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Sewage Contamination: Microbiology, Health Risks and Remediation

Participants will be in listen only mode.

9 a.m. (PST)

Presented by:

Harriet A. Burge, Ph.D.

Download the PDF:
http://www.emlab.com/m/media/sewage-contamination-webinar.pdf

Continuing Education Units (CEUs)

To receive a **certificate of attendance**, you must complete the survey after the webinar:

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We will discuss:

Specific microorganisms associated with infection risk likely to be present in the most common scenarios

- **Survival of each type of organism**
- **Conditions necessary for exposure**
- **Susceptibility to biocides**

Steps to cleanup currently recommended

Improvements in these recommendations to optimize effectiveness and cost of cleanup.

Outline

- Definitions of sewage and contamination
- Water categories
- Sewage sources
- Sewage microbiology and exposure
- Principal sewage health risks
  - Pathogens
  - Hypersensitivity disease
  - Toxicoses
- Remediation
  - Exposure risks to remediators
  - Strategy for planning remediation
  - Remediation process
  - Biocides
  - Clearance

Definition – Sewage

- Waste water and excrement carried in sewers
- Raw sewage, sewage sludge, or septic tank waste; mainly water containing excrement
- Liquid and solid waste carried off in sewers or drains
- Waste matter from domestic or industrial establishments that is carried away in sewers or drains for dumping or conversion into a form that is not toxic
- The waste matter that passes through sewers
- Waste water and excrement conveyed in sewers

Definition – Contamination

- We use this term regularly. What does it mean?
  - The act or process of contaminating something or becoming contaminated, or the unclean or impure state that results from this
  - Synonyms: pollution · adulteration · corruption · infection · uncleanness
  - Something that physically contaminates a substance or that corrupts a person morally

Definition – Contamination (cont'd)

- Our definition for this presentation:
  - Infectious or toxic agents that are present in water that has inadvertently entered the occupied space in a building

Water Classifications

- Sewage is 99% water
- Sewage can also leak into environmental water and be carried indoors during flooding
- Consideration of the risk related to water spills and flooding, regardless of the source, is an important part of remediation strategy

Category 1 Water

- Water originating from a sanitary source (potable water)
- Water from a broken clean water pipe or sink overflow
- Rainwater entering a window.
- **No substantial risk to occupants or restorers**

Category 2 Water

- Water contains some form of pollutant other than human waste
  - Dirty flooring
  - Overflowing clothes washing machine
  - Broken fish tank, or water bed
- **May cause discomfort or symptoms in some persons; risk to restorers minimal.**

Category 3 Water

- Grossly unsanitary water
  - Water containing human waste (fecal material, blood, vomitus)
  - Toilet overflow
  - Leaking sewer pipes
  - Floods with outdoor contaminated water
  - Usually contains pathogenic organisms and viruses
- **May cause major illness (infections) in some people.**

Sewage Sources

- Residential
  - Human gut organisms
  - Organisms related to food spoilage
  - Medications that are flushed
- Institutional
  - Human gut organisms
  - Drugs and other chemicals
- Commercial
  - Depends on type of business
- Industrial
  - Organisms and toxins in water mixtures used in manufacturing

How Sewage-Related Diseases Are Transmitted

- Contaminated hands touch your food or mouth
  - Hands can become contaminated through a variety of activities, such as touching surfaces (e.g., toys, bathroom fixtures, changing tables, diaper pails) that have been contaminated by stool from an infected person.
  - Hands can also become contaminated with *Shigella* while changing the diaper of an infected child or caring for an infected person.

How Sewage-Related Diseases Are Transmitted (cont'd)

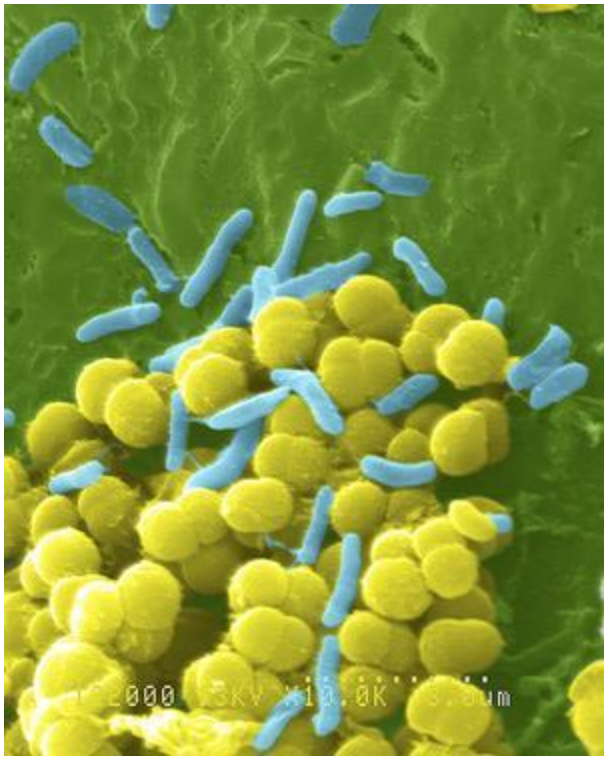
- Eating food contaminated with gut organisms (e.g.*Shigella)*
  - Food may become contaminated if food handlers have shigellosis
  - Produce can become contaminated if growing fields contain human sewage
  - Flies can breed in infected feces and then contaminate food when they land on it
- Swallowing recreational (for example lake or river water while swimming) or drinking water that was contaminated by infected fecal matter.
- Exposure to feces through sexual contact.

Principal Sewage Risk

- The principal risk associated with sewage is infection
- Risk depends on:
  - the types of organisms present
  - Condition of the person exposed.
- Sewage microbiology is complex, and continuously changing.
- The majority of organisms in the sewage mixture are not a risk for human health.

Organisms That May Present A Risk of Infection

- Pathogenic viruses, bacteria, and protozoa.
- Human gut organisms from diseases persons are a primary concern.
- Protozoa and bacteria from some other sources may also be associated with infection risk.



Bacterial Pathogens (cont'd)

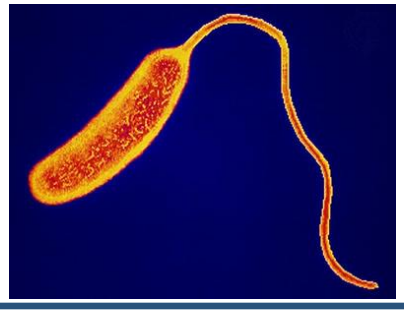
- *Salmonella*
  - Food poisoning
  - Contaminated food (cucumbers, frozen chicken, peanuts, etc.)
  - 1.2 million cases, 19,000 hospitalizations, 400 deaths
  - Also causes Typhoid fever, paratyphoid fever
- *Shigella*
  - 90 million dysentery cases/year worldwide, 100,000 deaths
  - Person to person fecal contact
- *Escherichia coli* O157:H7
  - Enterohemorragic diarrhea; and kidney failure
  - 73,000 cases in USA, 61 deaths

Bacterial Pathogens found in sewage

- *Campylobacter jejuni* – Gram neg. spiral rods
  - Most common cause of food-borne diarrhea worldwide. At least 1.9 million cases per year mostly from contaminated chickens
- *Clostridium perfringens* – Gram pos. spore forming rods
  - 1 million cases of foodborne illness/year in US
  - Unrefrigerated precooked food
- *Clostridium difficile*
  - 453,000 cases; 29,000 deaths
  - Antibiotic associated diarrhea mostly nosocomial

Bacterial Pathogens (cont'd)

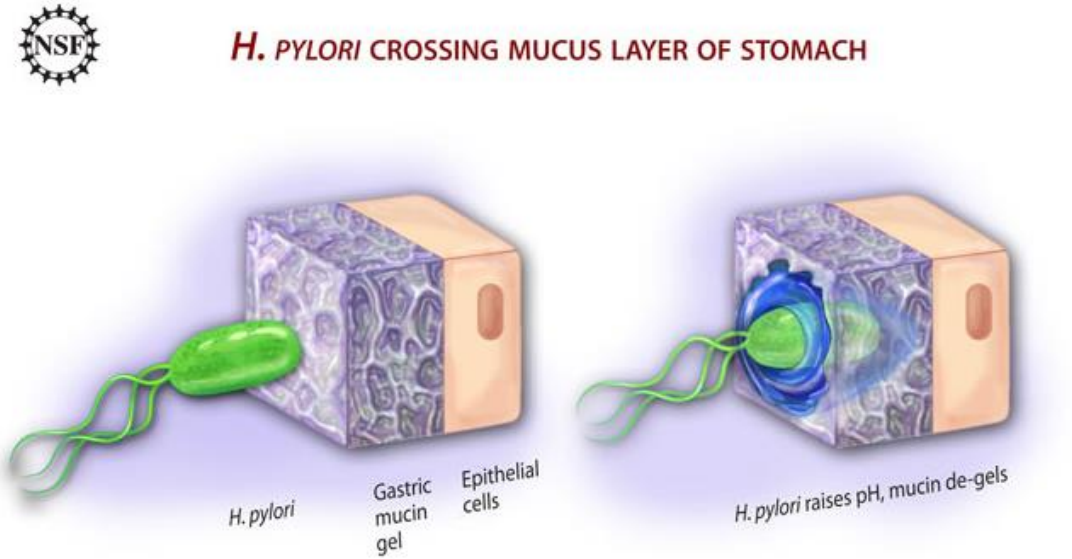
- *Vibrio cholerae*
  - Fish and shellfish source; food borne, causes cholera, wound infection, septicemia
  - 5 reported cases per year in USA; epidemic elsewhere
- *Aeromonas*
  - Ubiquitous in the environment
  - Gastroenteritis, mostly in children
  - Aquatic; ingesting contaminated water or food
  - Incidence unknown



Bacterium *Vibrio cholerae* which causes cholera

Bacterial Pathogens (cont'd)

- Nontuberculous mycobacteria
  - Cause lung infection in immunocompromised, can cause hypersensitivity pneumonitis when antigens are inhaled
- *Helicobacter pylori*
  - Common cause of many ulcers



Bacterial Pathogens – Survival On Dry Surfaces

- Dry on surfaces
  - *Staph aureus* (MRSA)
    - 2-4 days depending on inoculum strength
  - *Enterococci*
    - Days to months on fabrics and polyethylene
  - *Campylobacter*
    - Less than 24 hours

Protozoan Pathogens

- *Giardia*
  - Ciliated protozoan
  - Causes severe diarrhea
  - Asymptomatic carriers can spread infection
  - Hand to mouth fecal transmission is common
  - 20,000+ cases/year, many in children
- *Cryptosporidium*
  - Exist as resistant oocysts
  - Colonize the lower intestine
  - Immunocompromised and children most at risk
  - About 9,000 cases /year

Protozoan Pathogens (cont'd)

- *Cyclospora*
  - Common outside the US, and the disease is called traveler's diarrhea
- Microsporidia
  - Common in animals, and opportunistic in humans.
  - Cause generalized disease with fever, weight loss, and other symptoms
- Isospora
  - Internal opportunistic parasite

Protozoan Survival

- Dry on surfaces
  - Susceptible to desiccation; die quickly

Viral Pathogens in Sewage

coxsackie virus AB	Paralysis, meningitis
Echovirus	Meningitis, fever, respiratory disease, gastroenteritis
Hepatitis A	Hepatitis
Human reovirus	Unknown
Human rotavirus	Gastroenteritis
Human adenovirus	Gastroenteritis, respiratory disease, conjunctivitis
Human calcivirus (Norwalk, Hepatitis E)	Gastroenteritis, fever, Hepatitis
Human astrovirus	Gastroenteritis
Human parvovirus	Gastroenteritis
Human coronavirus	Gastroenteritis, Respiratory disease
Human torovirus	Gastroenteritis

Viral Survival in Water

- Viruses cannot reproduce in water
- Temperature
  - Viruses survive best at low temperatures
  - Hepatitis A, adenoviruses, parvoviruses have highest survival rate
- Light
  - UV light (in sunlight) inactivates many viruses
  - Double stranded DNA viruses (e.g., adenoviruses) are most resistant
- pH
  - Most viruses are stable in the normal pH of water (5-9). Significant inactivation occurs above and below this range

Survival Under Ideal Conditions (Bacteria and Viruses)

- Norovirus: up to 7 days
- *Salmonella* and *Campylobacter* survive on hard surfaces for 1-4 hours
- Norovirus and *Clostridium difficile* survive for up to 5 months.
- Hepatitis A: months
- Hepatitis B and C: up to 4 days

Virus Survival

- Norovirus
  - 10-14 days on dry countertop
- Rotavirus
  - 30-90 minutes

Sewage Treatment

- Primary treatment
  - Quiescent storage to settle solids
- Secondary treatment
  - Digestion by microorganisms to remove dissolved materials
- Tertiary treatment
  - Any additional treatment; filtration, disinfection

Disease Transmission

- Most of the pathogenic organisms in sewage cause some type of diarrhea.
- Most transmission of these pathogens occurs through hand to mouth following contact with food or infected animals or people
- Because these are gastrointestinal diseases, most of the organisms are often encountered in sewage.
- Reported cases from sewage contact are rare for most of the organisms

Exposure Risks

- Spread of infection depends on
  - Pathogen survival in water
  - Pathogen ability to multiply in water
  - Dose required for establishing infection in susceptible individuals
  - Exposure

Differential Risks

- Sewage microbiology varies according to its source.
- For example, single home sewage is associated with the least and most controllable risk
  - Disease in occupants is likely known, and restricted
- Sewage from hospitals represents a much higher risk
  - Many different disease organisms may be present in unknown relative concentrations

Reported Infection Risks

- Airborne norovirus exposure in Denmark sewage treatment workers
- Increased risk of Hepatitis A in sewage workers
- Association between gastrointestinal ER visits and flooding

Hypersensitivity

- IgE reactivity to chironomid midges in sewage workers
- Sewage treatment workers handling dry sludge exposed to endotoxin and other things, with adverse respiratory effects
- These are very unlikely in remediators

Toxicoses

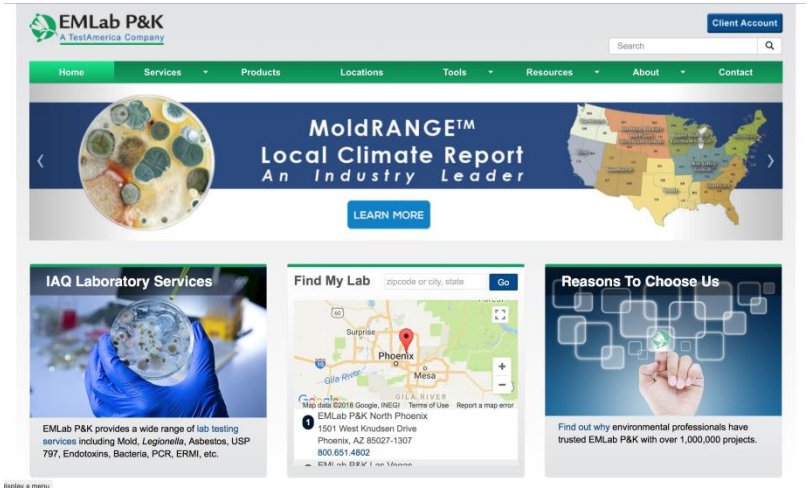
- Endotoxin
  - Sewage workers are variably exposed to endotoxin, and symptoms occur in highly exposed populations.
- Other toxins
  - Pharmaceuticals
  - Heavy metals
  - Industrial chemicals
- **It is important to know the sources of sewage.**

Exposure Risks To Remediators

- Hand to mouth contact with either bare or gloved hands
  - Glove removal will contaminate hands
  - Wash hands thoroughly after removing gloves
  - Removing contaminated clothing. Remove, bag and wash hands thoroughly
- Inhalation or mouth/eye contact with aerosols
  - Use of spray devices for cleanup will produce aerosols. Either use respiratory protection or don't use them.

Eurofins EMLab P&K Website

We've launched the redesigned EMLab P&K Website!



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With the new website features, you can:

- Navigate the site with ease
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You can still access all of your bookmarked and favorite features, such as the Fungal Library and Environmental Reporter articles!

Accredited for *Legionella* Water Testing

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EMLab P&K's New Jersey Lab is now **fully accredited** by the New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) for **potable and non-potable Legionella water testing** (NY Lab ID #12049).

Contact Kim Thomas, Account Manager, at (856) 952-9454
Or email KThomas@emlabpk.com

EMLab P&K's IAQ Pocket Guide

- **Sampling and regulatory guidelines for: Fungi, Asbestos, Bacteria, Allergens, and Industrial Hygiene**
- **Updated MoldRange™ data from over 350,000 spore trap samples**
- **Data interpretation guidelines**

To order a complimentary Pocket Guide, complete the survey after the webinar.

NOTE: Sent to United States and Canada only. Limit one per person per calendar year. See "Thank you" email (sent an hour after the webinar) for a link to the survey to order your Pocket Guide.

Remediation – Goal

- Goal of remediation
  - Remove both contaminated water and solids
  - Minimize risk to occupants and workers
  - Return space to pre-spill condition wherever possible

Remediation – Evaluation

- Evaluate the situation
  - Is the sewage contained or has it spread widely in the environment?
  - Do you need to evacuate occupants?
  - Are there furnishings that can be immediately removed to simplify cleaning?
  - Has installed carpeting been affected?

Remediation – Evacuation

- Evacuate occupants if sewage has spread beyond the room/space in which the spill occurred
- Keep occupants out of the spill space until cleanup is complete
- Caution susceptible people about risks
  - Recommend frequent, thorough hand washing for everyone
  - Recommend evacuation of highly susceptible people

Sewage Remediation

- Wear respiratory protection to prevent hand/mouth transfer of microorganisms
- Wear skin protection on your hands
- Wear boots/shoes that can be cleaned with bleach
- Either wear water impermeable clothing or remove and bag clothing and wash hands thoroughly when finished.
- Do not track sewage contaminated water outside of spill area

Remediation (cont'd)

- Remove all furnishings in the spill area
  - Preferably remove to outdoor site
  - Do not contaminate the path of removal
    - If it is not possible to remove without contamination, leave in place and include in complete cleaning protocol.
    - Bag small articles in a clean area before removal (i.e., don't let the outside of the bag contact the sewage)

Remediation (cont'd)

- Remove water
- Remove solids
- Remove contaminated furnishings
- Wash all hard surfaces with detergents
- Rinse surfaces with bleach (1/4 cup/gallon of water)
- Discard soft materials that cannot be cleaned

Remediation (cont'd)

- Remove sewage liquid quickly before mold growth occurs in occupied spaces
  - If wet-vacs are used, add 1/2 cup bleach to reservoir before beginning
  - Wet-vac contents can be flushed down the toilet providing the toilet is working properly
  - Clean wet-vac surfaces thoroughly with bleach after use
  - Ventilate and dehumidify during and after cleanup

Remediation (cont'd)

- Remove any solid sewage materials while still wet
  - Long handled rubber squeegees are useful for consolidating solids
  - Bag solids and place in landfill garbage
  - Clean all surfaces in possible contact with sewage using detergent solution, followed by rinse with bleach (1/4) cup/gallon of water)

Remediation – Soft Materials

- Washable clothing, towels, rugs, toys can be cleaned in washing machine with hot water, detergent, and bleach.
- If you can presoak, do so with bleach (1/2 cup/gallon of water).
- Upholstered furniture should be professionally steam-cleaned outside the home, and stored for at least a week following cleaning.
- Installed carpeting and pad should be discarded if possible. Otherwise professionally steam clean and dry.
  - Note that this must be done quickly if wood floors beneath carpeting are not to be ruined

Remediation – Contaminated Food

- Contaminated Food
  - Professionally canned food can be washed with detergent, then rinsed in bleach and dried.
  - Food packaged in paper/cardboard should be discarded
  - Food packaged in plastic is best discarded.
  - Fresh food (potatoes, onions, fruit, etc.) should be discarded

A Note About Biocides

- Many biocides are advertised
  - Most probably do work
  - The effect of “long lasting” biocides is transient
- Vinegar is not a useful biocide
- Sodium hypochlorite (bleach) is still the best and safest choice
  - Inexpensive, readily available, kills nearly all living cells within 5 minutes exposure

Biocides

- Use ½ cup of Clorox® Regular-Bleach per GALLON of water
- (This is a ~2500 ppm chlorine mixture using today's concentrated 8.25% REGULAR bleach)
- Pre-wash surface with detergent and water, then apply the sanitizing solution of bleach and water. Allow solution to contact surface for at least 5 minutes for optimum effectiveness. Afterward, rinse and-or air dry

Keep In Mind…

- The principal concern is for exposure to infectious agents
- These have a limited lifetime outside of the host, and most will not survive more than a week
- Most microorganisms in sewage are a normal part of the environment and are not pathogenic
- For a normal healthy person, sewage related illness is almost always caused by hand to mouth transmission
  - Wash hands frequently
  - Keep your hands away from your face at all times

Clearance

- Clearance involves addressing the negative case
  - The negative case cannot be proven
  - Trying to reach an acceptable probability of negativity requires many samples, and is not generally feasible
- Specific guidelines paired with specific methods would be nice, but do not exist

Current Standards

- All individuals who deal with sewage and waste water cleaning must comply with standard regulations. The OSHA, American National Standards Institute and the Institute of Inspection, Cleaning and Restoration Certification develop these regulations.

Current Standards – S500

- Protective Gear
- Vaccination against Hepatitis A, Tetanus, diphtheria and hepatitis B
- Preparation
  - Inspection
  - Designate areas for disposal/relocation
- Cleaning
- Testing (remediation swab)

Comments – Protective Gear

- Protective Gear
  - Protecting the worker
    - Prevent hand/mouth contact
    - Prevent exposure of open sores
    - Where aerosols are present, prevent inhalation
  - Protecting the others and the environment
    - Protective gear is NOT designed to protect the environment or other people in the environment
    - Once contaminated on the outside, protective gear becomes part of the contaminated environment
    - Assign a place to remove protective gear and to clean yourself and the gear before entering society again

Comments – Vaccination

- Vaccination
  - These vaccinations are good ideas for all who routinely work with sewage
  - They will not protect against gastrointestinal disease caused by other organisms or viruses

Comments – Preparation

- Preparation
  - Inspection is essential for developing a remediation plan
  - Designating spaces is essential for
    - Storing contaminated furnishings
    - Removal of protective gear, and personal hygiene

Comments – Cleaning

- Cleaning
  - Low pressure washing a necessity for preventing aerosol formation
  - Antimicrobial foaming
  - Agitation?
  - We suggest washing with bleach solution in a way that does not generate significant aerosol
  - We do not suggest agitation, which also produces aerosol
  - Note that unless you are working in containment, aerosols will spread through out the indoor space

Comments – Clearance Testing

- Clearance testing
  - Swabs
    - How much area?
    - What specific sites?
    - What organisms do you look for?
    - How many indicate a “clean” environment?
    - Is a swab method ever going to prove the negative case????

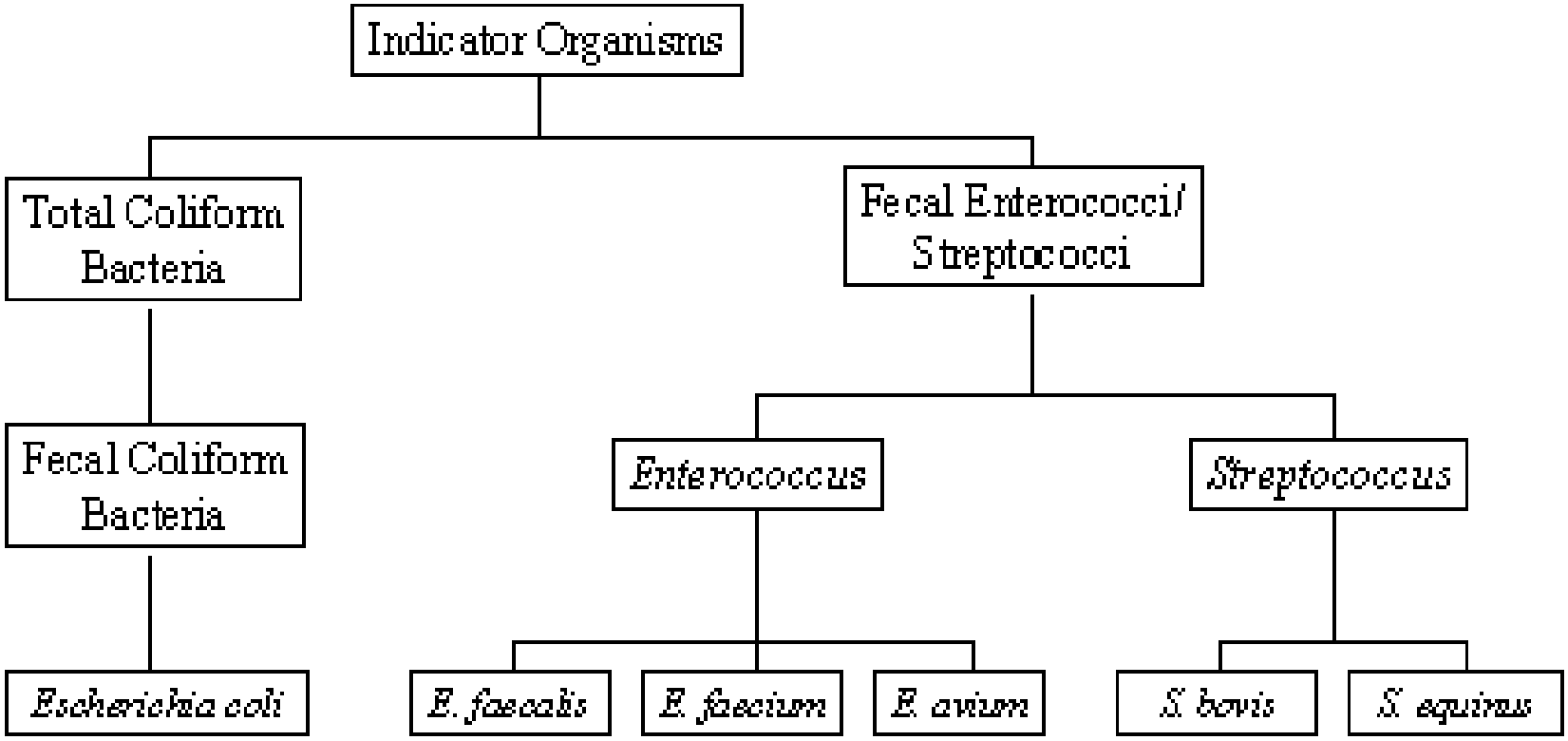
Comments – Clearance Sampling

- Clearance sampling
  - Don’t do it unless absolutely necessary
  - If you do it, include cautions about the reliability in your report
  - Otherwise, use some method that is actually representative of the area of remediation

Musings – Clearance Sampling

- Clearance sampling
  - Put on new sterile gloves
  - Dampen a good quality paper towel (Viva or Bounty) with sterile water
  - Wipe a large fraction of the remediated space with the towel
  - Place the towel in a new zip lock bag
  - Express to the lab on ice
  - Analyze for indicator organisms
  - Decide in advance how many you can accept as “clean”

Possible Indicator Organisms



Concentration Musings

- Ideally, none of your indicator organisms should grow.
- We would suggest that up to 10 indicator organisms per square foot of sampled area could be an upper limit.
- This needs to be tested in some real situations.

Concluding Remarks

- Sewage is and will probably always be with us
- For the most part, it will cause no harm if we:
  - Keep our fingers out of our mouths!
  - Clean up spills as quickly as possible
  - Don’t make sewage aerosols
  - Use personal protection properly

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Thank you for joining us!

Questions About Bacteria:
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