/waterborne_diseases_reach_all-time_low_in_pennsylvania/1259358

Limit the Outbreak - Public Notifications

PN requirements were revised to provide for different delivery deadlines of notices based on the persistence of the violations and the seriousness of any potential adverse health effects that may be involved.

http://www.portal.state.pa.us/portal/server.pt/community/public_drinking_water/21162/public_notification/1258843

Public Notifications – Tier 1

- Tier 1 (24 Hours) - Adverse health effects as a result of short-term exposure.
  - Provide direct delivery of public notice to each service connection using one or more of the following methods: hand delivery, electronic mail, automatic telephone dialing systems, or another form of direct delivery approved in writing by DEP.
  - Provide public notice to transient and non-transient service connections (if applicable) by using appropriate broadcast media (radio or television).

http://www.portal.state.pa.us/portal/server.pt/community/public_drinking_water/21162/public_notification/1258843

Public Notifications – Tier 2

- Tier 2 (30 days) - With the potential to cause chronic health effects as a result of long-term exposure.
  - Mail or other direct delivery, and any other method as needed to reach others.

http://www.portal.state.pa.us/portal/server.pt/community/public_drinking_water/21162/public_notification/1258843

Public Notifications – Tier 3

- Tier 3 (1 year) - That cause no health effects.
  - Mail or other direct delivery, and any other method as needed to reach others.

http://www.portal.state.pa.us/portal/server.pt/community/public_drinking_water/21162/public_notification/1258843

Is Bottled Water better?

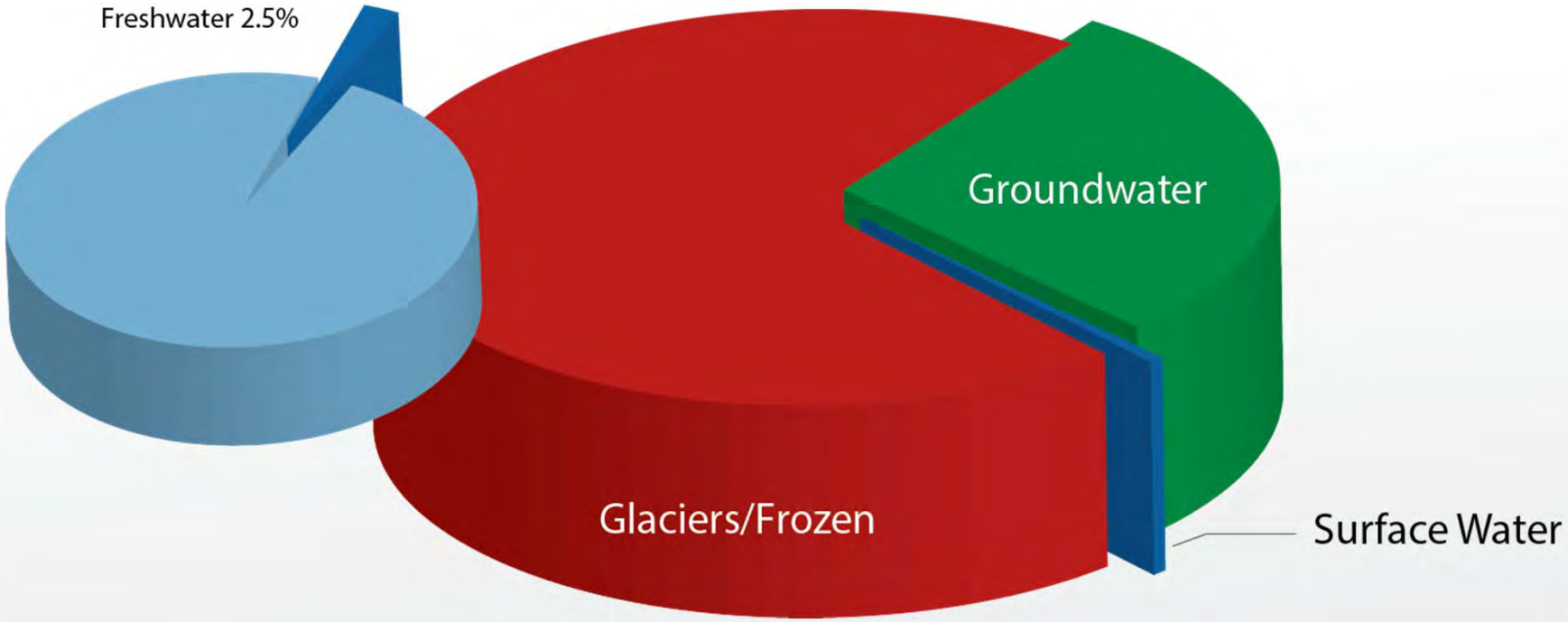
- "Bottled water is not necessarily safer than your tap water."
  - "EPA sets standards for tap water provided by public water systems; the Food and Drug Administration sets bottled water standards based on EPA's tap water standards."

http://safewater.supportportal.com/link/portal/23002/23015/Article/18873/Is-bottled-water-safer-than-tap-water

Private Wells

- Do private wells receive the same protection as public water systems?
  - Private water supplies, such as household wells that serve one or a few homes, are not regulated
  - Routine testing is highly recommended

Sources – Where Does Our Water Come From?



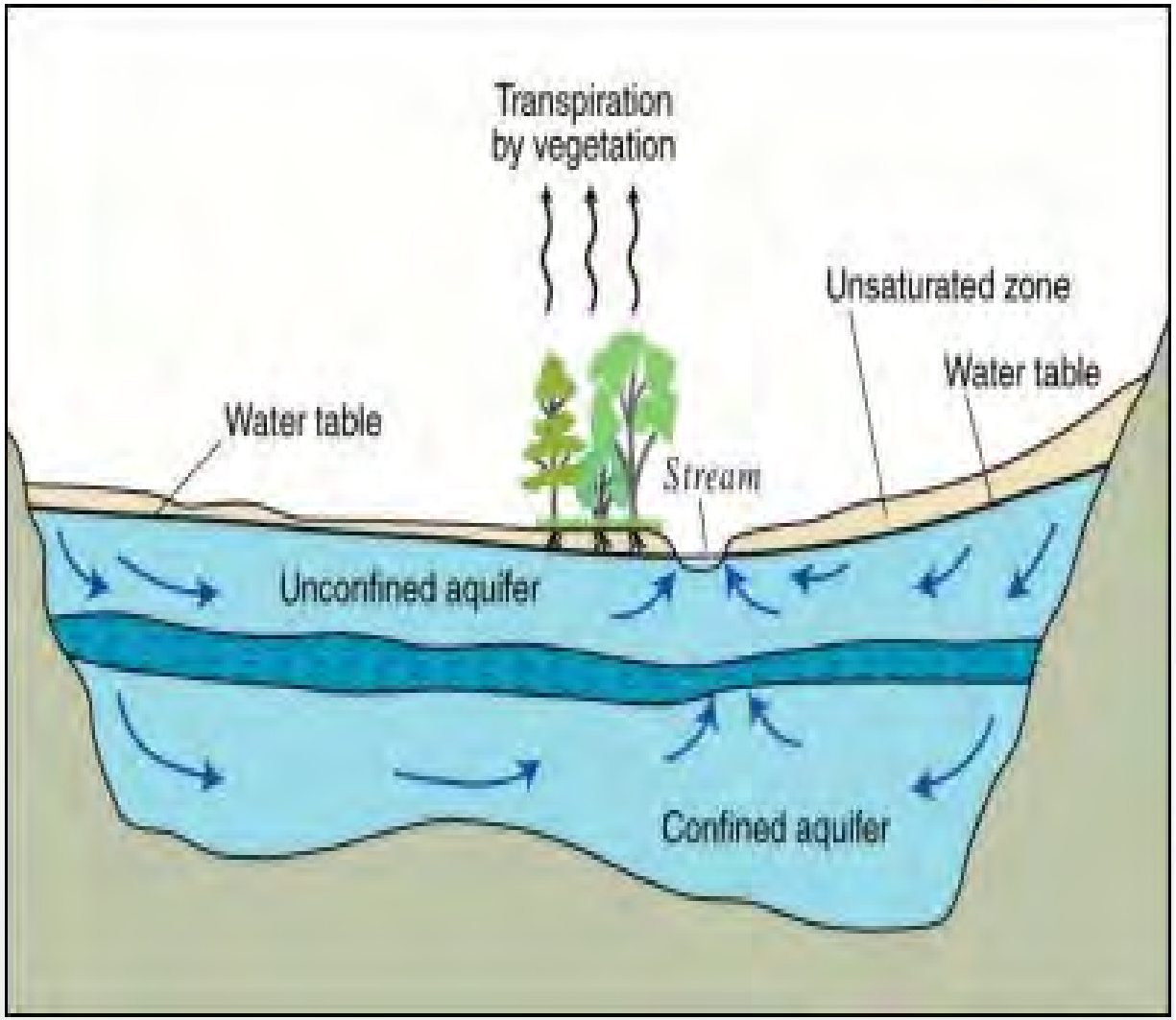
Sources

- **Surface Water:**
  - Water that systems pump and treat from sources open to the atmosphere
    - Rivers
    - Lakes
    - Reservoirs
- **Ground Water:**
  - Water pumped from wells drilled into underground aquifers (geologic formations containing water)

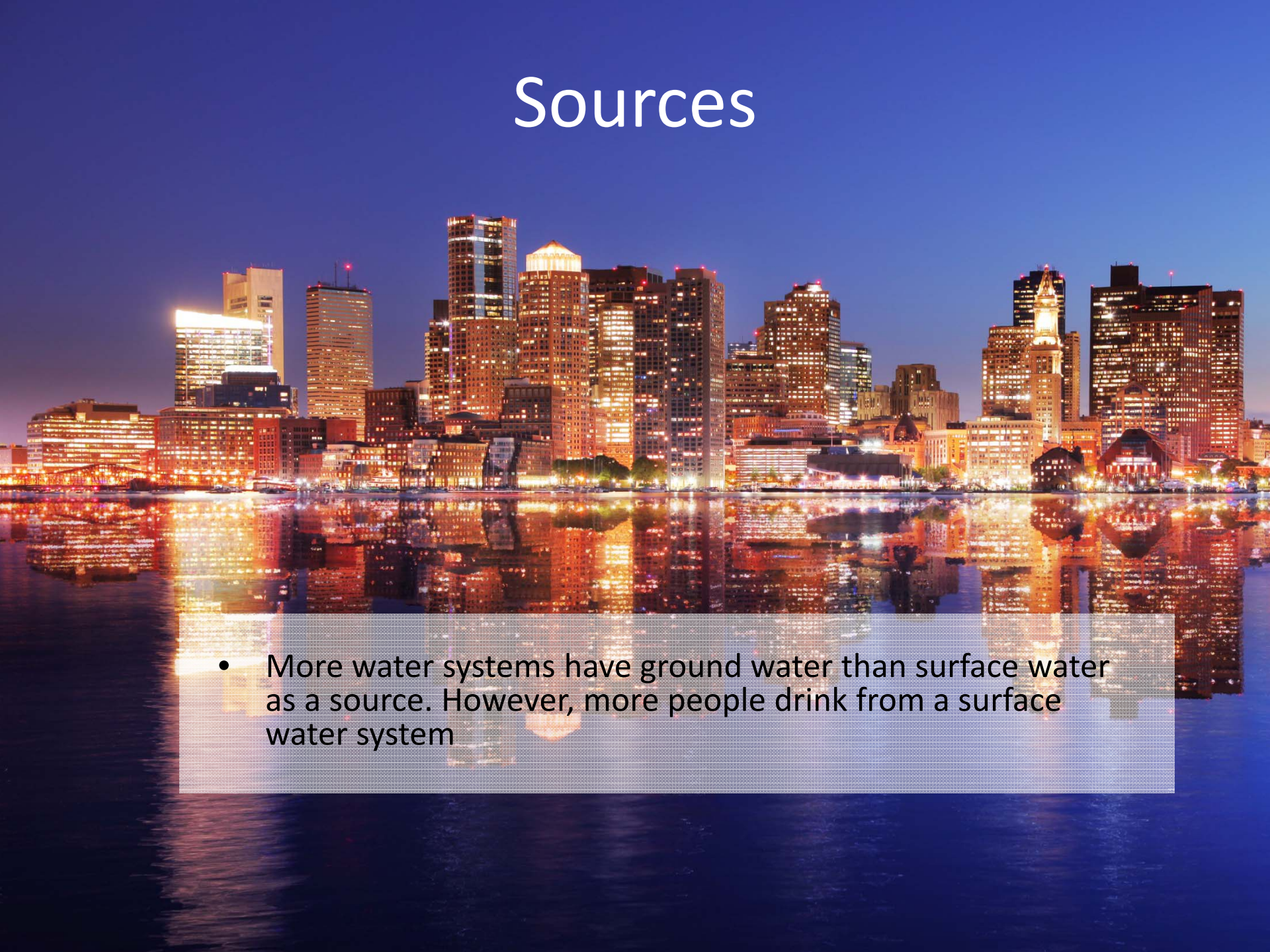
Groundwater

- Quantity produced depends on the nature of the rock, sand, or soil in the aquifer.

- Wells may be shallow (>50 ft) or deep (more than 1,000 ft).



Sources



- More water systems have ground water than surface water as a source. However, more people drink from a surface water system

Distribution System

Volume

- Adequate volume is based upon the number and types of customers in a service area.

- Fire flow needs also vary depending upon the types of customers in a given area.

Pressures

- Appropriate system pressure should be provided throughout the distribution system to ensure adequate service and protect against backflow.

- A system can have several different pressure zones to ensure minimum pressures are met and to control issues associated with over pressure.

Water Quality

- Excessive Detention Time
  - Result in a depletion of chlorine residual
    - Possible Microbial Contamination

- Contamination
  - Main Breaks
  - Cross Contamination

Distribution System Components

- Pipes
- Valves
- Hydrants
- Meters
- Storage
- Booster Stations

Pipes

- Sized to accommodate normal and peak flows and fire flows without adversely impacting water quality (too big) or resulting in an excessive pressure drop (too small). Needs to be just right.

- Constructed of material that is durable and corrosion resistant.

Valves

- Isolation Valves
  - Testing / Maintenance
  - Gate Valves (typical)
- Control Valves
  - Flow
    - Check / Backflow Prevention
  - Pressure
    - Pressure Reducing Valves
    - Pressure Sustaining Valves
    - Pressure Relief Valves

Pipe Surge

- Causes:
  - Opening / Closing Valves too quickly
  - Starting or stopping pumps
  - Opening / Closing fire hydrants too quickly

- Problems:
  - Pipe Bursting
  - Pipe Collapsing
  - Other system failures.

Meters

- Primary purpose is to measure, display, and record the amount of water that is:
  - Supplied to the overall system (or particular areas)
  - Used by a customer for billing purposes
  - Determining Unaccounted-for-water
- Types: Displacement Meters, Magnetic Meters, and Compound Meters

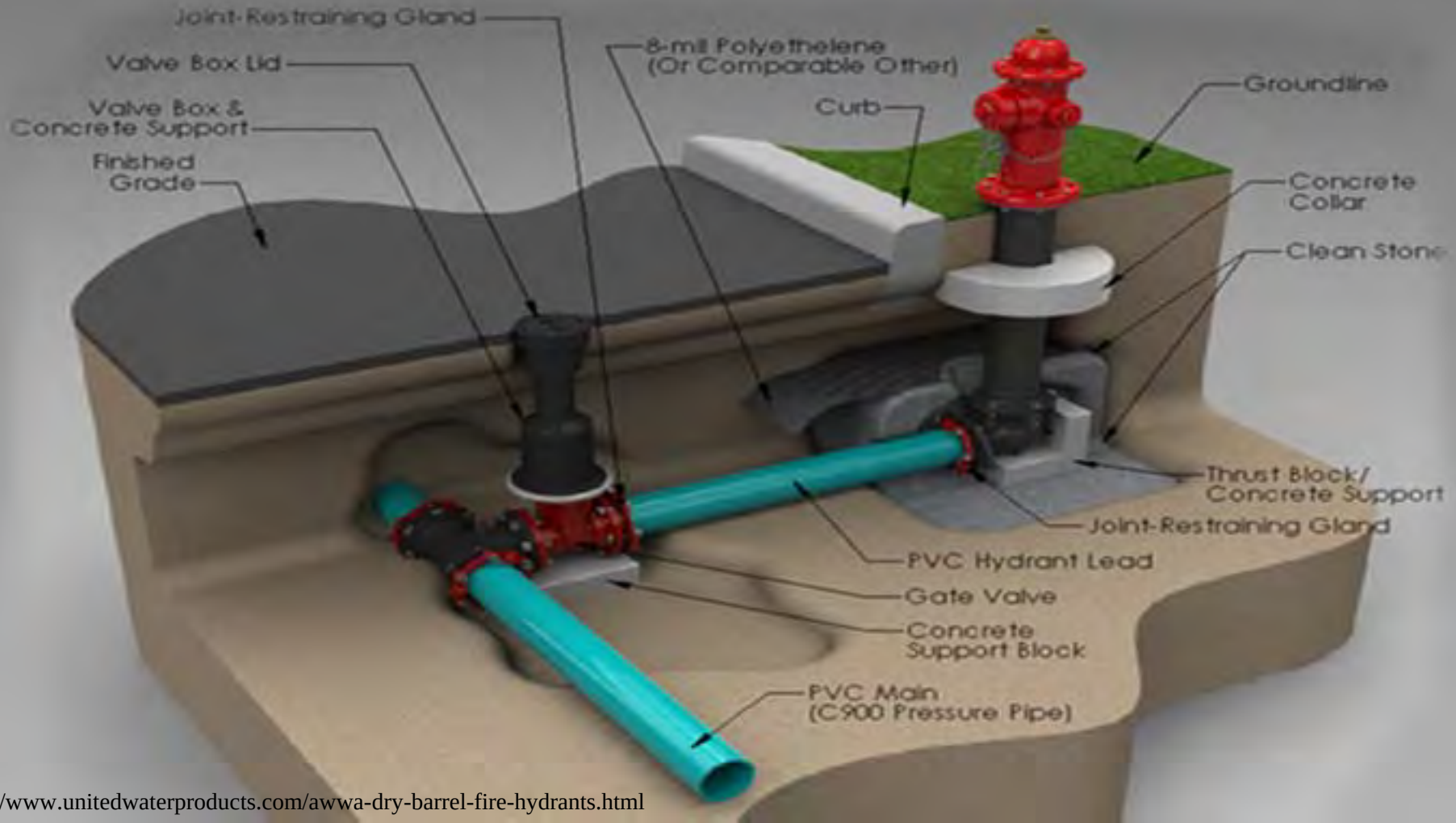
Meters

- Radio Read - In order to reduce manpower costs for meter readers and manual meter entry, many communities are going with radio frequency water meters.

- These offer the advantage of reduced costs (after installation) and allow the water supplier to more closely monitor water use by individual homes.

Hydrants

- Primary Purpose: Provide water at high flow rates to aid in extinguishing fires



http://www.unitedwaterproducts.com/awwa-dry-barrel-fire-hydrants.html

Storage

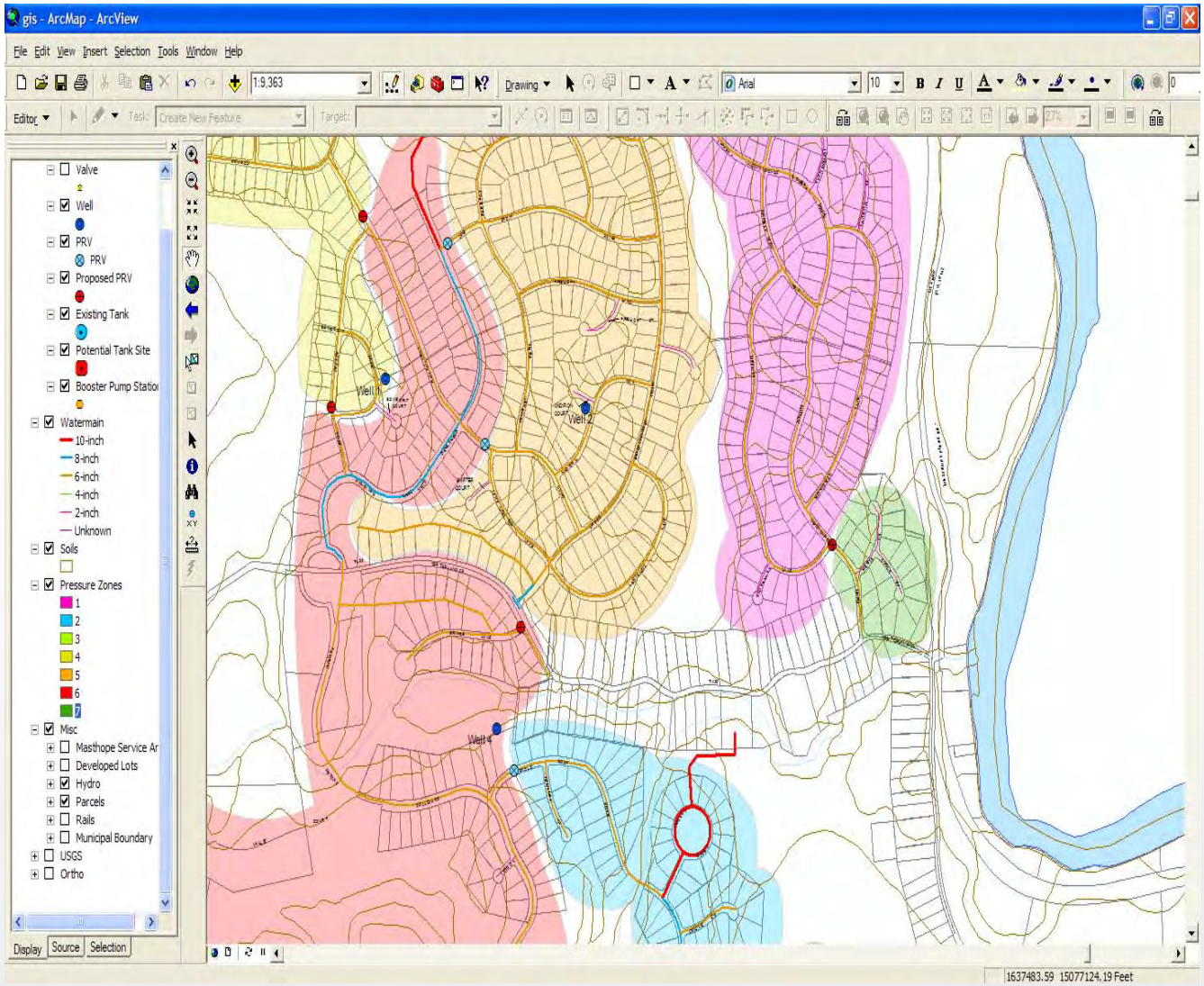
- Closed tank or reservoir
- Helps meet fluctuations in system demand
- Minimizes fluctuations in system pressure.
- Provides reserve volumes to help meet fire flow needs and an emergency supply

Booster Stations

- Booster stations are used to transport and boost water within the distribution system throughout other parts of the distribution systems to provide water at desired pressures

http://www.engineeredfluid.com/skid%20mounted%20pump%20stations.html

Water System Mapping



Importance of System Mapping

- Personnel need to know and understand their system
- Locate main, services, valves, and hydrants
- Identification of monitoring locations
- Perform maintenance and make repairs
- Respond to PA One Calls
- Save time and money

Keeping the information for future generation of operators

http://www.carroll-ohio.com/Water%20off-001.jpg.jpg

GPS Units

- Survey Quality
  - $50,000 - $60,000
  - Accuracy: ¼ inch
- GPS
  - $5,000- $20,000
  - Accuracy: 1 foot

Mapping

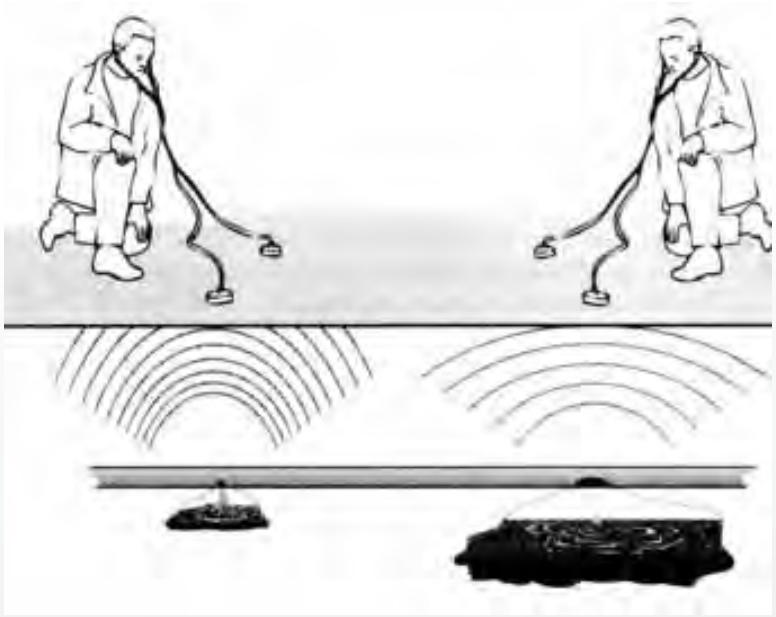
- 100% Complete System Map
  - Loch Ness Monster, Big Foot, Aliens.

Distribution System Maintenance

- Pipeline Maintenance
- Valve Maintenance
- Meter Testing and Maintenance
- Fire Hydrant Maintenance

Pipeline Maintenance

- Leak Detection
  - Direct Observation, Acoustic Equipment, and Water Audits
- Main Break Repair and Replacement
  - Asset Management Program
- Cleaning and Lining
  - Flushing Program, Mechanical, and Lining



Valve Exercise

- Inspection Program
  - Is it broke or buried?
- Exercising Program
  - Is it operable?

http://www.cityofbryan.net/PR20130315.asp

Meter Replacement Program

- Accuracy decreases over time (age of the meter) due to wear, deposits, and/or turbulence

- Periodic testing ensures accurate readings and limits lost revenue / unaccounted-for-water (under reading meters) and provides a more accurate picture of ACTUAL leaks within your distribution system

Fire Hydrant Maintenance

- Can be performed in conjunction with flushing program
- Inoperable hydrants should be noted and tagged

http://www.a2gov.org/government/publicservices/water_treatment/Pages/hydrantflush.aspx

SECTION 1

BREAK (10 Minutes)

Government Agencies

- United States Environmental Protection Agency (USEPA)
- Pennsylvania Department of Environmental Protection (PADEP)
- River Basin Commissions
  - Susquehanna River Basin Commission
  - Delaware River Basin Commission

USEPA

- EPA is mandated by Congress through the Safe Drinking Water Act (SDWA) to establish drinking water regulations and periodically review these regulations to update them.

- EPA studies health issues related to water quality and develops regulations, standards, and guidance documents related to drinking water.

PADEP

- PADEP has the responsibility for ENFORCEMENT of EPA drinking water regulations and ensure that the minimum requirements mandated by EPA are met.

Basin Commissions

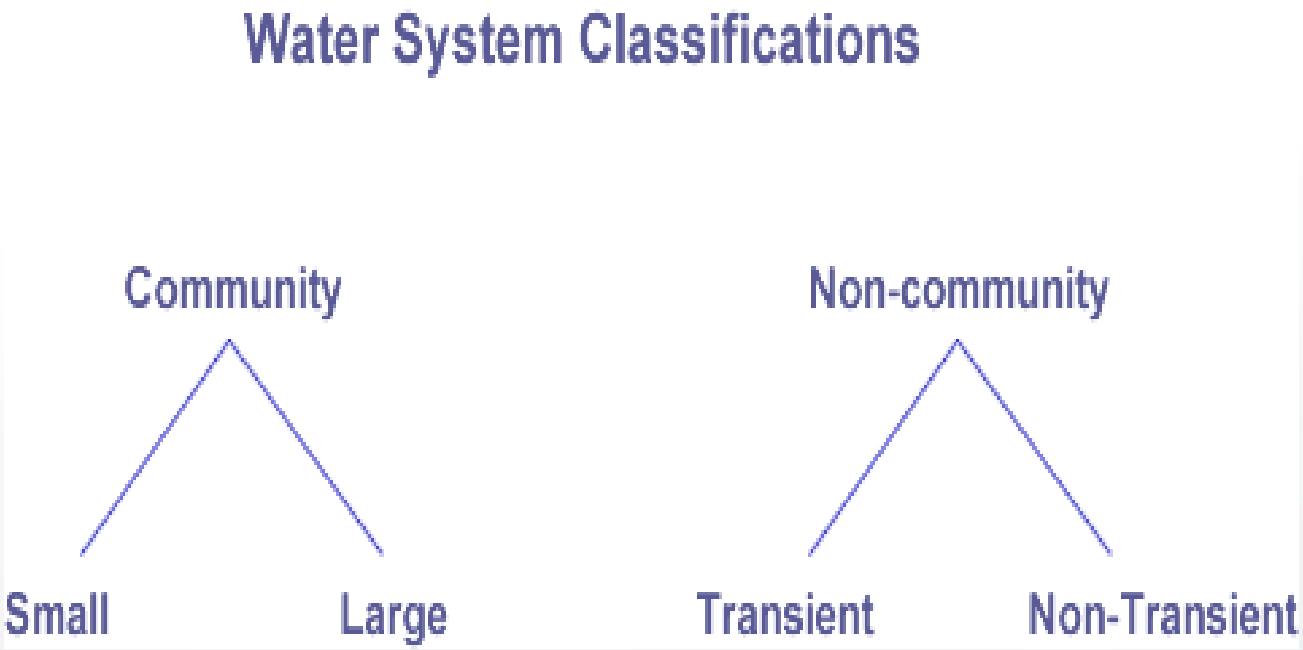
- Handle issues related to:
  - Water Allocation
  - Water Withdrawal Limits
  - Minimum Stream Flows and Required Reservoir Releases
  - Inter-basin Water Transfers
    - Water withdrawn from one river basin and discharged to another either directly or as treated wastewater after consumption

Water Supply System Classifications

Public Water System

- A public water system (PWS) is defined as a system that:
  - Serves piped water to at least 25 persons or 15 service connections for at least 60 days out of the year.

Water System Classification Tree

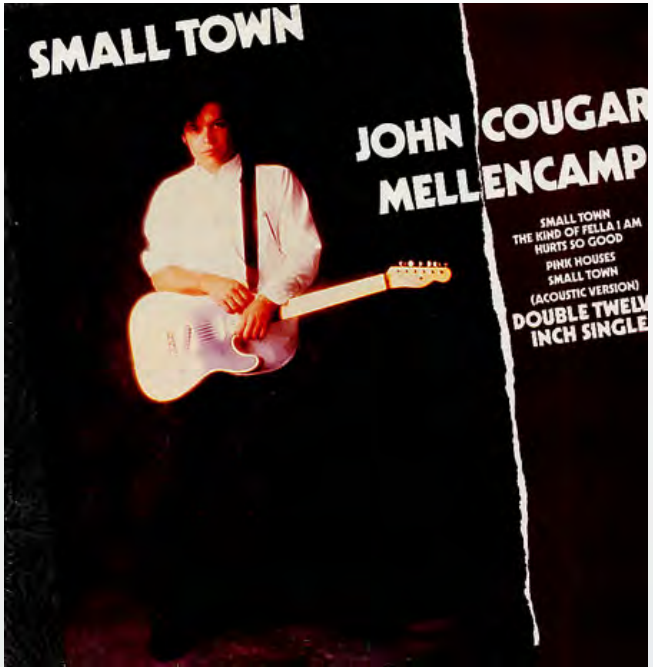


Community Water Systems (CWS)

- “A public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year round residents.”

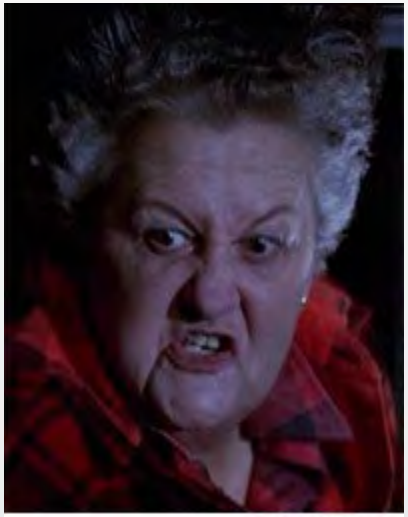
CWS - Small

- Small CWSs are systems that serve 3,300 persons or fewer.
  - Small water systems are not required to meet all the same requirements as larger systems.



CWS - Large

- Generally, water systems that serve more than 3,300 people are classified as Large Water Systems.
  - For certain specific regulations, a system must serve more than 10,000 people or 50,000 to be considered a “Large Water System.”



Warner Bros.

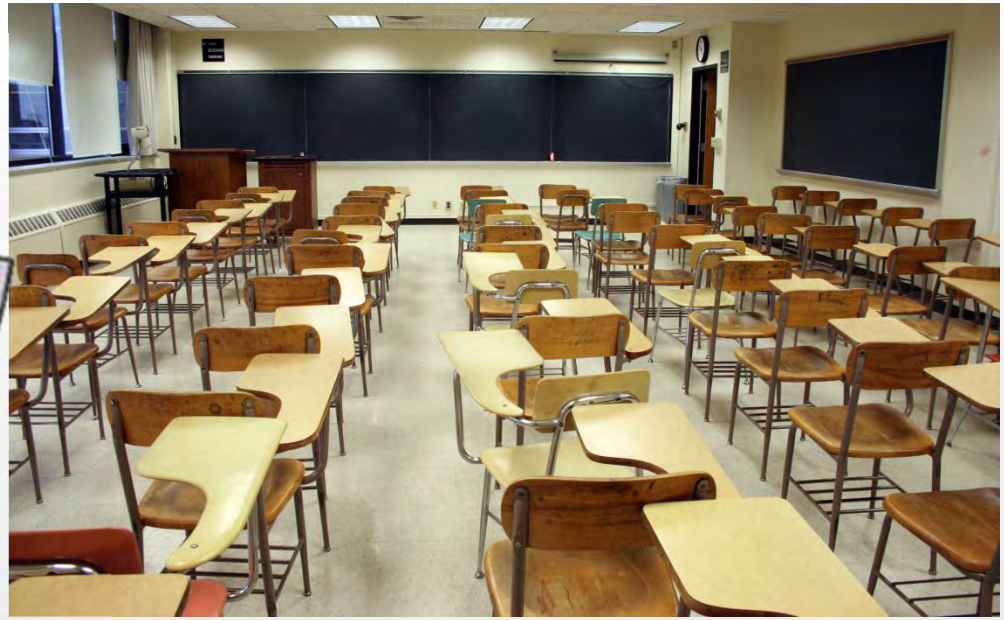
Non-Community Water Systems

- A public water system that serves at least 25 people, but does not serve the same people year-round.

- There are two types of non-community systems:
  - Non-Transient Non-Community Water System
  - Transient Non-Community Water System

Non Transient Water System

- A system that serves at least 25 of the same persons more than six months of the year, but not year-round.



Transient Water System

- A system that does not regularly serve at least 25 of the same persons over six months of the year.

Major Regulations

- Safe Drinking Water Act
- Surface Water Treatment Rule
- Filter Backwash Recycle Rule
- Disinfectants and Disinfectant Byproducts Rule
- Groundwater Rule
- Total Coliform Rule
- Arsenic Rule
- Lead and Copper Rule

Safe Drinking Water Act (SDWA) - 1974

- Congress passed the Safe Drinking Water Act (SDWA) to protect public health by regulating the nation's public drinking water supply and protecting sources of drinking water.
  - Amended in 1986 and 1996
- SDWA authorizes EPA to set national health-based standards
  - Primary
  - Secondary

Examples of Standards

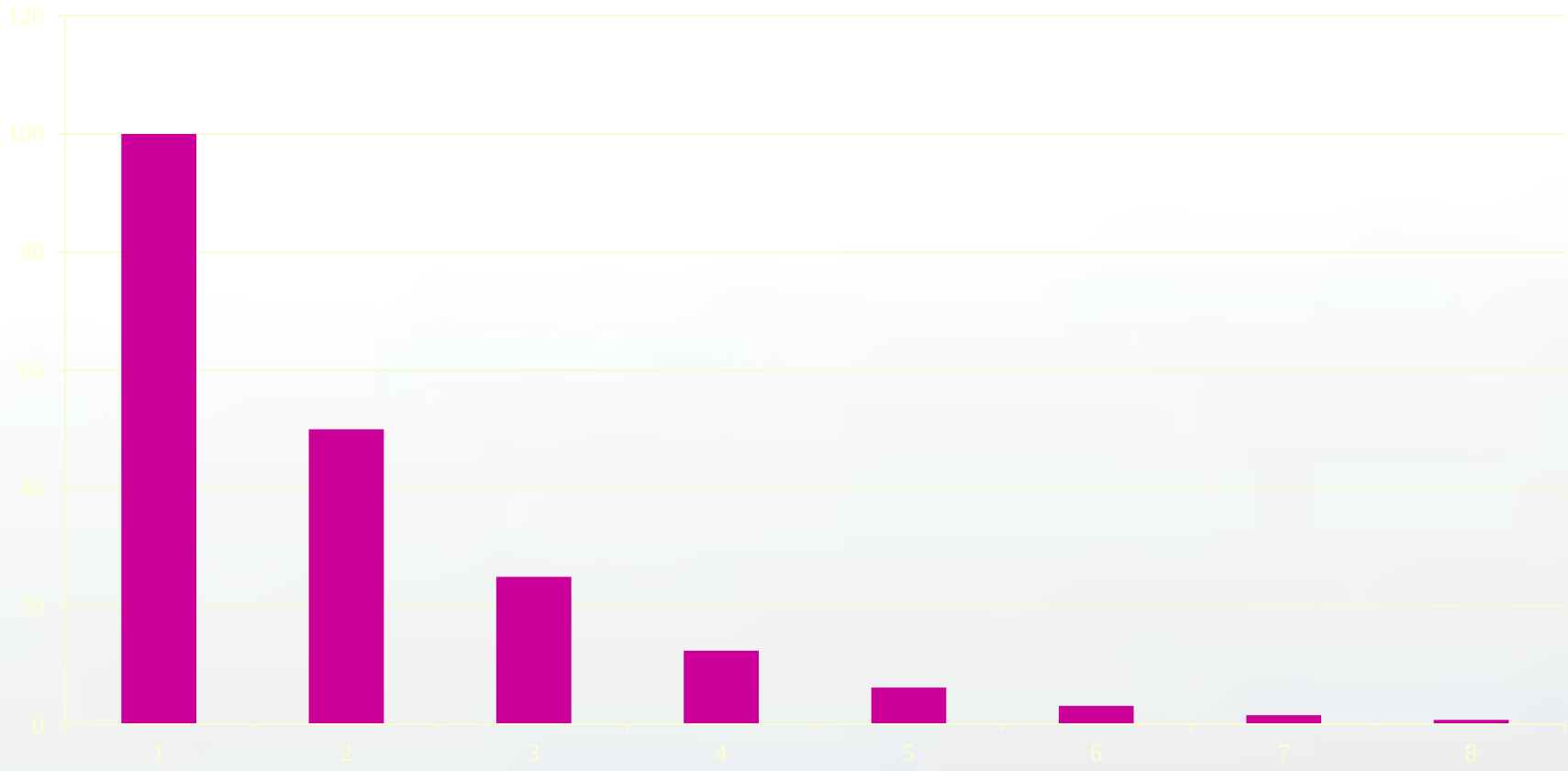
- **PRIMARY CONTAMINANTS**
  - Volatile Organic Chemicals (VOCs)
  - Synthetic Organic Chemicals (SOCs)
  - Disinfection Byproducts
  - Disinfectants (MRDLs)
    - CHLORINE (as Cl^2) = 4.0 mg/L
  - Radionuclides
  - Inorganic Chemicals (IOCs)
    - ARSENIC = 0.010 mg/L
  - Microbiological Contaminants
  - Turbidity
- **SECONDARY CONTAMINANTS**
    - MANGANESE = 0.05 mg/L

SDWA – Standards

- Maximum Contamination Level (**MCL**)
- Maximum Contamination Level Goal (**MCLG**)
- Maximum Residual Disinfection Level (**MRDL**)
- Maximum Residual Disinfection Level Goal (**MRDLG**)
- Treatment Technique (**TT**)

Law of Diminishing Return

- Sometimes also referred to as the *law of variable proportions*.



SDWA

- Requires public notification of violations and annual reports to customers on contaminants
  - Consumer Confidence Reports (**CCRs**)

SDWA

- Establishes a federal-state partnership for regulation enforcement
- Includes provisions designed to protect underground sources of drinking water
- Requires disinfection of surface water supplies

SDWA

- Establishes a multi-billion-dollar state revolving loan fund for water system upgrades

- Requires an assessment of the vulnerability of all drinking water sources to contamination

Surface Water Treatment Rule (SWTR) - 1989

- Requires disinfection of all surface supplies.
- Establishes treatment techniques to achieve at least:
  - 99.9% removal or inactivation (“3-log removal”) of Giardia lamblia cysts
  - 99.99% (“4-log” removal) of viruses.
- Systems must be operated by “qualified personnel.”

SWTR

- Establishes criteria for operating without filtration.
  - To avoid filtration, a system must meet specific source water quality criteria and must still meet the disinfection requirements.
    - All systems that do not meet the avoidance criteria must provide filtration.

SWTR

- Establishes “CT” as the basis for disinfection.
  - Disinfectant Residual Concentration x Contact Time in minutes.
    - Means of determining the level of disinfection being achieved.
  - Establishes a methodology for determining effective detention time for different basin and clear well configurations.

SWTR

- Establishes suitable filtration technologies and performance criteria for removal of turbidity and *Giardia.*

- Establishes sampling requirements and MCL's for combined filter effluent turbidity to monitor performance of the filtration system.

Interim Enhanced Surface Water Treatment Rule (IESWTR) - 1999

- This rule builds upon the SWTR to improve control of microbial pathogens and address risk trade-offs with disinfection byproducts (DBPs).

- This rule generally only affects systems that use surface water and serve 10,000 people or more.

IESWTR

- Must achieve at least 99% (2-log) removal of the protozoan *Cryptosporidium.*
  - Systems are considered to be in compliance with this requirement if filter effluent turbidity requirements are met.

- Strengthened filter effluent turbidity requirements.
  - Combined filter effluent turbidity must be below 0.3 NTU in at least 95% of the turbidity measurements taken, and measurements must be taken at least every four hours.
  - Combined filter effluent turbidity must be below 1 NTU at all times.
  - Effluent turbidity of all individual filters must be monitored continuously.

IESWTR

- Includes disinfection CT benchmarking/profiling requirements to insure changes in disinfection practices to reduce disinfection byproducts .

- Don’t result in any reduction of disinfection of pathogens.
  - Must record disinfectant residual, water temperature, pH, and contact time daily during peak hourly flow for one year.
  - Using the recorded information, calculate the *Giardia lamblia inactivation for* each day.
    - Using the daily data, the operator must determine the average *Giardia lamblia* inactivation for each month and plot on a graph. This is the disinfection profile.

IESWTR

- States are required to conduct sanitary surveys for all systems using surface water (or groundwater under direct influence of surface water).

- All new treated water storage tanks and reservoirs must be covered.

Long Term 1 Enhanced Surface Water Treatment Rule (LT1) - 2002

- Like the IESWTR, this rule was put in place to improve control of microbial pathogens, specifically the protozoan *Cryptosporidium,* and to address risk trade-offs with disinfection by-products (DBPs).

- However, this rule applies to public water systems that serve fewer than 10,000 people.

Long Term 2 Enhanced Surface Water Treatment Rule (LT2) - 2009

- It builds upon the earlier SWT rules to address higher risk public water systems for protection measures beyond those required for existing regulations.

- Higher risk systems include filtered water systems with high levels of Cryptosporidium in their sources and all unfiltered water systems.

LT2

- All systems covered by this rule will monitor their sources with two years of monthly sampling for Cryptosporidium (or E. coli for small systems).

- Systems are classified into treatment bins based on their monitoring results.
  - Many systems will be classified in the lowest treatment bin which carries no additional treatment requirements.
  - Systems classified in higher treatment bins must provide 90 to 99.7 percent (1.0 to 2.5-log) additional treatment for Cryptosporidium.

Filter Backwash Recycling Rule (FBRR) - 2001

- This rule was passed to regulate filter backwash recycling methods and prohibit practices that may compromise treatment.

- Applies to all systems that use surface water (or GUDI systems), use conventional or direct filtration, and recycle spent filter backwash water and/or liquids from sludge thickening and dewatering processes.

FBRR

- Recycled water must be reintroduced into the process upstream of any chemical treatment.

- Water system operators must submit information to their state related to their treatment process, including:
  - A treatment process schematic
  - Recycle flow streams
  - Backwash flow rates
  - Treatment provided to the waste streams before they are recycled.

Stage 1 Disinfectants and Disinfection Byproduct Rule (Stage 1) - 1999

- This rule sets maximum contaminant levels (MCL's) for total trihalomethanes (TTHM's) and the total of five haloacetic acids (HAA5).

- It also sets maximum disinfectant residual concentrations for chlorine, chloramines, and chlorine dioxide.

Stage 1

- Applies to all public water systems that add a disinfectant.
- Sets MCL for TTHM's at 0.08 mg/L and MCL for HAA5 at 0.06 mg/L.
- Sets MCL for chlorite (a by-product of chlorine dioxide) at 1.0 mg/L and MCL for bromate (a byproduct of ozone) at 0.01 mg/L.

Stage 1

- Sets maximum residual disinfectant levels (MRDL's) of 4.0 mg/L (as Cl2) for chlorine, 4.0 mg/L (as Cl2) for chloramines, and 0.8 mg/L for chlorine dioxide (as ClO2).

- Requires removal of total organic carbon (TOC) in raw water by enhanced coagulation (for systems using conventional treatment).

Stage 2 Disinfectants and Disinfection Byproduct Rule (Stage 2) - 2009

- PURPOSE: The Stage 2 Rule was issued to supplement existing regulations by requiring drinking water suppliers to meet disinfection byproduct maximum contaminant levels at each monitoring site in the distribution system.
  - The rule seeks to better identify monitoring sites where customers are exposed to high levels of disinfection byproducts. This regulation will reduce byproduct exposure, provide more equitable health protection, and result in lower cancer and reproductive and developmental risks.

Stage 2

- Created a new TTHM/HAA5 site selection procedure known as the IDSE for systems serving 10,000 or more people.
  - The IDSE is intended to identify areas of the distribution system that are or likely to cause high levels of disinfection byproducts (DBPs). These locations will be used as monitoring locations under Stage 2.

- Monitoring schedule is based on source water type, population served and population of the largest system in a combined distribution system (CDS).

Stage 2

- The monitoring (frequency and number of required samples) is based on source water type and population served (excluding CDS).
- Compliance is now determined as a locational running annual average (LRAA) at each TTHM and HAA5 monitoring site to better protect customers.
- Systems collecting compliance samples on a quarterly basis are subject to an operational evaluation level (OEL).
- Requires systems to submit a monitoring plan to identify locations and the sample collection schedule for TTHM/HAA5 samples.

Groundwater Rule (GWR) - 2009

- PURPOSE: The GWR provides for increased public health protection against fecal contaminants at public water systems served by groundwater sources. The GWR establishes a risk-targeted strategy to identify the subset of groundwater sources that are at higher risk of fecal contamination and require corrective actions to reduce or eliminate that risk.

- The GWR specifically targets viral pathogens as a category of fecal contaminants.

GWR

- Community groundwater systems are required to provide continuous disinfection and at least 4-log treatment of viruses (99.99% removal and/or inactivation).

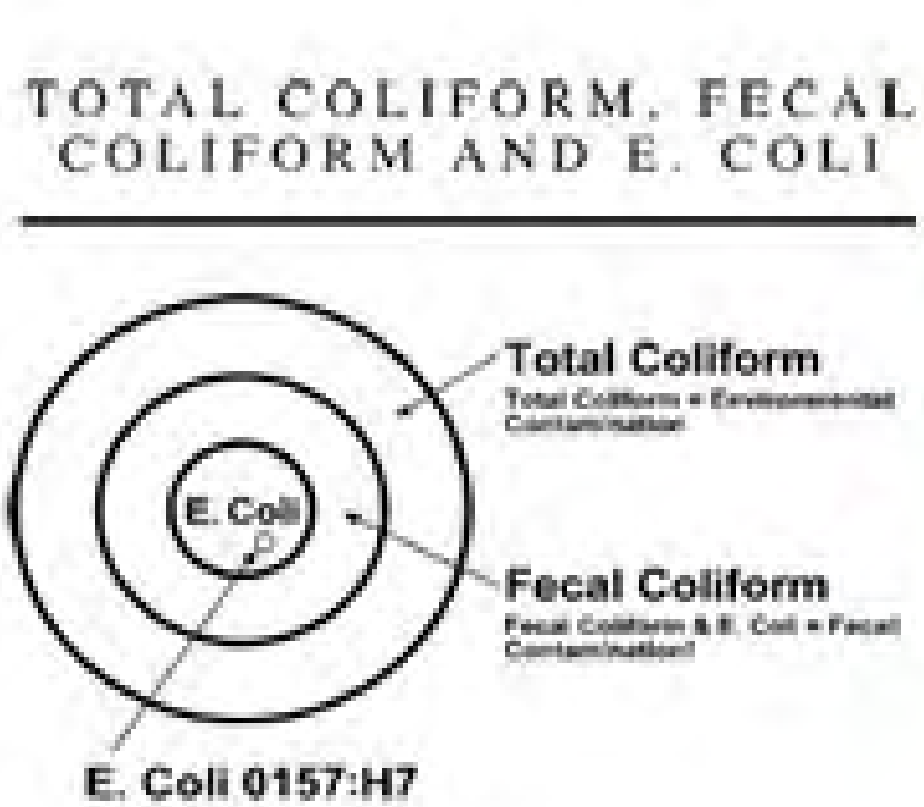
- Community groundwater systems are required to maintain at each groundwater entry point a minimum residual disinfection concentration approved by DEP to provide 4-log treatment of viruses.

- DEP must conduct sanitary surveys that address the 8 components every 3 years.
  - Source, treatment, distribution system, finished water storage, pumps/facilities/controls, monitoring, reporting and data verification, system management and operation, and operator compliance with state requirements.

GWR

- The following State GWR regulations are more stringent than Federal regulations:
  - At least 4-log treatment of viruses at all CWSs is required.
  - CWSs will be required to maintain at least 0.40 mg/L chlorine residual or other Department approved residual capable of achieving 4-log treatment of viruses.
  - PA does not allow discontinuation of 4-log treatment if put into place because of a corrective action.
  - A breakdown in 4-log treatment requires a Tier 1 Public Notification (PN) to be consistent with existing PN regulations.
  - The federal GWR allows source water sampling to be conducted at a location after treatment if approved by the state. PA will only allow source water sampling for the GWR at locations prior to treatment.

Total Coliform Rule



Total Coliform Rule - 1990

- All systems must have a written sample sighting plan.
- For Community Water Systems, the number of samples is based on minimum population served.
- If any samples are positive for total coliforms, repeat samples (i.e., check samples) must be taken as follows:
  - Systems that collect more than one sample per month must collect at least three repeat samples within 24 hours for each sample that tested positive for total coliforms.
  - Systems that collect only one sample per month must collect at least four repeat samples within 24 hours for each sample that tested positive for total coliforms.
  - Systems must continue to collect repeat samples until all samples are negative or it is determined that the system has violated the MCL.
  - Systems that collect less than five samples per month must collect at least five routine samples during the month immediately following the positive sample.
  - Any sample that tests positive for total coliforms must be analyzed for *E. coli or fecal* coliforms.

Arsenic Rule - 2001

- PURPOSE: This rule reduces the MCL for arsenic in drinking water from its previous concentration of 0.05 mg/L (50 ppb) to 0.01 mg/L (10 ppb).

- This rule also examines the “best available technologies” (BAT’s) for arsenic removal.

Treatment Technology	Maximum Percent Removal
Ion Exchange	95
Activated Alumina	95
Reverse Osmosis	>95
Modified Coagulation and Filtration	95
Modified Lime Softening	90

Lead and Copper Rule

Lead and Copper Rule (LCR) - 1994

- PURPOSE: “Protect public health by minimizing lead (Pb) and copper (Cu) levels in drinking water, primarily by reducing water corrosivity. Pb and Cu enter drinking water mainly from corrosion of Pb and Cu containing plumbing materials.

- Requires monitoring of lead and copper levels at customer taps.
  - Monitoring requirements vary, depending upon the size of the system.
    - Monitoring requirements are broken down by systems serving more than 50,000 persons, systems serving 3,301 to 50,000 persons, and systems serving 3,300 or fewer persons.
    - Transient non-community water systems are excluded from this rule.

LCR

- Where lead and copper levels at the customer tap exceed action levels in the 90th percentile sample result (0.015 mg/L for lead and 1.3 mg/L for copper) must institute corrosion control practices.

- Follow-up monitoring is required to verify corrosion control practices are working.

- Water systems must provide educational info. to their customers outlining :
  - Causes of elevated lead and copper levels
  - Health effects of lead and copper
  - Actions the customers can take on their own to reduce their risk of exposure.

Treatment

Treatment

- Water utilities treat nearly 34 billion gallons of water every day.

- Generally, surface water require more treatment than ground water

Treatment Objectives

- Remove turbidity (suspended) material.
- Reduce concentrations of chemical contaminants
  - Levels low enough that they do not pose a health risk and meet or exceed regulatory requirements.
- Remove or inactivate pathogenic protozoans, bacteria, and viruses.

Treatment Objectives

- Produce water that is clear, with no objectionable colors, odors or taste.

- Produce water that is chemically stable, and is not corrosive to metal piping and fixtures.

Treatment

- The most commonly used processes include:
  - Coagulation (Flocculation / Sedimentation)
  - Filtration
  - Disinfection

Coagulation (Flocculation / Sedimentation)

- *Flocculation:* This step removes dirt and other particles suspended in the water.
  - Alum , iron salts or synthetic organic polymers are added to the water to form floc particles.

- *Sedimentation:* The flocculated particles then settle naturally out of the water.

Filtration

- Removes particles include clays and silts, natural organic matter, precipitates from other treatment processes in the facility, iron and manganese, and microorganisms.

Disinfection

- Typically disinfected before it enters the distribution system to ensure that microbial contaminants are killed.

- Chlorine, Chlorinates, or Chlorine dioxide
  - Most often used because they are very effective disinfectants, and residual concentrations can be maintained.

Security

Security

- "The Public Health Security and Bioterrorism Preparedness and Response Act" (2002) requires that all community water systems serving more than 3,300 people evaluate their susceptibility to potential threats and identify corrective actions.

Emergency Response Plan

- Emergency Response Plan Template for Water Suppliers (3800-FM-WSFR0300)

- Water suppliers can use this template to address all emergency response plan elements required under Chapter 109.707 including new requirements that became effective May 9, 2009 when the PN revisions were published.

Emergency Response Plan

- Section 1 - Organization Table
- Section 2 – Communication Procedures and Contact Information
- Section 3 – Means of Communications
- Section 4 - Summary Description of the System
- Section 5 – Assessment of Available Equipment
- Section 6 – Corrective Actions for Probable Emergencies

EPAs Water Security Site

- “EPA's site provides information to help drinking water and wastewater utilities: assess and reduce vulnerabilities to potential terrorist attacks, plan for and practice response to emergencies and incidents and develop new security technologies to detect and monitor contaminants and prevent security breaches.”

http://www.portal.state.pa.us/portal/server.pt/community/emergency_preparedness_for_water_and_wastewater_facilities/21174

Criminal History Record / Mandatory Operator Security Course

- All applicants for a drinking water or wastewater operators certification are required to submit a copy of their Criminal History Record (CHR).

- All certified operators must complete the department's system security course "Securing Drinking Water and Wastewater Facilities".

http://www.portal.state.pa.us/portal/server.pt/community/emergency_preparedness_for_water_and_wastewater_facilities/21174

PaWARN

- PaWARN provides water and wastewater utilities with:
  - A Mutual Aid Agreement and process for sharing emergency resources among water and wastewater agencies statewide.
  - A mutual assistance program consistent with other statewide mutual aid and assistance programs and the National Incident Management System.
  - The resources to respond and recover more quickly from a natural or human caused disaster.
  - A forum for developing and maintaining emergency contacts and relationships.

www.pawarn.org

http://www.portal.state.pa.us/portal/server.pt/community/emergency_preparedness_for_water_and_wastewater_facilities/21174

Pandemic Flu

- A pandemic flu could dramatically reduce the number of available workers, which could threaten essential services and operations within and across our nation.

- Water and wastewater facilities need to plan and prepare for operating their facilities in the midst of severe staff shortages.

http://www.portal.state.pa.us/portal/server.pt/community/emergency_preparedness_for_water_and_wastewater_facilities/21174

Spill / Flood Alert Networks

- Delaware Valley Early Warning System (EWS)
  - https://www.delawarevalleyews.org/EWS
- The River Alert Information Network (RAIN)
  - https://www.3rain.org/about.php/
- The Susquehanna River Basin (SRBC)
  - http://www.srbc.net/

http://www.portal.state.pa.us/portal/server.pt/community/emergency_preparedness_for_water_and_wastewater_facilities/21174

AlertPA

- AlertPA provides timely information to assist you in making informed decisions.
- AlertPA delivers emergency and weather alerts, health notifications, tax notifications, building alerts and updates to steer, guide and warn you through email, cell phone, pager and/or Smartphone/PDA messages.
- When an incident or emergency occurs, authorized senders will instantly notify you using AlertPA.

https://alert.pa.gov/index.php?CCheck=1

http://www.portal.state.pa.us/portal/server.pt/community/emergency_preparedness_for_water_and_wastewater_facilities/21174

ICS Training / Emergency Management Institute (EMI)

- Incident Command System (ICS) training can greatly increase a system's ability to plan for and respond to natural or manmade events at their facility.

- Understanding ICS principles will enable water systems to match the response structure of other responding agencies, speak a "common language" and encourage communications with local responders before an incident occurs.

http://training.fema.gov/IS/NIMS.aspx

Regional Equipment Center

- The 12th R.E.C. provides municipalities and non-profit organizations with excess federal equipment on a temporary, short term or long term basis.

- It also can provide the opportunity to complete earth moving projects, to include: ball field construction, stream restoration, DEP revitalization, road slide cleanup and reconstruction.

- The 12th R.E.C. can provide equipment operators, assistance in selecting proper equipment, and an Engineer that will analyze project plans & specifications

http://12threc.net/

http://www.portal.state.pa.us/portal/server.pt/community/emergency_preparedness_for_water_and_wastewater_facilities/21174

SECTION 1

QUIZ – SECTION 1 ONLY
(10 Minutes)

BREAK
(5 Minutes)

SECTION 2
WASTEWATER

(1 Hour 20 Minutes)
(Quiz = 10 minutes)

References

- Wastewater Treatment Plant Operator Certification Training - Modules 23 and 24 on Wastewater Collection Systems
  - http://www.prwa.com/content/operator-certification-modules
- PADEP - Domestic Wastewater Facilities Manual
- Pumping Station Design 2nd Edition, Sanks, Tchobanoglous, Bosserman, and Jones, 1998
- http://www.werf.org
  - Laterals
- http://www.magnesiaspecialties.com
  - Hydrogen Sulfide
- http://www.nassco.org
  - Great reference material / Provides Specs
- http://www.sewergrouting.com
- Gerardi, Michael. *Nitrification and Denitrification in the Activated Sludge Process*. New York: John Wiley and Sons, Inc., 2002. Print.

Wastewater Questions

- What is in wastewater? Why does it need to be treated?
- How does my wastewater get to the treatment plant from my house?
- How is wastewater treated?

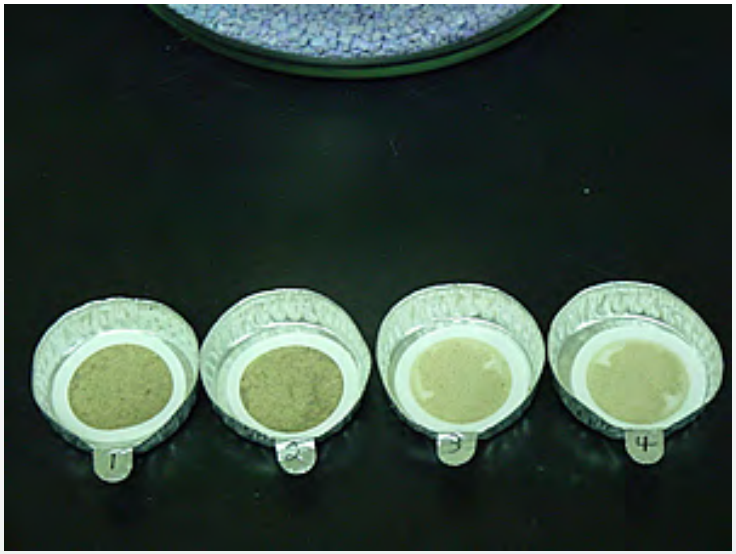
Wastewater Characteristics

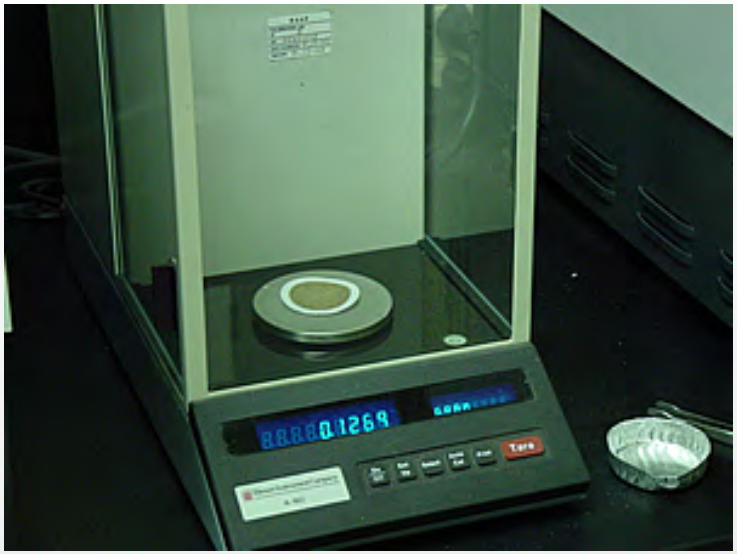
Typical Domestic WW

Contaminants	Low (mg/L)	Medium (mg/L)	High (mg/L)
TSS	**120**	**210**	**400**
BOD	**110**	**190**	**350**
Nitrogen (total as N)	**20**	**40**	**70**
Organic	8	15	25
Free Ammonia	12	25	45
Nitrites	0	0	0
Nitrates	0	0	0
Phosphorus (total as P)	**4**	**7**	**12**
Organic	1	2	4
Inorganic	3	5	10

TSS

- Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter.

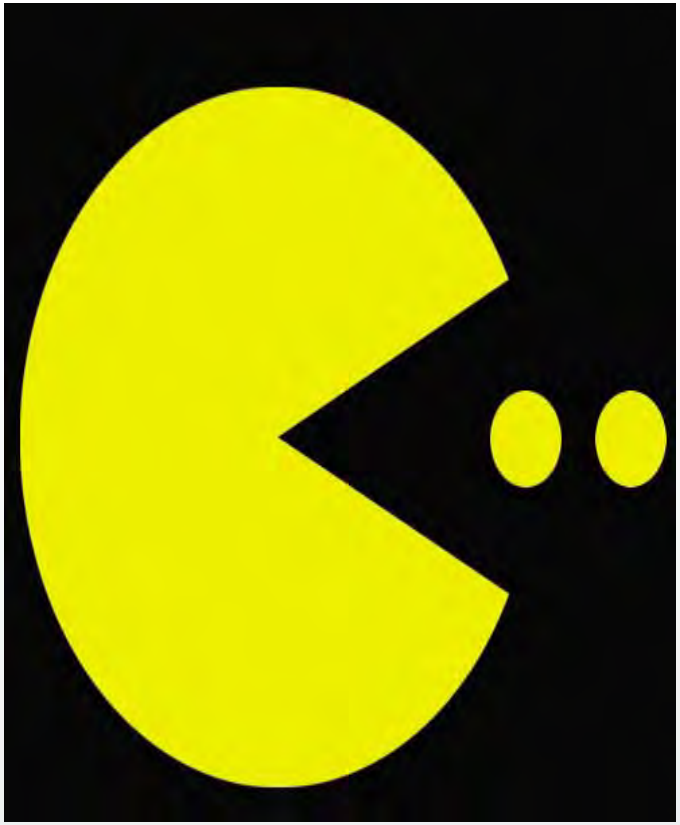




http://water.me.vccs.edu/courses/env211/tss.htm

BOD

- Wastewater contains organic materials that are decomposed by microorganisms.
- Use oxygen in the process.
  - The amount of oxygen consumed by these organisms in breaking down the waste is known as the **biochemical oxygen demand** (BOD).



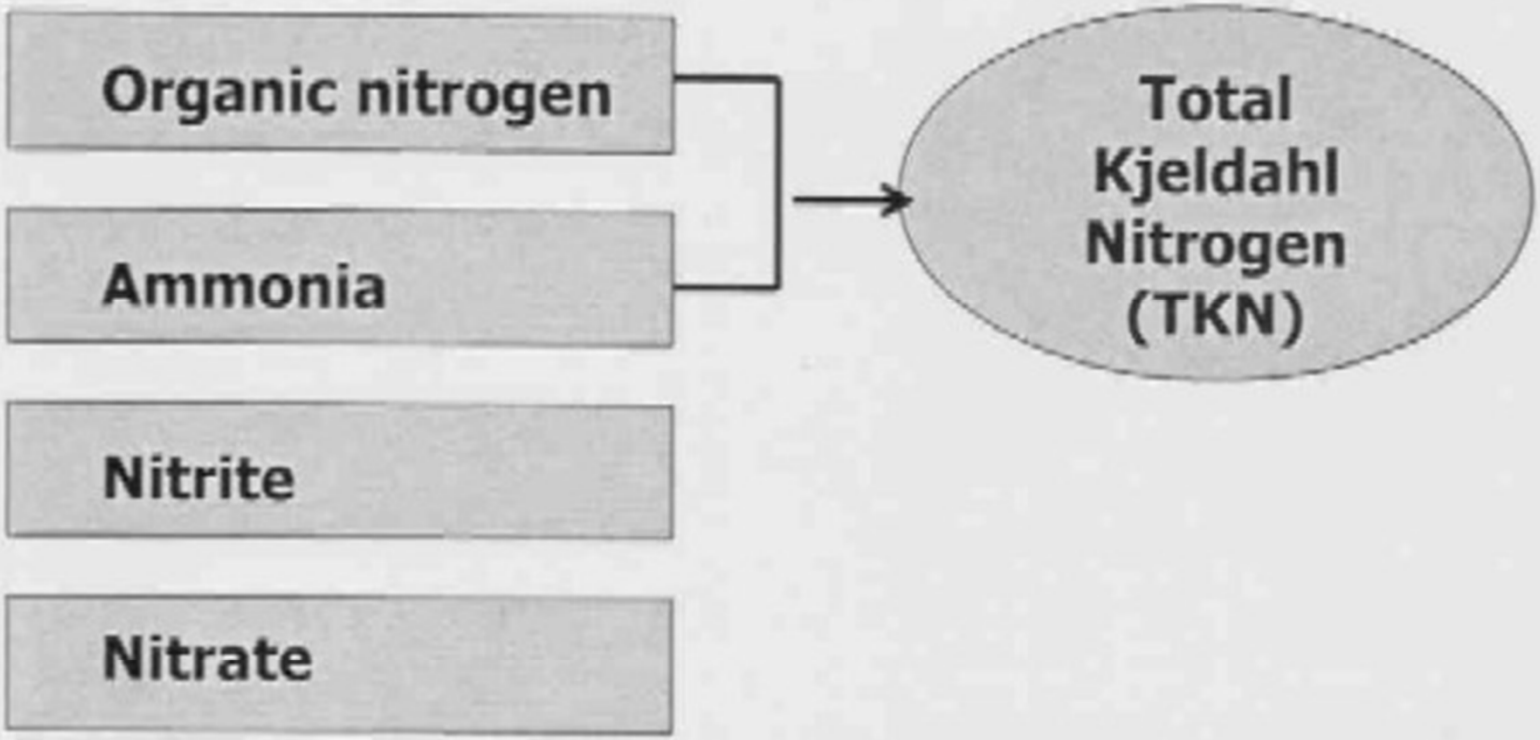
Sources of Nitrogen

- Nitrogen is a naturally occurring element that is essential for growth and reproduction in all living organisms.
- Nitrogen is the most abundant compound in the atmosphere
- Pollution Concerns

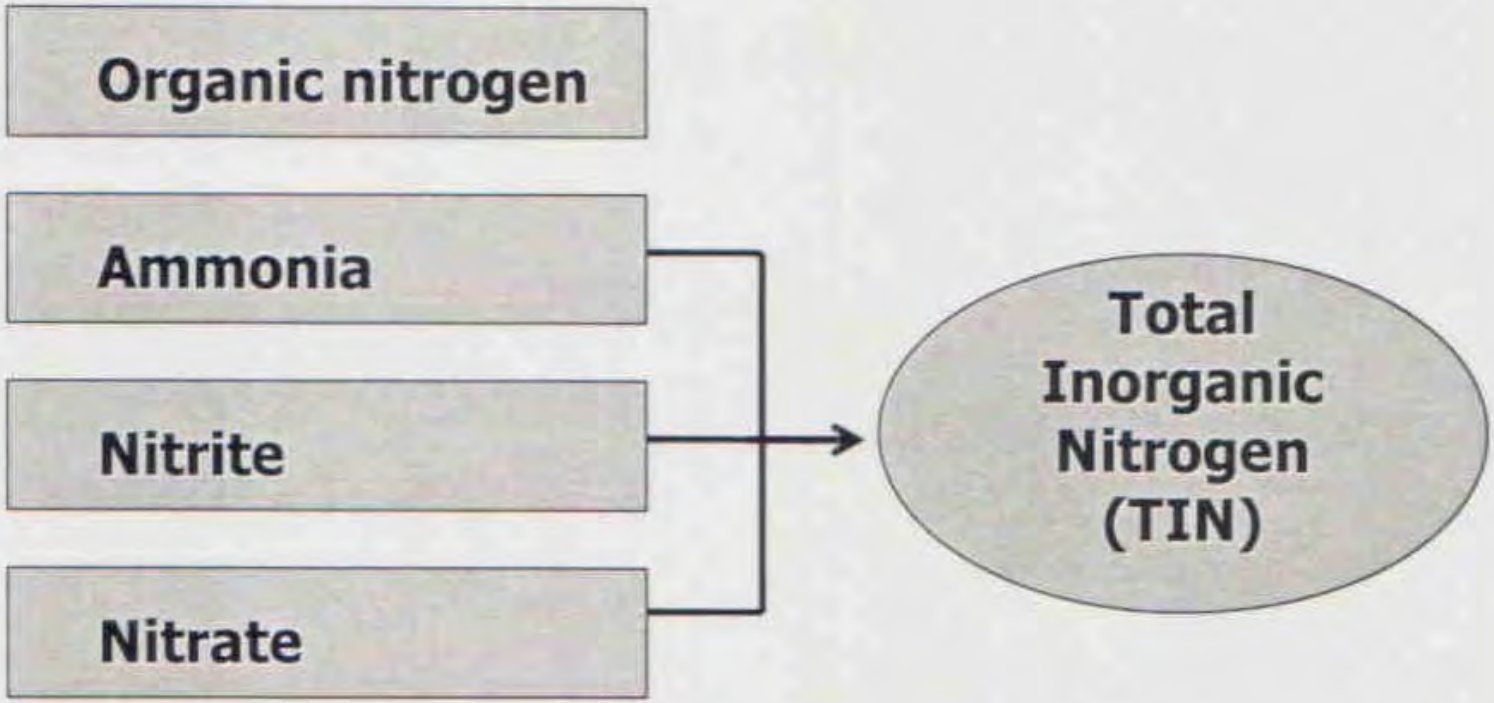
Forms of Nitrogen

- Ammonia (NH_3)
- Ammonium ion (NH_4^+)
- Nitrogen Gas (N_2)
- Nitrite (NO_2^-)
- Nitrate (NO_3^-)
- Organic Nitrogen

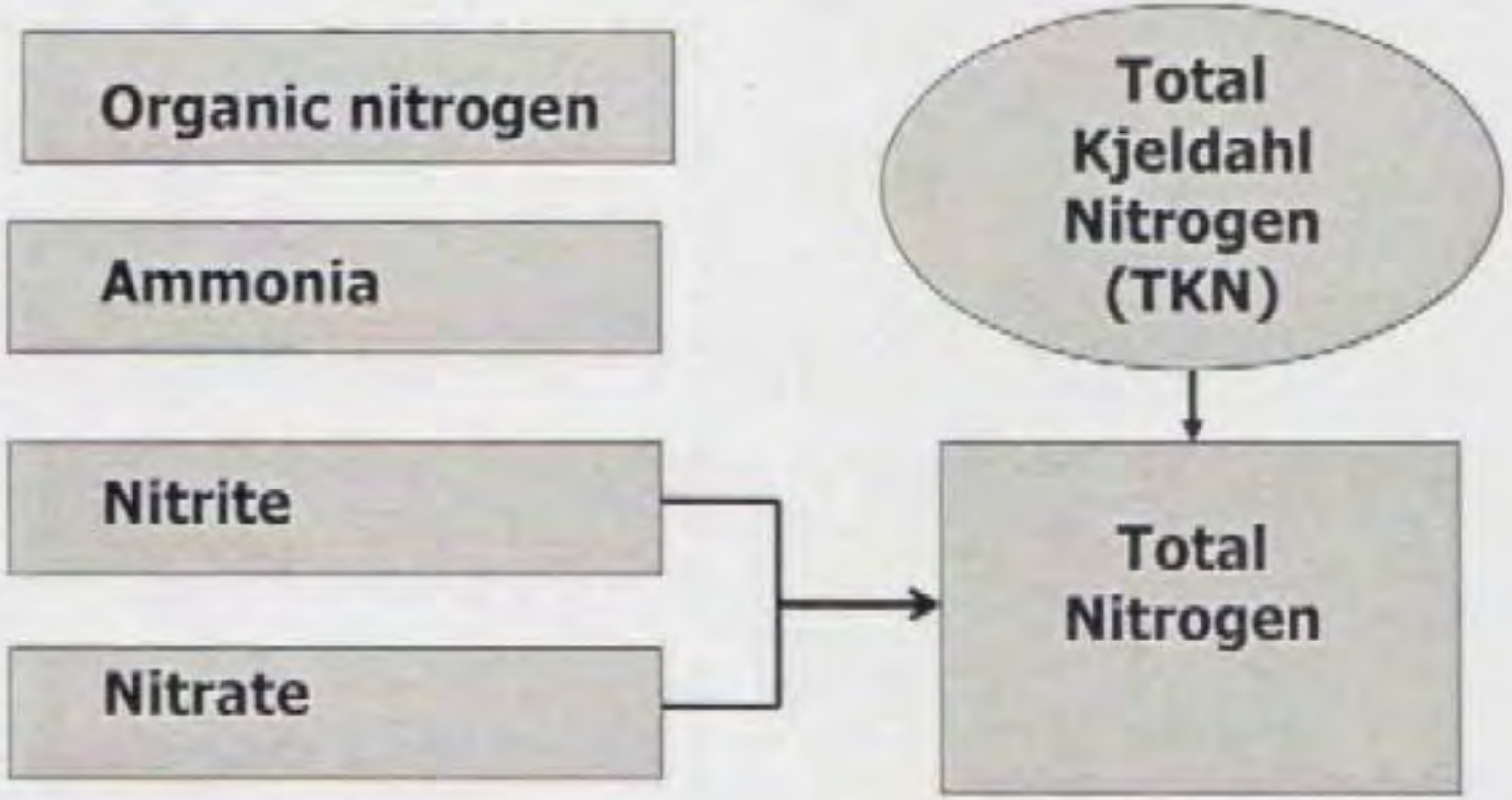
Groups of nitrogenous compounds



Groups of nitrogenous compounds



Groups of nitrogenous compounds



Nitrogen in Wastewater

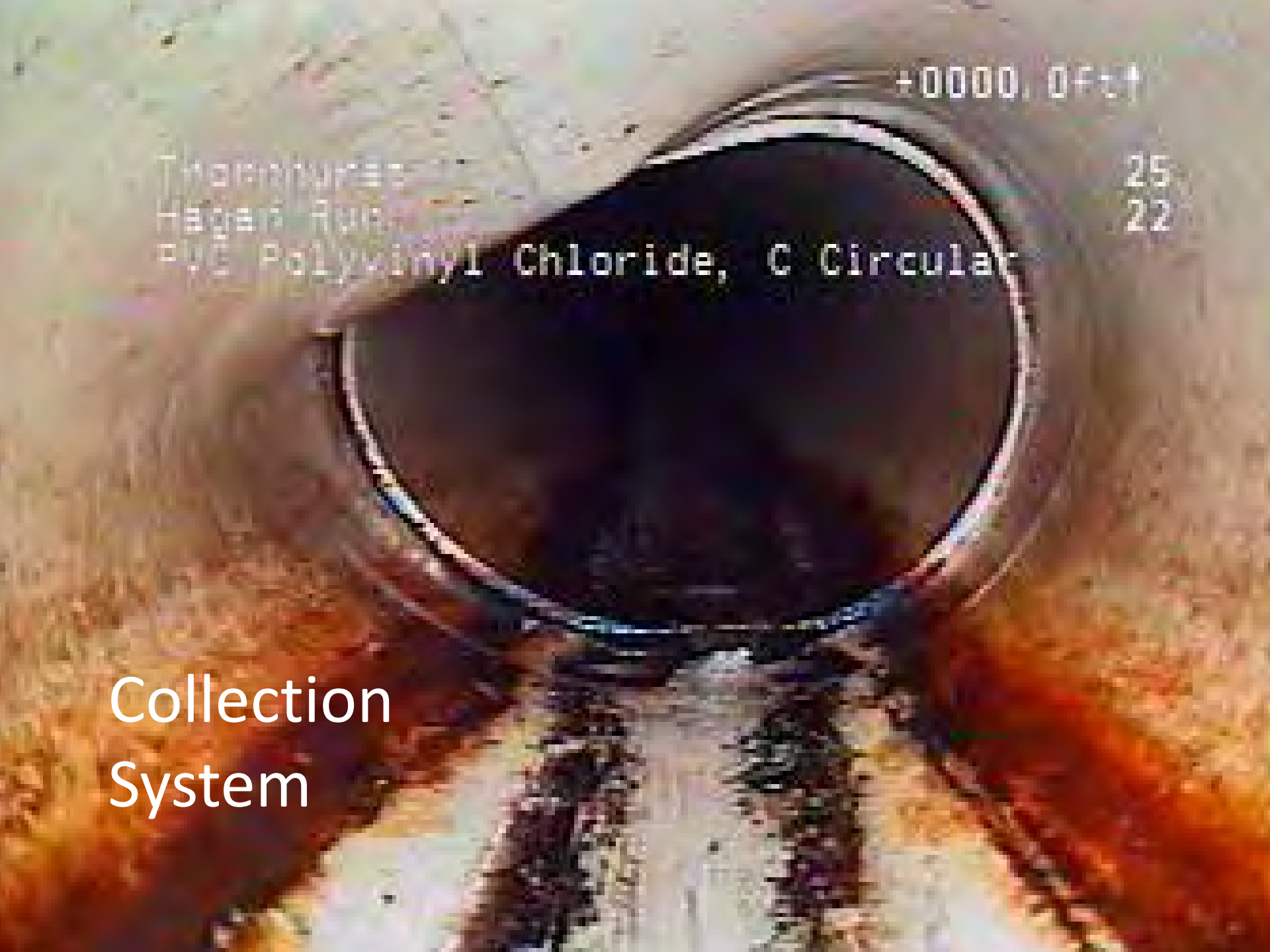
- Domestic Wastewater
  - 60% is in ammonium ion form (NH_4^+)
  - 40% is in organic nitrogen form
    - Ammonia Acids
    - Proteins
    - Urea

Sources of Phosphorus

- Phosphorus is a key component in the process of energy metabolism by cells and the cell membrane.
- Phosphorus is found in Fertilizers / Detergents / Cleaning Products / Human & Animal Waste
- Pollution Concerns

Forms of Phosphorus

- Ortho-phosphates
- Poly-phosphates
- Organic phosphorus



Collection System

New Sewer Construction Design

- In designing sanitary sewers, the following factors should be considered:
  - Maximum hourly quantity of domestic and other wastewater from residential and nonresidential users
  - Groundwater infiltration
  - Topography of area
  - Location of wastewater treatment plant
  - Depth of excavation
  - Pumping requirements.

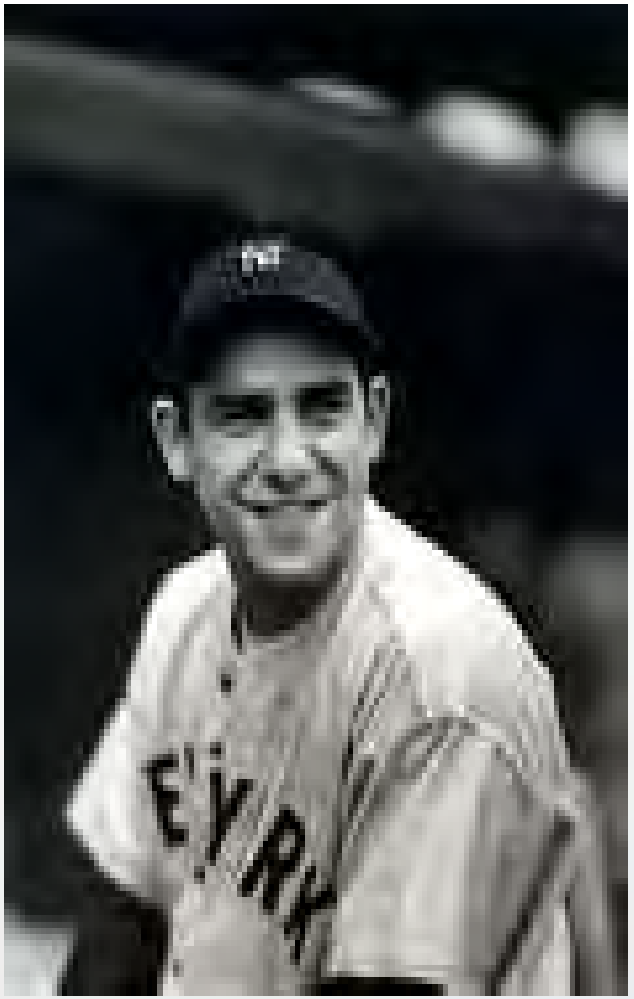
PADEP Domestic Wastewater Facilities Manual (10/97), Page 16

Collection System

- Conventional Gravity System
  - Lateral
  - Main
  - Interceptor
  - Pump Stations
- Alternative Systems
  - LPSS
  - Vacuum
  - STEP

Collection System Challenges

- Biological activity
- Varying flows / terrain
  - It flows downhill unless its uphill
- Solids deposition
  - Min. 2 ft/sec
- Grease and Root issues
- System Access
- Other Utility Conflicts

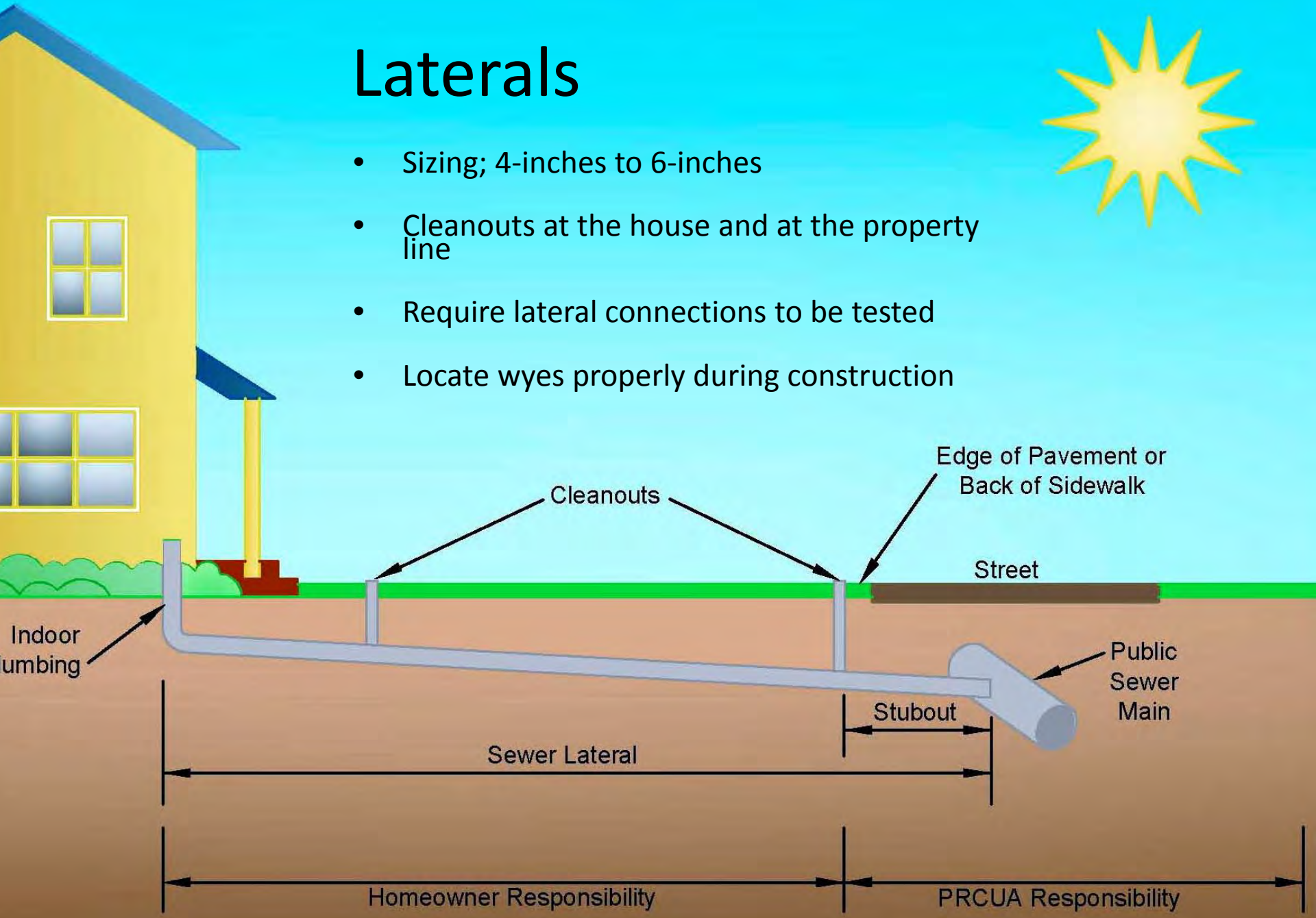


Gravity Sewer - Components

- Pipe
  - Concrete, HDPE, Clay, Ductile Iron, Cast Iron, and PVC
  - PVC SDR 35 with push-on joints is most prevalent today.
    - 25 to 30 feet burial depth
    - Deeper with profile wall
- Manholes
  - Precast concrete
  - Fiberglass, PVC, and Poured-in-place concrete
- Pump Stations and Force Mains

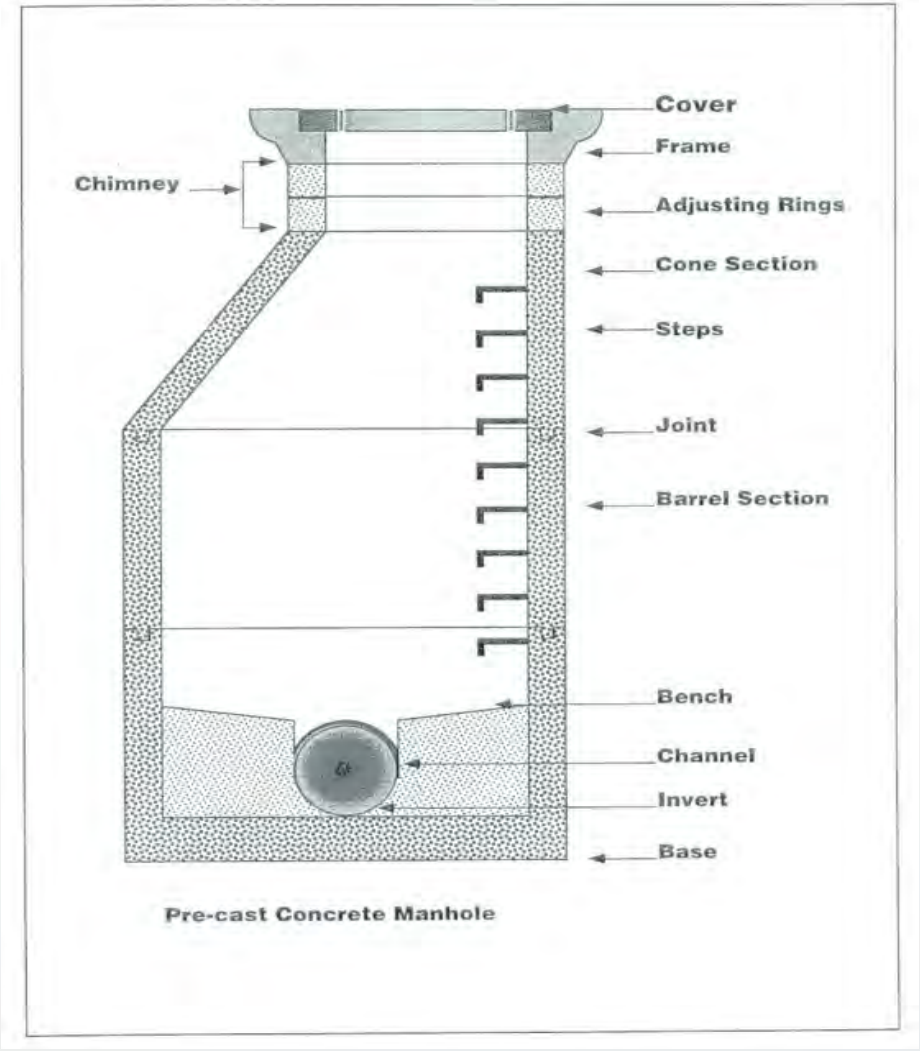
Laterals

- Sizing; 4-inches to 6-inches
- Cleanouts at the house and at the property line
- Require lateral connections to be tested
- Locate wyes properly during construction



Manholes

- Properly sized
- Elevation
- Pipe Connections
- Drops
- Location



Pump Stations

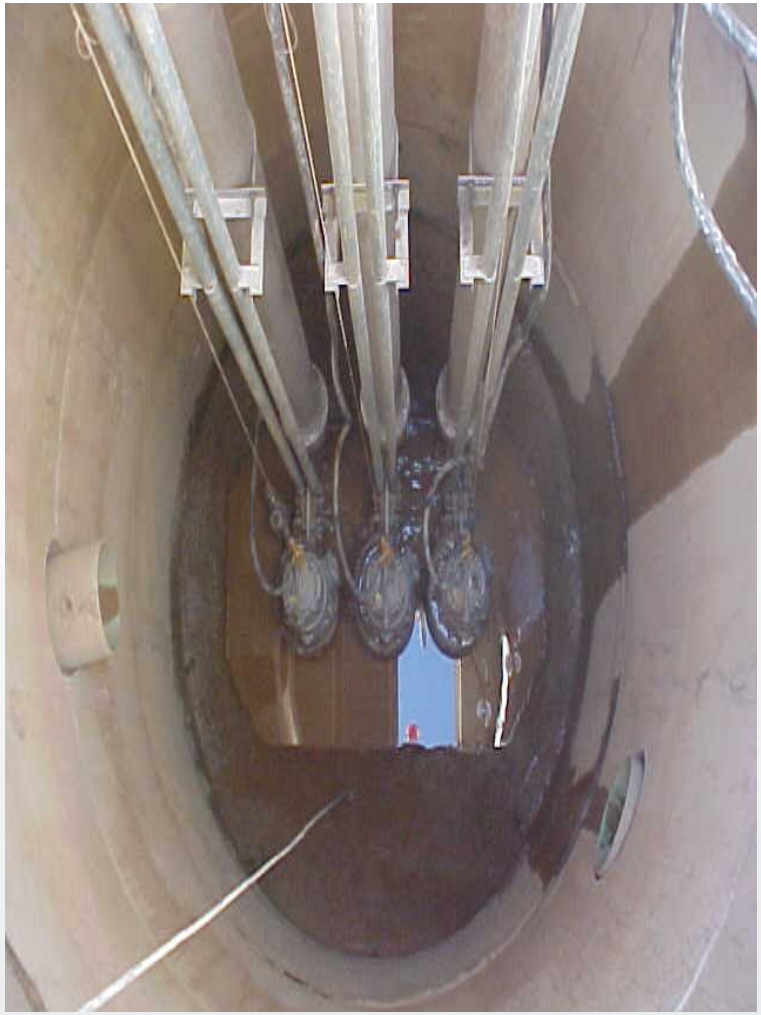
- Location
- Required Capacity
- Wastewater Characteristics
- Mode of Operation
  - Constant Speed
  - Variable Speed
  - Mixture of the two

Pump Stations

- Two main types of pumping stations
  - Wet well / Dry Well
  - Submersible
- Other types of pumping stations include:
  - Suction Lift / Screw Pumps
- Alarm Systems
- Emergency Operation
- Operator Training and Maintenance

Wet Wells

- Size and control setting
- Detention Time
  - Not to exceed 10 minutes for the maximum monthly flow.
- Sloping Floor
- Ventilation



Types of Pumps

- Two main types of pumps used:
  - Centrifugal
  - Positive Displacement

- Understanding of the difference in operation between Centrifugal and PD Pumps
  - Cars on a highway - Joe Evans, PhD
  - http://www.pumped101.com/

Pump Controllers

- Four main types of pump controllers used:
  - Floats
  - Ultrasonic Measurement
  - Pressure transducers
  - Air Bubblers

- NEC Requirements for Class 1, Division 1, Group D

Force Main Piping

- 4-inches unless grinding is utilized
- Velocity – 2 ft/sec
- Termination; 2 feet rule
- Reaction blocking
  - Thrust Blocks / Mechanical restraints
- Cleanouts

Force Mains

- Components:
  - Isolation Valves Air and Vacuum Relief Valves
    - Air
      - Design profile to rise all the way to exit (preferred)
      - Install ARVs
      - Velocities that will scour air bubbles (increases friction - increases TDH)
- Odor and Corrosion Issues
  - Chemical Conditioning
  - Turbulence

Inflow & Infiltration

Infiltration (Ground Water)

- INFILTRATION – “The total extraneous flow entering a sewer system or portions thereof, excluding sanitary sewage, because of poor construction, corrosion of the pipe from the inside or outside, ground movement or structural failure through joints, porous walls or breaks.”

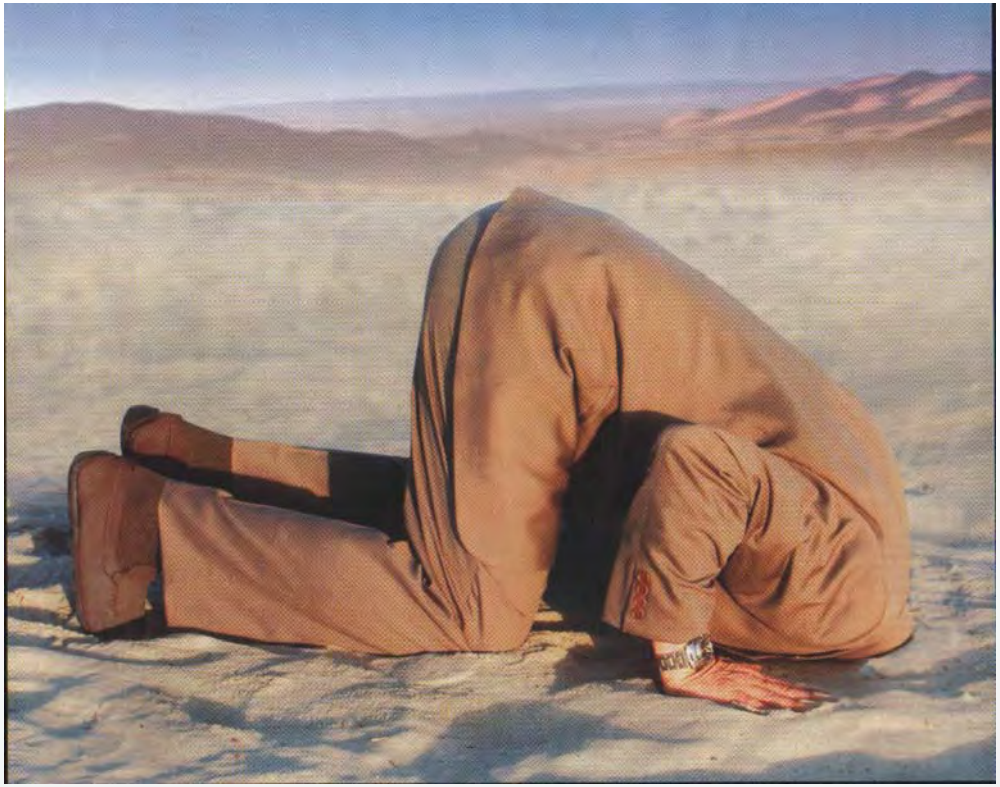
WPCF MOP No. FD-5

Inflow (Direct Wet Weather)

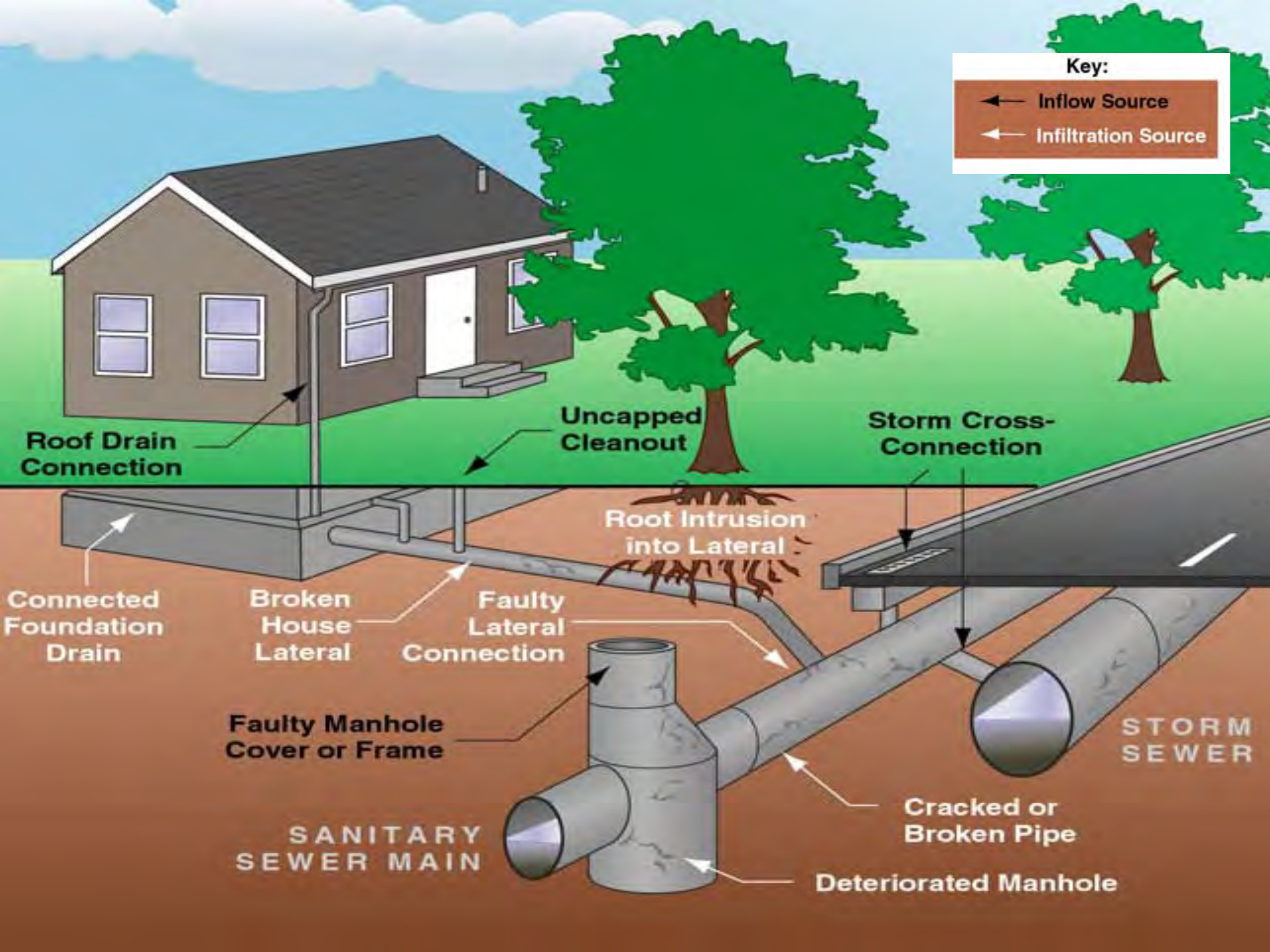
- INFLOW – “The extraneous flow which enters a sanitary sewer from sources other than infiltration, such as roof leaders, basement drains, land drains, and manhole covers. Inflow, in short, is usually man made and intentional.”

  WPCF MOP No. FD-5

“I Don’t Have I&I!”



- Every sanitary sewer system has some I&I even newly constructed systems.
- For new construction, the leakage exfiltration or infiltration shall not exceed 100 gallons per inch of pipe diameter per mile per day for any section of the system


Key:
Inflow Source
Infiltration Source
Roof Drain Connection
Uncapped Cleanout
Storm Cross-Connection
Root Intrusion into Lateral
Connected Foundation Drain
Broken House Lateral
Faulty Lateral Connection
Faulty Manhole Cover or Frame
STORM SEWER
Cracked or Broken Pipe
SANITARY SEWER MAIN
Deteriorated Manhole

Do I have a problem with I&I?

- Quick & Dirty:
  - DMRs and Chapter 94 Report
  - Pump Stations
    - Hour Meters
    - Drawdown Test
  - Known Overflows
    - Exceed Hydraulic Capacity
    - Blockages


07.14.2010 08:38


07.14.2010 09:05

A little water never hurt anyone

- Problems associated with excessive I&I:
  - Hydraulic & Treatment impacts on Wastewater treatment processes
  - Uncontrolled overflows and bypasses.
  - Basement back-ups
  - System deterioration
  - CATASTROPHIC FAILURE
    - Undermining of piping/structures

How can paperwork stop I&I?

- Since every sanitary sewer system has some I&I, the key is to control the amount through:
  - Design review
  - Up-to-date Sewer Rules and Regulations / Ordinances
  - Control of improper (illegal) connections through enforcement through regulations and ordinances
  - Connection Permits
  - Lateral and sewer extension inspection

No more I&I Problem?

"I did I&I work five years ago and I still have a problem!"

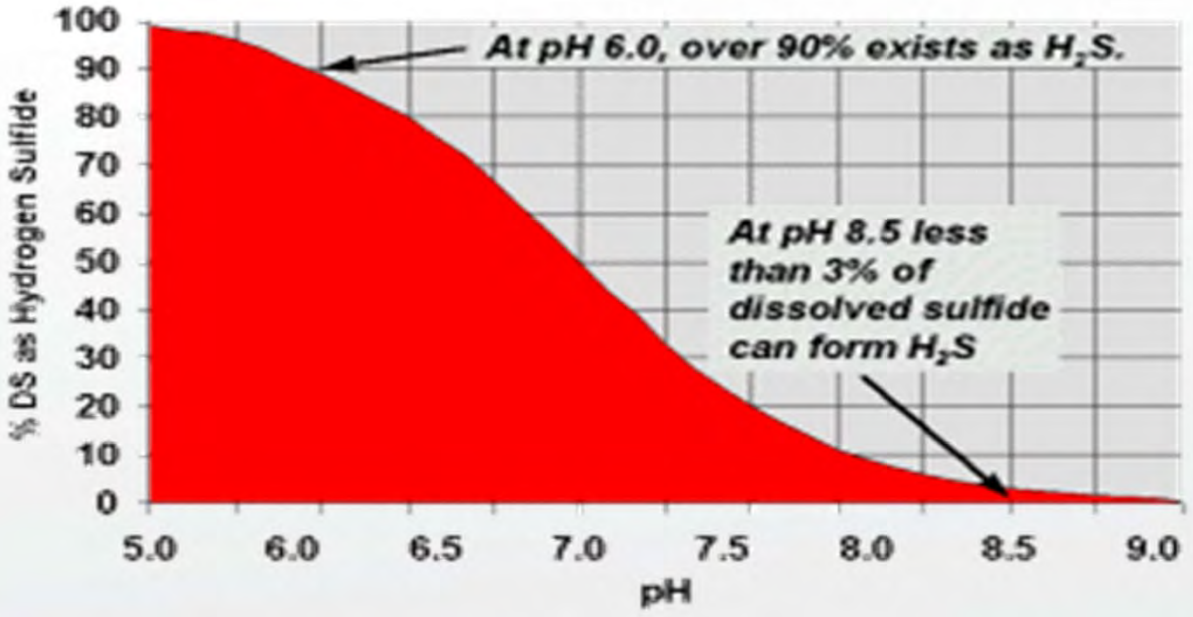
The reduction and control of I&I should be considered a disciplined, long-term monitoring and maintenance program.

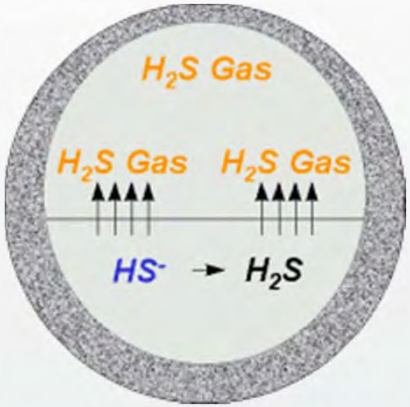
- NOT A ONE TIME FIX. IT'S A PROGRAM NOT A PROJECT.

HYDROGEN SULFIDE

Hydrogen Sulfide - Odor

- Hydrogen sulfide (H_2S) is a product of stale sewage and has a rotten egg smell.
- Odors occur when waste water pH allows hydrogen sulfide to evolve from liquid phase hydrosulfide (HS-).





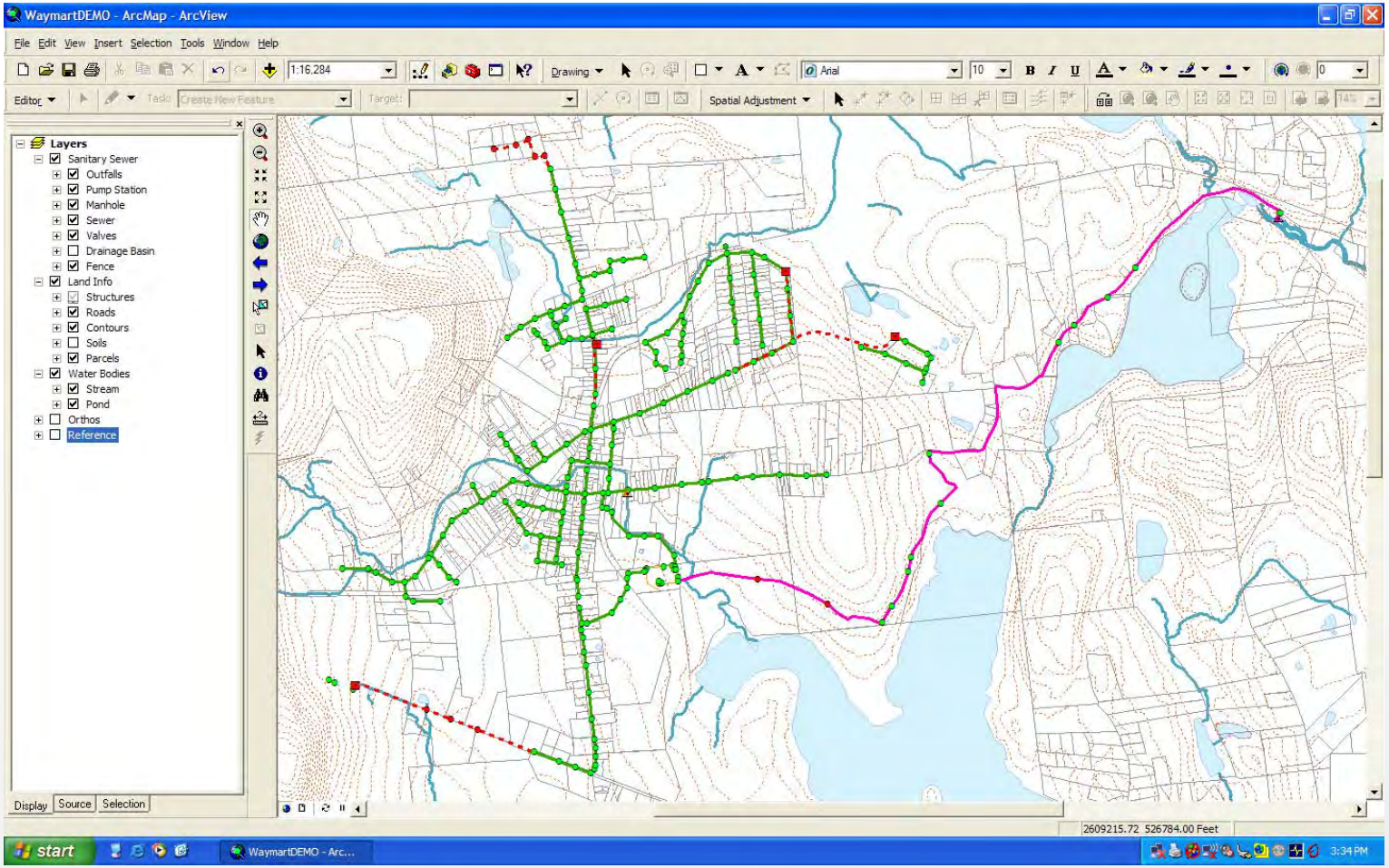
www.magnesiaspecialties.com/Thioguard/thio_direct.htm

Hydrogen Sulfide - Corrosion

- Certain bacteria convert Hydrogen sulfide (H_2S) to sulfuric acid, which is very corrosive to electrical equipment and to concrete, iron, and steel.

- Steak, Cheeseburger, and 3-day old nachos.
  - O_2
  - NO_x
  - SO_x

System Mapping



Mapping

- You must know what you have before you can assess its condition! At least an idea.
  - Existing Mapping / Available Data
  - Field locate MH / Pump Stations / Overflow Points (CSO & SSO) / Critical Monitoring Points / Etc.
    - Name each facility.
    - Operator Updates – they know more than what is on the map.
  - GIS Mapping
    - Database creation
      - Future prioritization.

System Investigation - 1

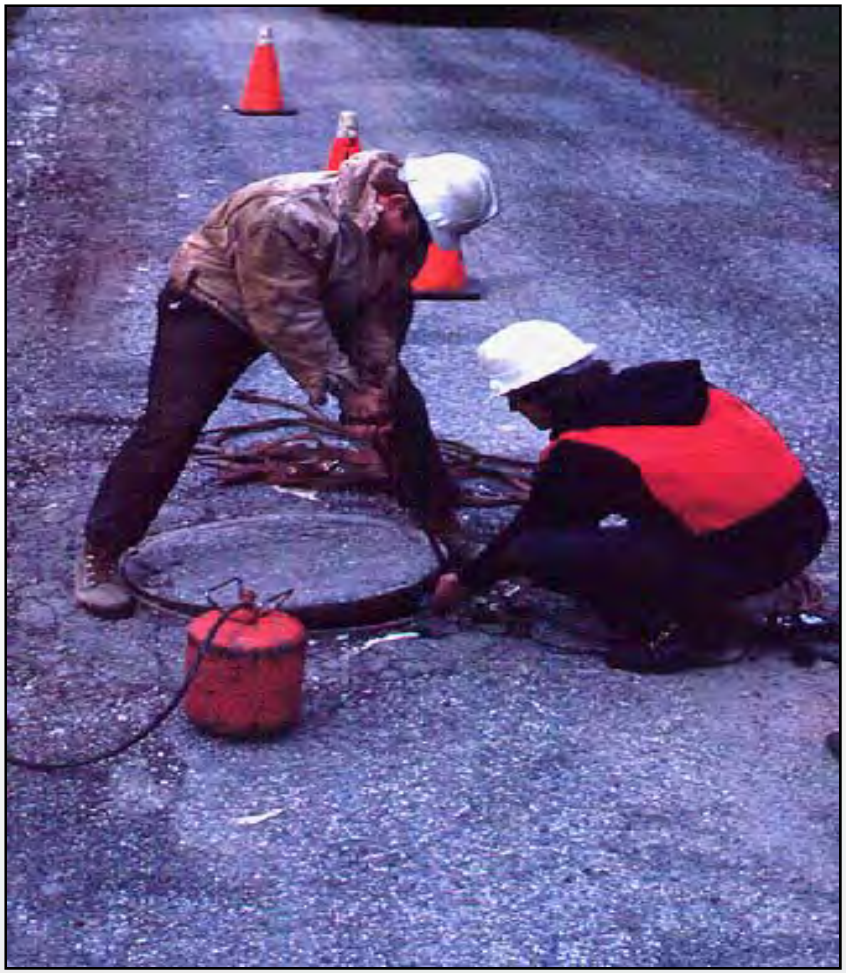
Manhole Visual Inspections

- MH inspections should denote such items as:
  - MH Location / Drainage path
  - MH to MH connections
  - Pipe Sizes
  - Structural Condition
  - Active / Evidence of Infiltration (staining/debris)
  - Evidence of Inflow (staining/debris)
  - Cycled flow
  - Clear flow
  - Increase or decrease in quantity of flow
  - Etc….


Pump Station Visual
Inspections

Wet Weather / Night Investigations

- Wet Weather
  - Select Manholes
- Night Time
  - Select Manholes



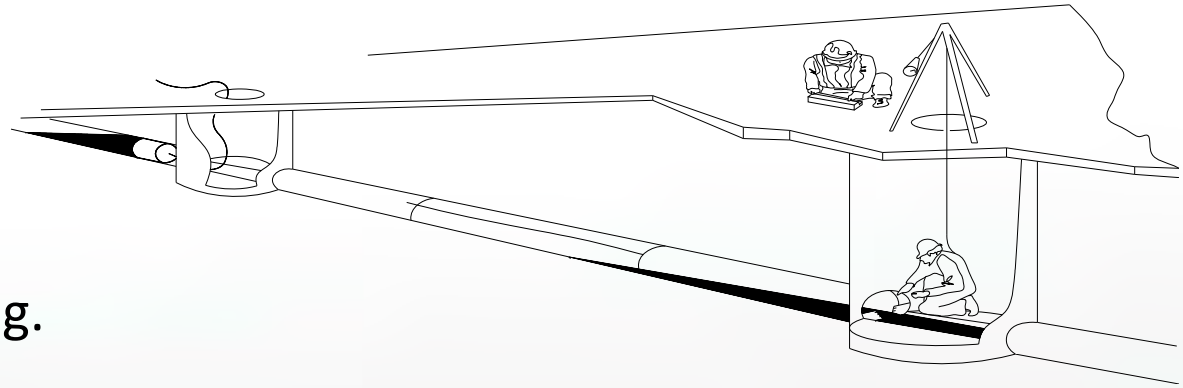
Dye Testing

- Verification of suspect sources
  - Roof leaders
  - Storm Inlets
  - Unknown pipes

System Investigation - 2

Flow and Rainfall Monitoring

- Flow Monitoring.
  - Instantaneous
  - Short-term
  - Long Term
  - Permanent



- Rainfall Monitoring.

- “6/8” guideline.
  - 6 to 8 weeks with 6 to 8 rainfall events
  - Like to see at least 2 events with 1-inch or better.

Flow and Rainfall Monitoring

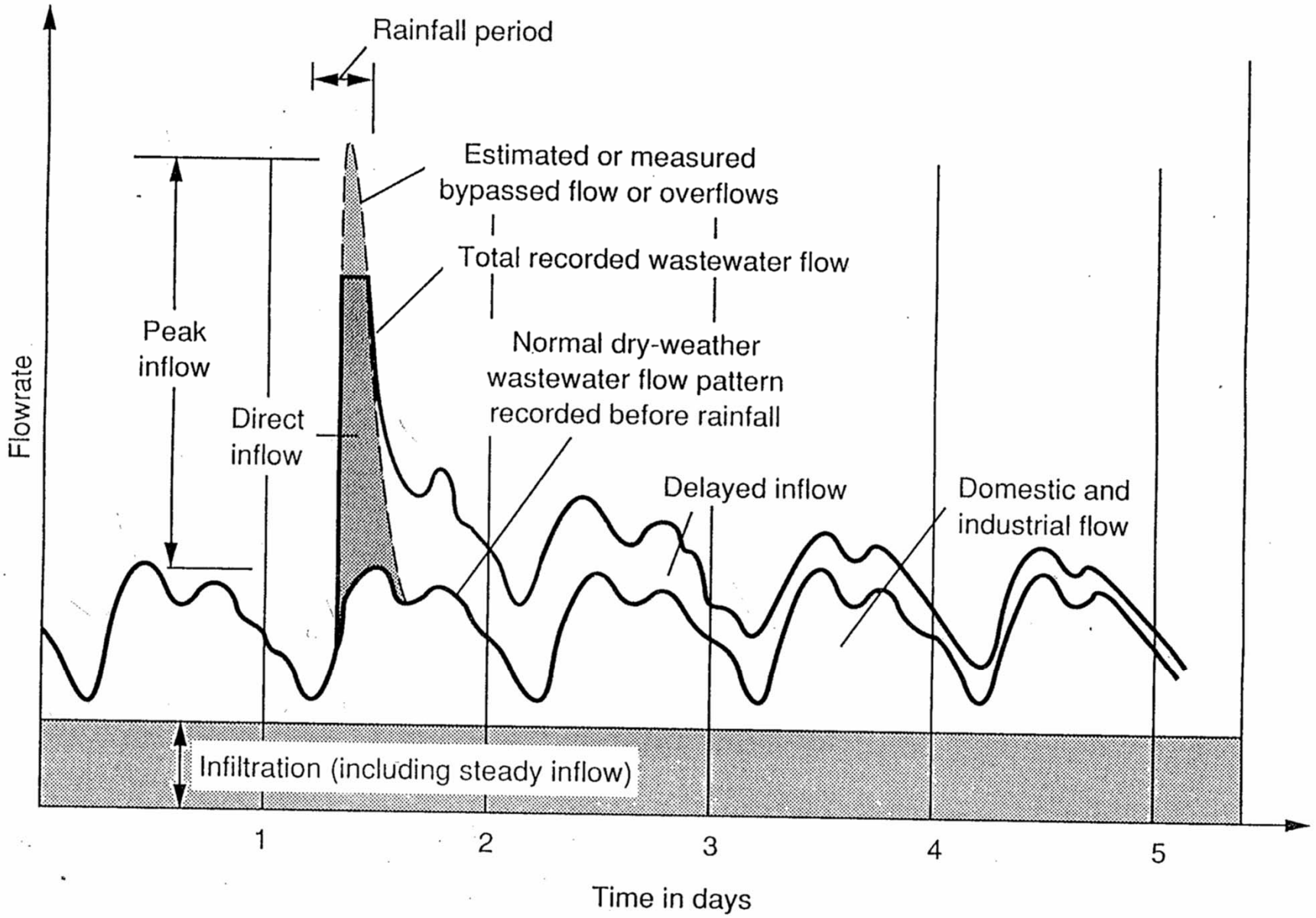
- To measure wastewater flows through the sanitary sewer system it is important to select the appropriate flow meter and location.

- The measured flow correlated to the time of day and precipitation will determine whether the system is susceptible to infiltration, inflow, or both.

Flow and Rainfall Monitoring - Do I mainly have I or I?

- Methods for determining Quantity of Inflow
  - Graph wastewater flows and denote precipitation and spikes within the graph.

- Methods for determining Quantity of Infiltration
  - Nighttime flows during dry weather conditions.


Rainfall period
Estimated or measured
bypassed flow or overflows
Total recorded wastewater flow
Peak
inflow
Direct
inflow
Normal dry-weather
wastewater flow pattern
recorded before rainfall
Delayed inflow
Domestic and
industrial flow
Flowrate
Infiltration (including steady inflow)
1
2
3
4
5
Time in days

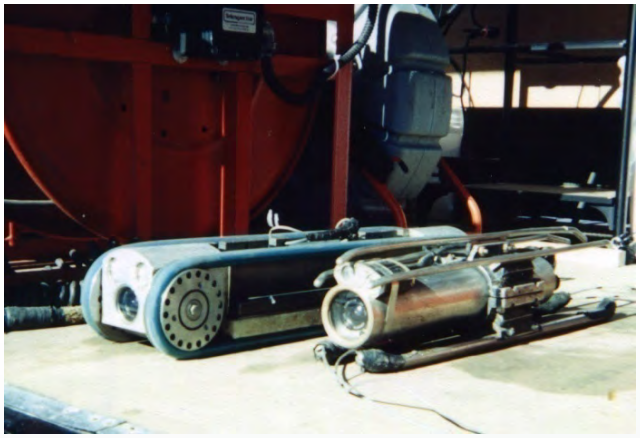
Smoke Testing

- An easy and cost effective method to identify I&I.
- Smoke testing can identify illegal connections, storm water cross connections, abandoned lines not properly plugged, cracked pipes, and bad service connections.
- Proper Trap does not allow smoke to enter.

System Investigation - 3

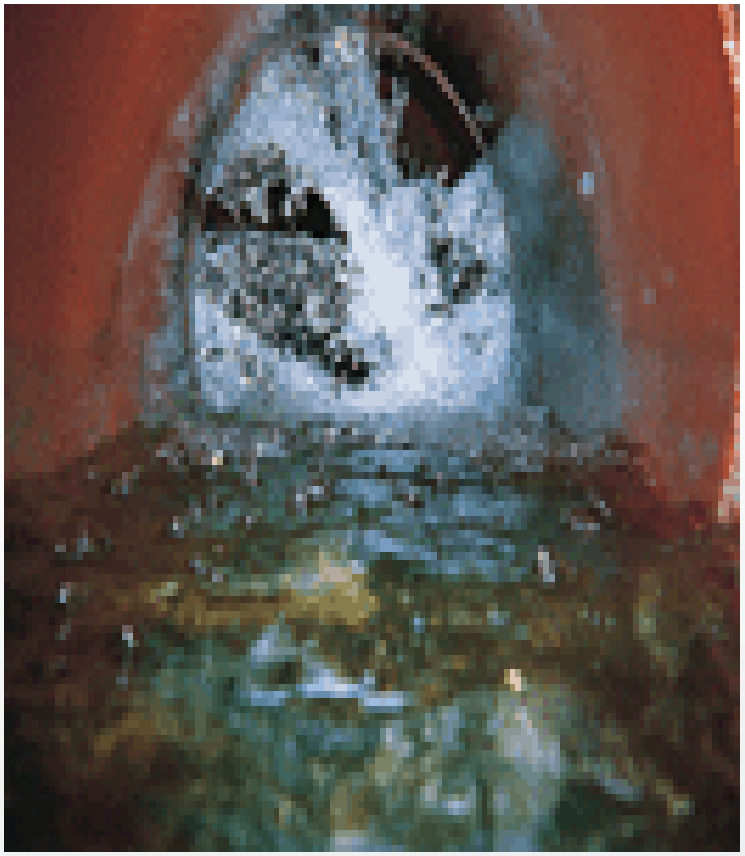
Cleaning / CCTV Pipe Inspection

- Cleaning
  - Debris Removal
  - Root removal
- CCTV Pipe Inspection
  - Maintenance
  - Structural
  - I&I



Decoding your TV Reports

- Understand the defect coding method used.
- How to Prioritize repairs?
  - Immediate Structural Repairs (ASAP)
  - Structural Repairs (Prioritize / Cost)
  - Major Sources of I&I (Prioritize / Cost)
  - Minor Sources of I&I (Prioritize / Cost)



System Investigation – Private Side

Building Inspections

- Roof Leaders
  - Smoke Testing
  - Dye Testing
- Sump Pumps
  - Dye Testing
- Basement/Driveway/Yard Drains
  - Smoke Testing
  - Dye Testing
- Others

Building Inspections

- An 8-inch diameter sewer can adequately move the domestic wastewater flow from up to 200 homes, which is roughly equivalent to:
  - 8 Sump Pumps operating at full capacity.
    - A single sump pump can contribute over 7,000 gpd, which is equal to the average daily flow from 26 homes.
  - 6 homes with downspouts connected

www.globalw.com/support/inflow.html

Building Inspections - Public

- Most residents are unaware whether they have these types of connections and that they are illegal.

- Notify and Educate the Public.
  - Notify and educate the public about I&I problems and the steps that you are taking to reduce I&I.
    - Mailings with utility bill, newspaper announcements, and on web sites.
  - Informed residents will understand the nature and impact of I&I problems and will be more likely to voluntarily correct illegal connections and consent to inspections.

Lateral Inspection

- Lateral CCTV
  - Push Camera
    - From cleanout towards main line
  - Self-propelled
    - From main line up the lateral
- Pressure Testing
  - Air
  - Water

SECTION 2

BREAK (10 Minutes)

Planning, Reporting, And Permitting

Planning Requirements

- Act 537 – Sewage Planning Area
  - OLDS
  - Sewer Service Area
  - Anti-degradation
  - Etc.

- The act states: “All proposed wastewater facilities must demonstrated consistency with local wastewater facilities plans and conform to state law. This is accomplished in part by the municipality updating its official sewage plan or by the municipality, owner, sub-divider, or agent of the proposed land completing Planning Modules for Land Development.”

Permitting Requirements

- NPDES Part I
  - PADEP sets limits and volumes
- Water Quality Management Part II Permit
  - Sewer Extensions and Pumping Stations that have the potential to serve more than 250 EDUs.
- Erosion and Sedimentation Control Plan
  - Required for all earth moving activities

CSO Policy

- Proper operation and regular maintenance programs for the sewer system and the CSO outfalls
- Maximum use of the collection system for storage
- Review and modification of pretreatment requirements to ensure that CSO impacts are minimized
- Maximization of flow to the POTW for treatment.
- Elimination of CSO during dry weather
- Control of solids and floatable materials in CSO
- Pollution prevention programs to reduce contaminants in CSO
- Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts
- Monitoring to effectively characterize CSO impacts and the efficiency of CSO controls

Basin Commissions

- Lower limits
- Chesapeake Bay Strategy
  - Existing WWTP not designed to limit nutrients
  - Limit Total Nitrogen (TN) and Total Phosphorus (TP) discharges

    - 0.4 MGD X 6 mg/L TN X 8.34 X 365 days
      = 7,306 # TN per year

    - 0.4 MGD X 0.8 mg/L TP X 8.34 X 365 days
      = 974 # TP per year

Reporting Requirements

- Chapter 94
  - The treatment plant permittee needs to submit a complete and accurate wasteload management report to PADEP by March 31 of each year.
    - Includes contributing sewer systems from other municipalities

Reporting Requirements

Chapter 94 report requires:

- Description of the Wastewater System
- Hydraulic Loading Projections
  - Max. Monthly Flow; Part II
- Organic Loading Projections
  - Highest Daily Organic Load; Part II
- Industrial Waste Report
- Sewer Extensions & Proposed Projects
- Sewer System Monitoring, Maintenance, and Repairs
- Condition of Sewer System
- Pumping Stations; Flow Rates; 2 year projection
- Sludge Disposal
- Proposed Plan to Reduce Overload Conditions
- Corrective Action Plan

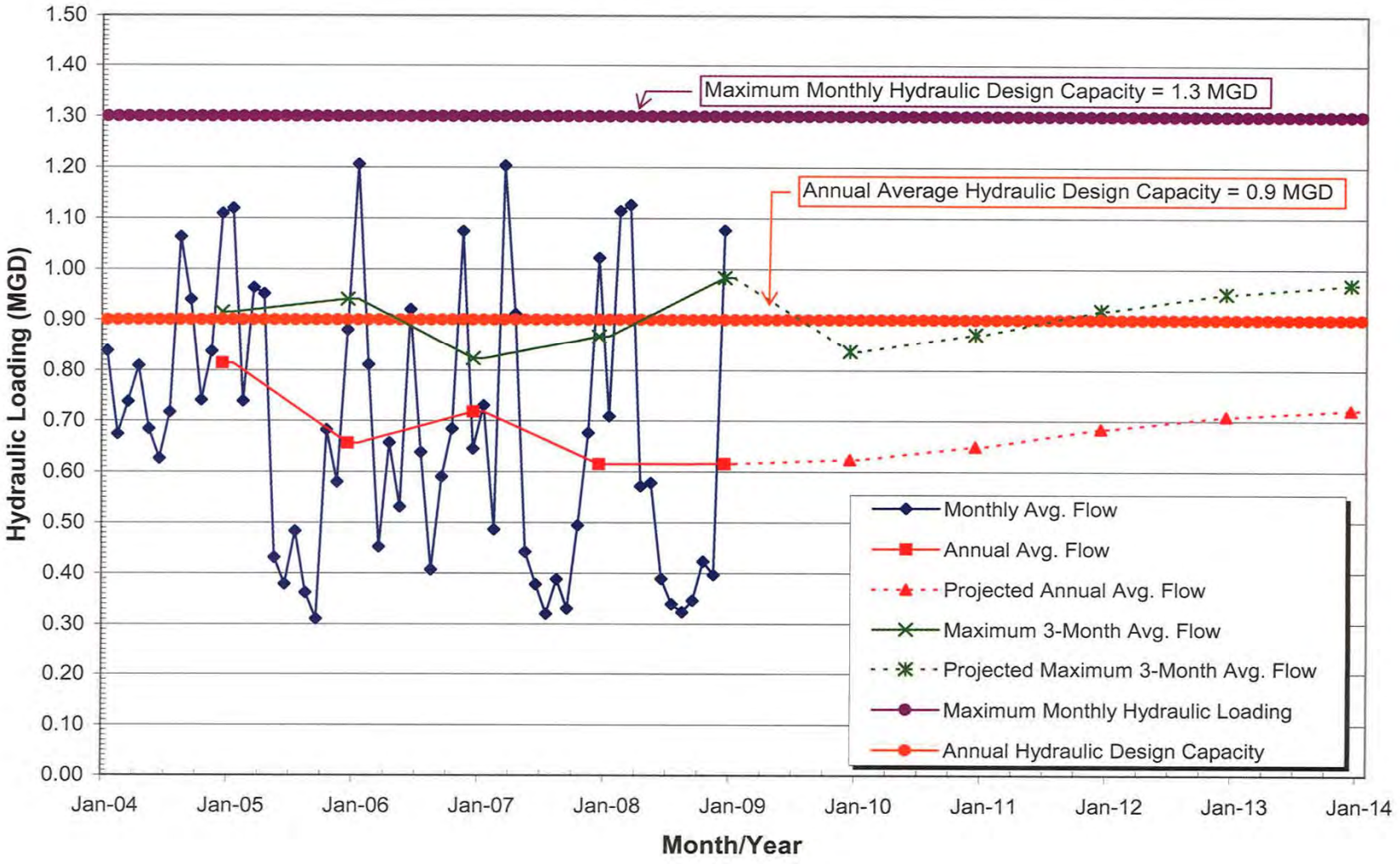
TABLE 2-1
Hydraulic Loading Data

Borough of Orwigsburg
Wastewater Treatment Plant

MONTH	MONTHLY AVERAGE WASTEWATER FLOWS (MGD)					PROJECTED WASTEWATER FLOWS (MGD)				
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
January	0.838	1.119 *	1.206 *	0.730	0.709 *					
February	0.674	0.739 *	0.811 *	0.486 *	1.114 *					
March	0.738	0.963 *	0.452 *	1.203 *	1.126 *					
April	0.809	0.951	0.657	0.911 *	0.571					
May	0.684	0.431	0.531	0.442	0.578					
June	0.626	0.379	0.920	0.378	0.389					
July	0.717	0.483	0.638	0.320	0.339					
August	1.063 *	0.362	0.407	0.388	0.323					
September	0.940 *	0.310	0.590	0.330	0.346					
October	0.741 *	0.682	0.684	0.494	0.423					
November	0.837	0.580	1.074	0.676	0.397					
December	1.109	0.880	0.645	1.022	1.076					
ANNUAL AVERAGE	0.815	0.657	0.718	0.615	0.616	0.624	0.650	0.684	0.709	0.722
NUMBER OF CONNECTIONS	1379	1392	1400	1410	1412	1450	1567	1723	1837	1896
FLOW per CONNECTION (GPD)	591	472	513	436	436	430	415	397	386	381
MAX 3-MONTH AVERAGE	0.915	0.940	0.823	0.867	0.983	0.837	0.871	0.918	0.951	0.968
RATIO (MAX 3-MONTH TO ANNUAL AVERAGE)	1.123	1.432	1.146	1.409	1.596					
AVERAGE OF 5-YEAR RATIOS					1.34					

* Indicates the maximum three consecutive months

FIGURE 2A
Hydraulic Loading



Treatment

Typical Domestic Wastewater – Influent Medium Strength

Key Wastewater Constituents for Process Design

- BOD = 190 mg/L
- TSS = 210 mg/L
- TKN = 40 mg/L
- NH_4-N = 25 mg/L
- NO_3-N = 0 mg/L
- Total Phosphorus = 7 mg/L
- Alkalinity = 200 mg/L (as $CaCO_3$)

Design Flow

"Plants should be designed to serve about 20 years projected population from the initiation of design. Deferred construction of those units which can easily be easily increased in capacity is a consideration to minimize the initial construction costs."

PADEP Domestic Wastewater Facilities Manual

Pretreatment

Screening Devices

- Coarse Bar Rack
- Manually Cleaned Bar Screen
  - Frequently used as an emergency bypass for Mechanically Cleaned bar Screen, Fine Screens, and Communitors.
- Mechanically Cleaned Bar Screen
- Fine Screens
- Comminutors – “Old” School
- Grinders – No separate waste stream

Coarse Screen

- Coarse (0.25” to 6” Opening)
  - Hand Cleaned
    - Design Note: The length of the hand cleaned screens should not exceed the distance that can be conveniently raked by hand (approx. 10 ft)
  - Mechanically Cleaned
    - Chain Driven
      - Front Clean / Front Return
      - Front Clean / Back Return
      - Back Clean / Back Return
    - Reciprocating Rake (Climber)
    - Catenary
    - Continuous Belt

Fine Screen

- Fine (Less than 0.25”)
  - Static Wedgewire
  - Drum
  - Step
- Less than 0.12” (3 mm) for MBR

Screening Handling, Processing, and Disposal

- High capital costs and maintenance
- Screening Washer / Compactor
  - Return soluble wastes back to treatment process
  - Used to dewater and reduce the volume of screenings
    - Can reduce the water content by up to 50% and the volume by up to 75%
- Means of Disposal of Screenings include:
  - Landfill / Co-disposal with solid wastes
  - Incineration
  - Discharge to grinders / macerators and returned to the wastewater

Other Pretreatment

- Grit Removal Facilities – More prevalent on combined systems
  - Before or after influent pump station?
  - Is this a necessity?
  - Types of Grit Chambers
    - Horizontal Flow
    - Aerated Grit Chambers
    - Vortex-Type
- Flow Equalization
  - Used to control the operational problems caused by flow rate variations
    - Inflow and Infiltration?
  - MBR, 2:1 peak flow ratio
  - Usually on Smaller facilities
- Pre-Aeration and Flocculation
  - Odor Control, prior to primary clarifiers
  - Limited use in current technologies

Biological Treatment

General

- “With proper analysis and environmental control, almost all wastewaters containing biodegradable constituents can be treated biologically. Therefore, it is essential that the environmental engineer understand the characteristics of each biological process to ensure that the proper environment is produced and controlled efficiently.”

Treatment Method

- Degree and consistency of treatment required
- Type of waste to be treated
- Proposed plant size
- Anticipated degree of operation and maintenance
- Operating and capital costs

Types of Biological Treatment

- Suspended Growth Processes
  - In suspended growth processes, the microorganisms responsible for treatment are maintained in liquid suspension by appropriate mixing methods.

- Attached Growth Process
  - In attached growth processes, the microorganisms responsible for treatment are attached to an inert packing material.

Types of Biological Treatment

- Suspended Growth Process
  - Activated Sludge
- Attached Growth Process
  - Trickling Filters
  - Rotating Biological Contactors
  - Re-birth with IFAS
    - IFAS = Integrated Fixed Film Activated Sludge

Activated Sludge

- A suspended growth system, where bacteria are kept in suspension under appropriate conditions to grow and consume pollutants in the wastewater.

- Suspended growth systems must properly balance the biomass in the reactors versus the capacity of the secondary clarifiers.

AS – Process Control

- The principal approaches to process control are:
  - Maintaining dissolved oxygen levels in the aeration tanks
  - Regulating the amount of return activated sludge (RAS)
  - Controlling the amount of waste activated sludge (WAS)

- The parameter used most often commonly for controlling the activated sludge process is SRT.

Activated Sludge Treatment

- Conventional
- Complete Mix
- Step Aeration
- Contact Stabilization
- Extended Aeration and Oxidation Ditches
- SBR
- MBR
- IFAS

Sequencing Batch Reactor (SBR)

- Variable volume suspended growth treatment technologies that uses time sequences to perform the various treatment operations that continuous treatment processes conduct in different tanks.

Aeration

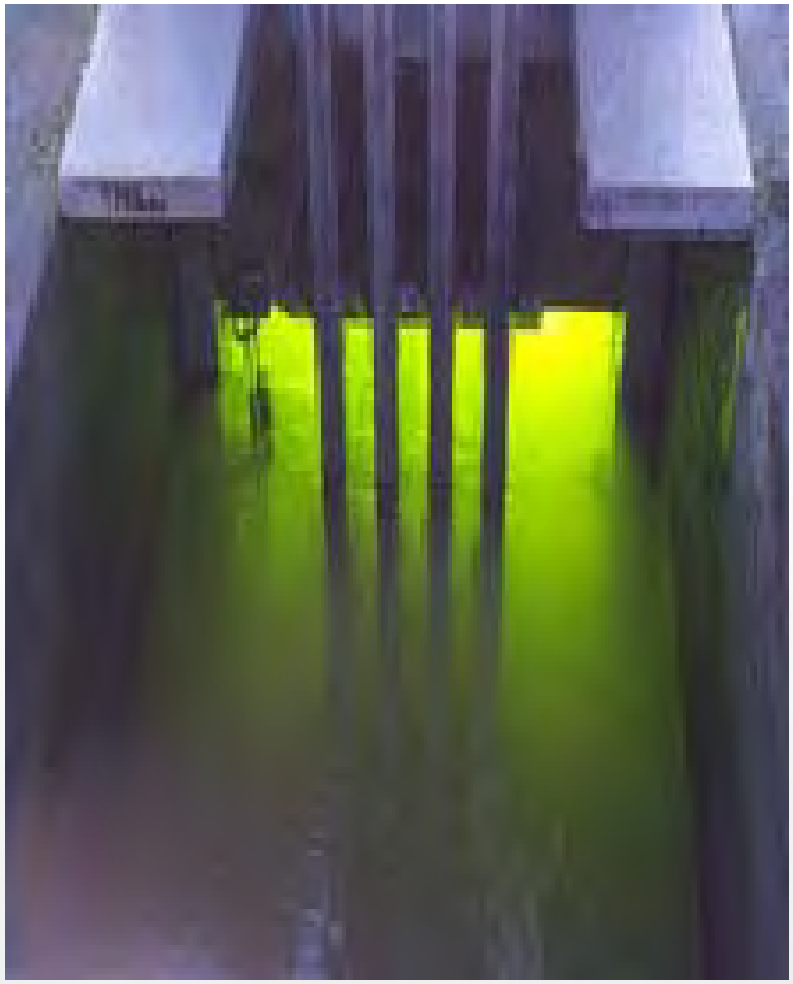
- Diffused Air Systems
  - Coarse
    - Used on Sludge Process Aeration
  - Fine
    - Used to increase oxygen transfer efficiencies
- Jet Aeration
- Mechanical Aeration

Settling

General

- Primary Clarifiers
- Secondary Clarifiers
- Number of Units
- Flow Distribution
  - Flow splitting and Control
- Tank Configuration
  - Tank Size and Shape

Disinfection



Forms of Disinfection

- Chlorine (most common)
  - TRC Limits are being set
- Chlorine Dioxide
- Ozone
- Bromine
- Ultraviolet Radiation
  - Becoming more common
- Hydrogen Peroxide

Ultraviolet Disinfection

- UV light involves exposing treated effluent to radiation from UV light. The treatment works because UV light penetrates an organisms cell walls and disrupts the cell's genetic material, making reproduction impossible.


Biological Nutrient Removal

Biological Nutrient Removal

- The removal of nitrogen and/or phosphorus from wastewater using biological methods of treatment.
  - **Aerobic**: Dissolved Oxygen (D.O.) Present
  - **Anoxic**: NOxN Present, Little D.O. Present
  - **Anaerobic**: No D.O. Present, No NOxN Present
- Remember Steak, Cheeseburger, and 3 day old Nachos

BNR Process Configurations

- Although the exact configurations of each system differ, BNR systems designed to remove TN must have:
  - Aerobic Zone for nitrification
  - Anoxic Zone for denitrification
- BNR systems designed to remove TP must have:
  - Anaerobic Zone

Nitrification

$$NH_4^+ + 1.5\ O_2 \rightarrow NO_2^- + H_2O + 2\ H^+$$

Oxygen Required = 3.43 lb / lb N Oxidized

Alkalinity Required = 7.14 lb as $CaCO_3$ / lb N Oxidized

$$NO_2^- + 0.5\ O_2 \rightarrow NO_3^-$$

Oxygen Required = 1.14 lb / lb N Oxidized

For Both Reactions

Oxygen Required = 4.57 lb / lb N Oxidized

Alkalinity Required = 7.14 lb as $CaCO_3$ / lb N Oxidized

Nitrification

- pH
  - Optimum 7.5 to 8
- Toxicity
  - Sensitive
- Metals
  - 0.25 mg/L Nickel, 0.25 mg/L Chromium, and 0.25 mg/L of Copper.
- Un-ionized ammonia
  - NH_3; free ammonium
  - Unionized nitrous acid (HNO_2)

Denitrification

$$NO_3 + \text{Org. Carbon} \rightarrow N_2 + CO_2 + OH + H_2O$$

$$CO_2 + OH \rightarrow HCO_3$$

$$NO_3 \rightarrow NO_2 \rightarrow NO \rightarrow N_2O \rightarrow N_2$$

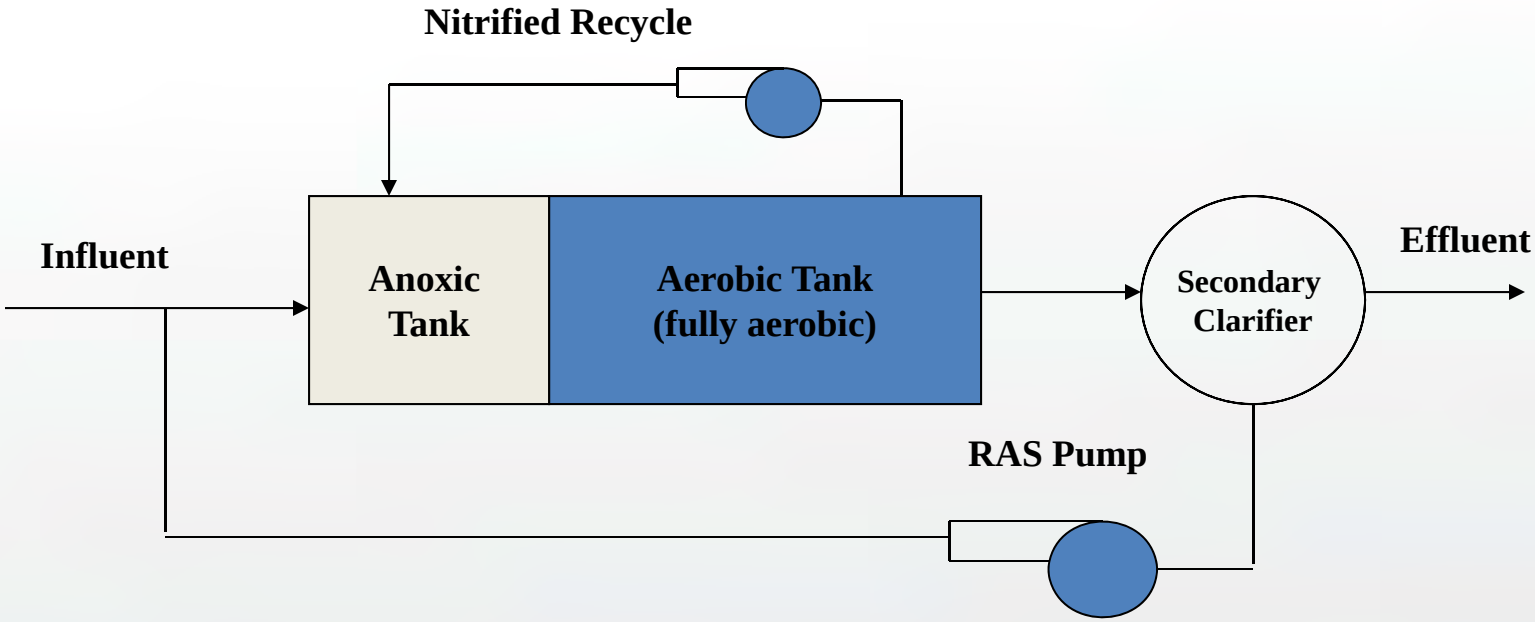
- 2.86 lbs oxygen recovered / lb NO_3-N
- 3.57 lbs alkalinity recovered / lb NO_3-N

Return of Alkalinity

- Alkalinity is lost during nitrification
- Approximately 7.14 mg/l of alkalinity are lost for each mg/l NH_4^+ oxidized to NO_3^-
- Denitrification returns approximately 50% of the alkalinity lost during nitrification

Modified Ludzack Ettinger (MLE)

- This process modifies the Ludzack-Ettinger process by adding a recirculation of mixed liquor recycle (MLR) from the end of the aeration tank to the beginning of the anoxic tank.



Denitrification – Carbon Augmentation

- A number of substances:
  - Methanol
  - Ethanol
  - Acetate
  - Molasses
  - Soft drink wastes, and
  - Brewery wastes
  - Engineered substances

TP Removal Considerations

- Influent BOD to P ratio
- Sludge Processing
- Chemical Addition
- Point of Chemical Addition

Biological Phosphorus Removal

Advantages When Compared to Other Techniques

- Relatively inexpensive
- Demonstrated ability to remove **P** to low effluent concentrations
- Reduces chemical costs
- Reduces sludge disposal costs

I Already Remove Phosphorus

- Influent phosphorus = 4 - 12 mg/L
- Without phosphorus removal
  - 5% to 10%: Primary Settling / Secondary Clarification
  - 20% to 25%: Bacteria growth in Activated Sludge process
  - Therefore, final effluent: 3 mg/L to 4 mg/L TP

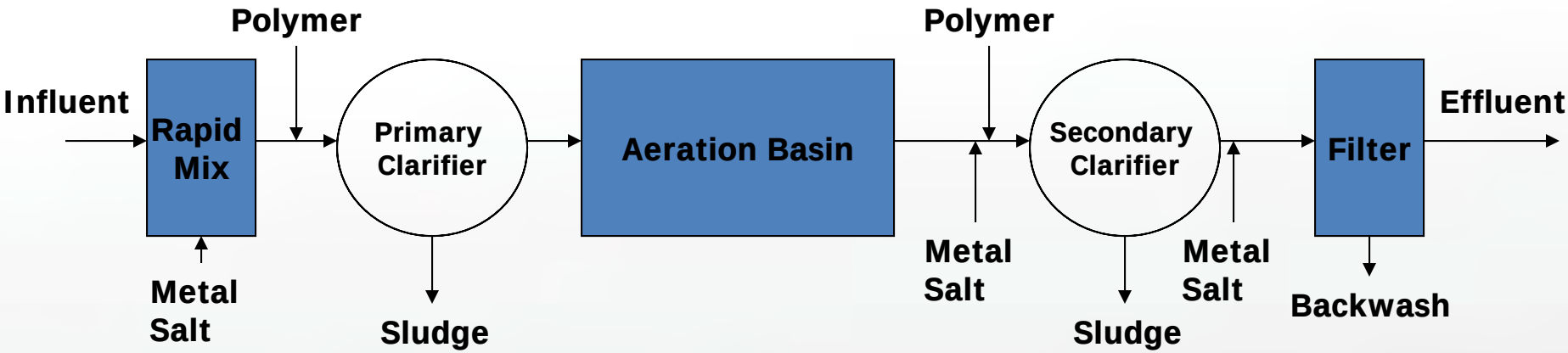
(Further) Phosphorus Removal

- Traditional chemical precipitation.
- Biological phosphorus removal.
- Steps to remove PO_4-P biologically.
  - Volatile fatty acid (VFA) production (anaerobically)
  - Phosphorus release by bio-P bacteria (anaerobic conditions)
  - Excess phosphorus uptake by bio-P bacteria (anaerobic after metabolizing stored food)

Phosphorus Removal- Chemical Precipitation

- Chemical Alternatives
  - Lime Precipitation
  - Metal Salt Precipitation
    - Iron Salts
      - Ferric Chloride
      - Ferrous Chloride
      - Ferrous Sulfate
    - Aluminum Salts
      - Aluminum Sulfate (Alum)
      - Sodium Aluminate
      - Polyaluminum Chloride
      - Aluminum Chloride

Dosing


Polymer
Polymer
Influent
Rapid Mix
Primary Clarifier
Aeration Basin
Secondary Clarifier
Filter
Effluent
Metal Salt
Sludge
Metal Salt
Sludge
Metal Salt
Backwash

Sludge Storage, Processing, And Disposal

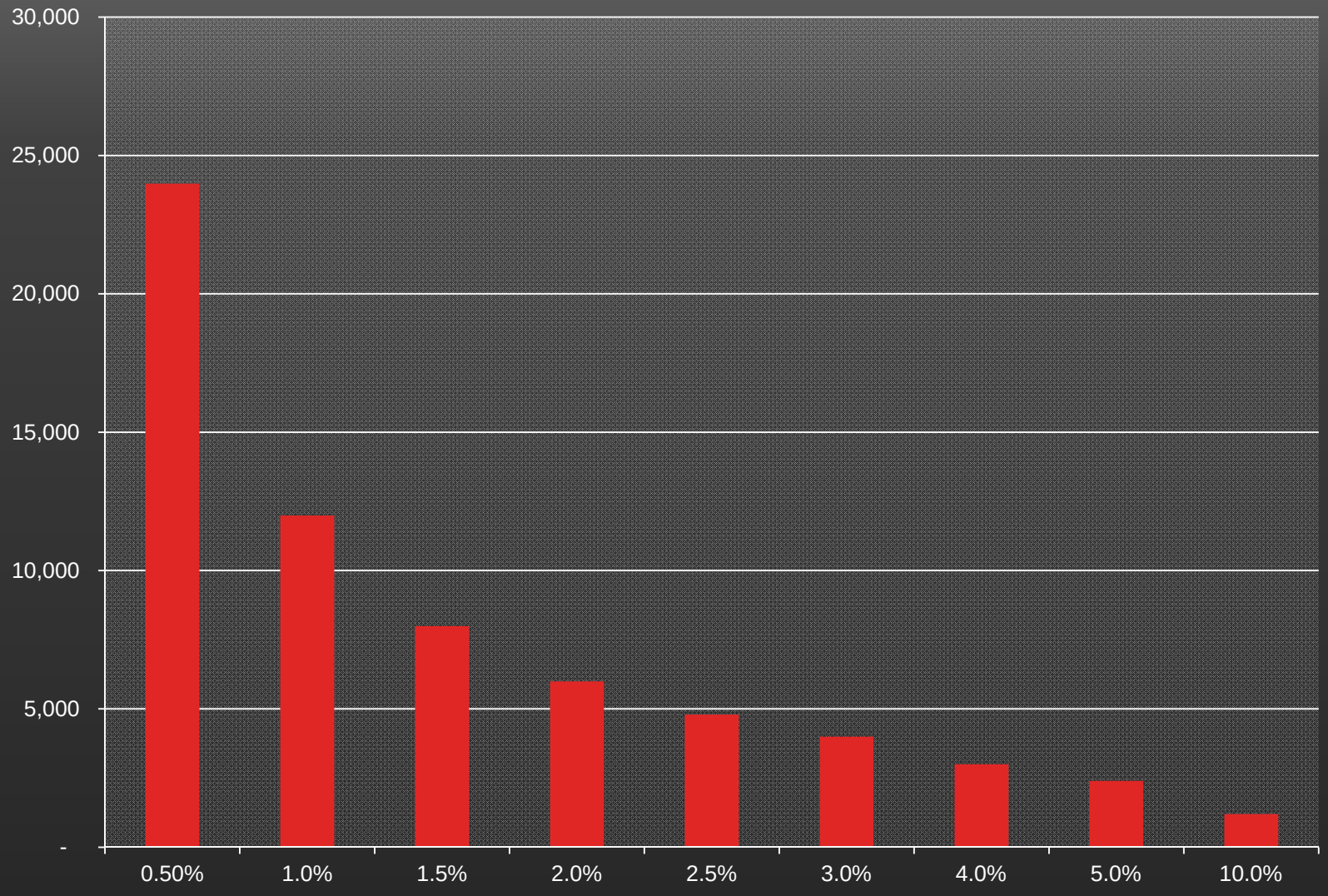
Sludge General

- Characteristics of the sludge
- Method of Ultimate Disposal
- Stabilization Requirements
- Cost Effectiveness
- Storage Requirements
- Back-up techniques available
- Equipment Complexity
- Staffing Requirements

Sludge Treatment Processes

- Sludge Thickening
- Sludge Digestion / Stabilization
  - Anaerobic Digestion
  - Aerobic Digestion
- Sludge Dewatering
  - Sludge Drying Beds
  - Mechanical Dewatering Facilities

1,000 # of Solids and Volume of Sludge



Sludge Storage / Ultimate Disposal

Sludge Cake
- Landfill
- Incineration
- Drying
  - Class A
  - Cement Kilns

Liquid Sludge
- Land Application

Section 2

Quiz – Section 2 Only
(10 Minutes)

Break
(5 Minutes)

Section 3

Financing And Community Involvement

General Budgeting Process

- The goal is to insure stable and predictable rates for both the long and the short term.
  - Accomplished by understanding fixed and variable costs.

- Those that do not plan for a rainy day or the simple rehabilitation / replacement of old infrastructure will find themselves paying more to borrow money and reacting to problems.

Revenue

- User Fees
- Tapping Fees
- Federal or State Reimbursements
- Developer Contributions / Special

Costs

- Debt Service
- Manpower, Salaries, Benefits
- Utilities / Power
- Solids Disposal
- Chemicals
- Legal / Engineering

Planning

- Worth of your assets
- Expecting Life Span
- Replacement Costs
- Capital Improvements Plan
  - 5-Year Horizon
  - 10-Year Horizon

Cost Effective Projects

- “In many cases, through more effective planning and management of infrastructure improvements and system operations, organizations can realize annual savings of 20 to 40%”

Journal AWWA, Nov 2001, Vol 93, Stern and Kendall, 2001

Communication Plan

- What do you want to communicate?
- Why is it applicable to the reader?
  - Reader centered approach.
- What actions (if any) are you REQUIRING or REQUESTING?
- What was the response?

Media Channels

- Meetings
- Newsletters / Bill Stuffers / Door Hangers
- Newspaper
- Website / Social Media
- Trained Personnel

SECTION 3

QUIZ – SECTION 3 ONLY
(10 Minutes)

Questions?