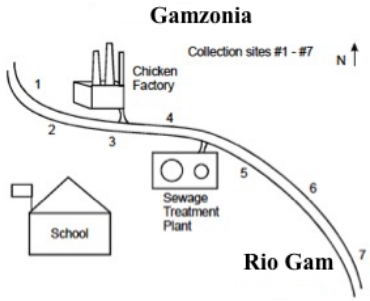
BOD and Wastewater

What's Happening In the Rio Gam?



- The main pollutants from the area include fertilizer and organic matter.
  - Fertilizer increases the amount of algae in the river, therefore also increasing the amount of organic matter in the river.

Biological Oxygen Demand

- The amount of oxygen that would be consumed if all the organics in one liter of water were oxidized by bacteria and protozoa.
  - Can be used as a water quality measurement.

$$\text{Organic Matter} + O_2 \xrightarrow{\textit{Bacteria}} CO_2 + H_2O$$

- What can live in a stream is determined by the amount of dissolved oxygen.
  - When oxygen levels are too low, area will be dominated by organisms that undergo anaerobic respiration.

Let's Model It!

Modeling BOD with Milk and Yeast!

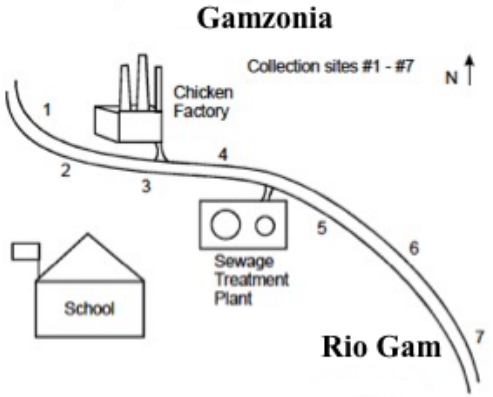
In our Model, the milk acts as our organic matter and the yeast is our decomposers.

Milk Concentration	Time To Reach 0 mg/L of Oxygen (sec)
10%	449
60%	258
100%	230

The more organic material present, the faster the oxygen levels drop.

The more organic material present, the more the oxygen levels drop.

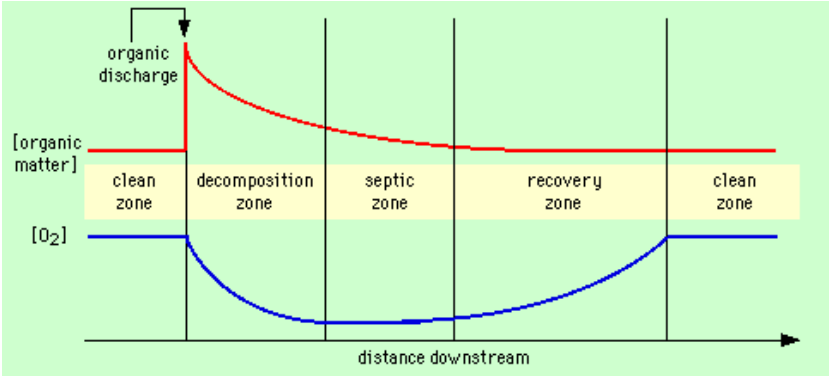
What's Happening In the Rio Gam?



- Now that we know why the number of macro invertebrates changed, let's look at how distance from the pollution source affects the areas up and down stream!

Let's Figure It Out Using the Dissolved Oxygen Sag Curve!

Dissolved Oxygen Sag Curve



- As the amount of organic material is decomposed the amount of dissolved oxygen decreases.

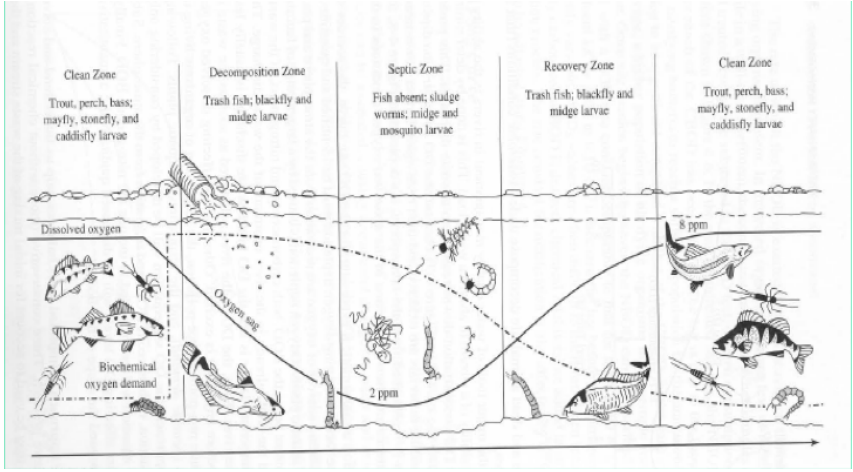
How Did You Do?

Clean Zone
9. Water is clear and healthy
21. Occurs prior to point source contamination
3. Sensitive organisms such as trout, perch, bass, mayfly, and stonefly are present
17. Dissolved oxygen levels are high
12. Biological Oxygen Demand levels are low
Decomposition Zone
2. Water is contaminated due to point source
7. Occurs immediately after point source contamination
8. Tolerant fish such as carp and gar can still survive
19. Decomposition (of waste or algal blooms) begins causing dissolved oxygen to go down
15. Biological oxygen demand begins to increase

How Did You Do?

Septic Zone
11. Nothing is able to survive here but decomposers
16. Massive decomposition occurs.
20. Bacteria consume most to all of the oxygen, and DO levels are at their all time low
14. As decomposition slows, BOD begins to decrease as well
Recovery Zone
1. BOD is continuing to decrease
10. DO begins to rise as decomposition has stopped
5. Tolerant fish such as carp, gar, and leeches return
18. Occurs furthest from point source
13. Clean zones can be found immediately following this zone
6. Decomposition has stopped

Dissolved Oxygen Sag Curve



Biochemical Oxygen Demand (BOD)

- The amount of oxygen that would be consumed if all the organics in one liter of water were oxidized by bacteria and protozoa.

The higher the BOD, the higher the organic matter content.

- As organic matter is consumed, the BOD will decrease.
  - As organic matter is consumed, the amount of oxygen available in the lake or pond also decreases.
    - Hypoxia - lower than 2 ppm
    - Anoxia - no oxygen present (dead zone)

Feedback Loop

Nutrients added to a lake increases algae

↓

BOD increases

↙

Available Oxygen decreases

↘

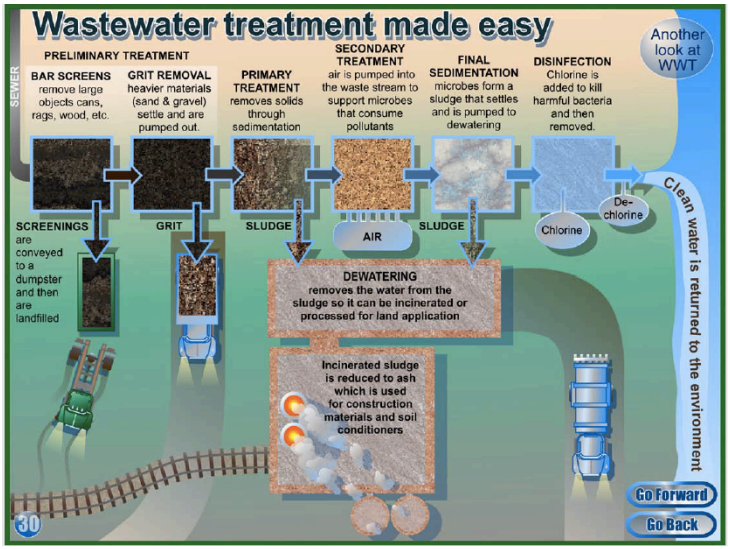
Fish and animals die

↖

Positive Feedback Loop!

Why Not The Sewage Treatment Plant?

Overview of A Wastewater Treatment Facility



Who Is Who in Wastewater Treatment?

Primary Treatment is…

Physical **Chemical** **Biological**

Goal of primary treatment is to settle the solids!

Secondary Treatment is…

Physical **Chemical** **Biological**

Goal of secondary treatment is to decompose the organic matter!

Who Is Who in Wastewater Treatment?

Disinfection is…

Physical **Chemical** **Biological**

Goal of disinfection is to kill harmful bacteria!

The disinfection options are…

Chlorine **Ozone** **UV Radiation**

Which one of these methods does Southington use?

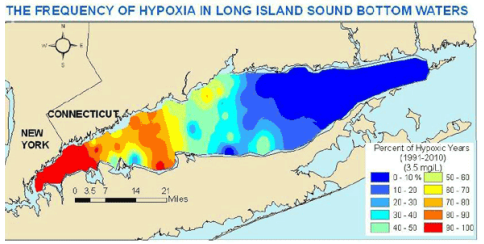
Who Is Who in Wastewater Treatment?

Tertiary Treatment is…

Physical **Chemical** **Biological**

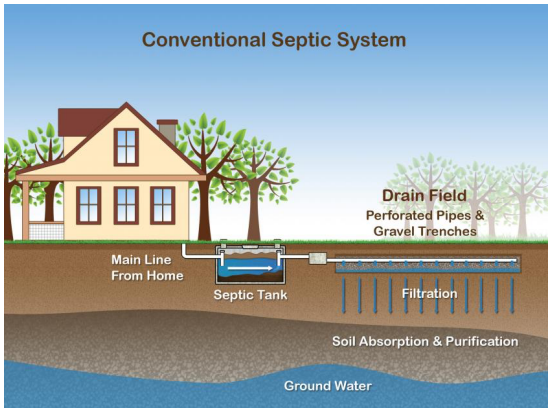
Goal of tertiary treatment is to remove nitrogen and phosphorus from the wastewater to prevent cultural eutrophication of local waterbodies.

Southington has tertiary treatment to prevent dead zones forming in Long Island Sound!



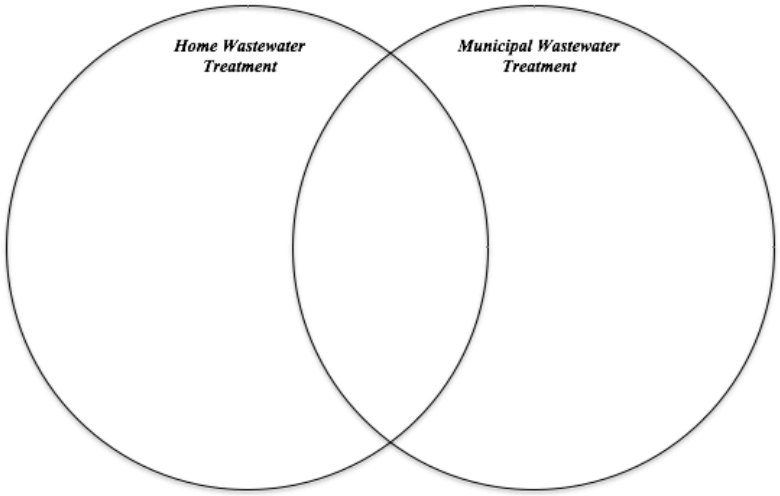
Keeping Things Close To Home!

Not everyone uses sewer systems, but instead treats the wastewater from their house using a septic system.



Let's Explore How These Work!

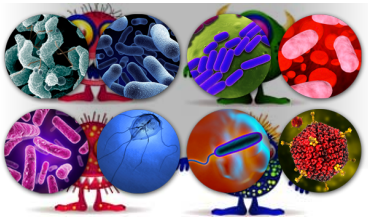
Similar But Different!



Human Wastewater

- Human wastewater must be treated before discharged into a water body.
  - Organic matter increases BOD.
  - Nitrogen and Phosphorus lead to eutrophication.
  - Contains pathogens that can cause illness.

Pathogens include viruses, bacteria, and parasites.



- The usual culprits are…
  - Cholera
  - Typhoid fever
  - Stomach flu
  - Diarrhea
  - Hepatitis

Testing For Safety

- To determine presence of human wastewater, scientists use fecal coliform bacteria as an indicator species.
  - Group of generally harmless microorganisms that live in the intestines of humans and other organisms.

Most common form used is E. coli.

- After storms in particular, the local environmental agency will test local water bodies for fecal coliform.
  - Allowable coliform levels are 500 - 10,000 per 100 mL.
  - If levels are higher, water ways are closed.

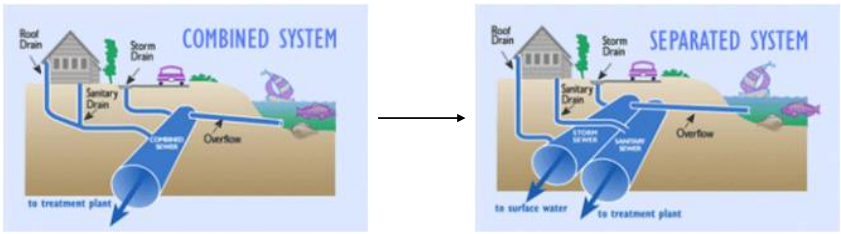
Watch What You Eat

- Bivalves like clams and oysters can be contaminated with bacteria and viruses.
  - They live close to the shore where water runs off the land.
  - They obtain their food by pumping water through their system and filtering out small organisms.

When eaten "on the half shell", people can ingest the bacteria or viruses that have been absorbed by the bivalve.

Combined Sewer Overflow

- Collection systems designed to carry sanitary sewage and storm water in a single piping system to a treatment facility.
  - If there is too much entering the system, the overflow will be discharged to nearby streams, lakes, and harbors, untreated.



Municipalities are currently trying to convert to separate systems, but it takes time and new infrastructure.

Manure Lagoons

- Large farms need to store manure so that it doesn't wash into waterways.
  - Broken down by bacteria and then used as fertilizer.

- The decomposition process produces methane.
  - Can be captured and used to generate electricity.

Manure Lagoons

- Problems can occur from these lagoons if not done properly.
  - They can leak or overflow into nearby waterways.

- CAFOs use hormones and antibiotics to promote faster growth and keep animals healthy.

These antibiotics and hormones wash into the waterways with the manure and have an additional effect on the environment.