Residential Wastewater Profiles

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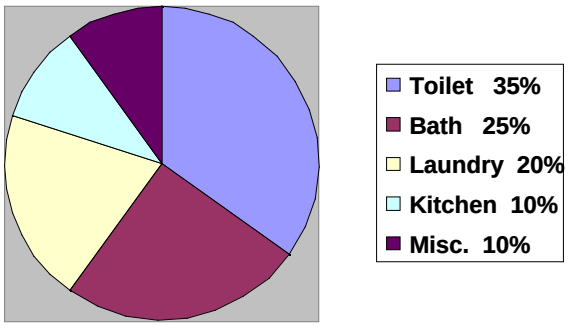
Introduction

Onsite sewage disposal systems can provide an economical, practical, and environmentally sound method of treating and disposing of residential sewage. Past practices have focused on the disposal aspect, installing systems in the coarsest available soils. As our understand of soil-based systems has increased, we have shifted to heightened levels of treatment prior to disposal. Unfortunately these new systems are sensitive to many factors including the strength of the waste inflow. Systems designed based n typical residential flow, can experience problems when receiving high or unusual waste. The intent of this presentation is to discuss what makes up residential waste and the impact that a high waste strength or unusual waste may have on the system.

What is Residential Wastewater?

It is the waste carried by the plumbing to the outside of the home. In our discussion, we will be referring to wastewater discharged by a two compartment septic tank with a detention time of 3 to 5 days.

What are the sources?



What are its components?

A. Flow volume: Typically measured in gallons and presented in Gallons Per Day (GPD).
B. Biological load or waste strength: Typically measured by the BOD_5, TSS & FOG (O&G). *The above diagram does not depict the percentages of biological loading.*

A residential system is designed based on the number of bedrooms multiplied by gallons per bedroom per day figure (usually 120 to 150 GPD). This is known as the ***design flow***. In actuality, individuals generate around 50 gallons per person per day or 200 gallons per residence per day. This is known as ***true flow***. The difference between the two is the safety factor.

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How do I collect information regarding flow volume?

A. Water meter
B. Cycle counter on pump
C. Hour meter on pump
D. Number of people in home x 50 GPD
E.

What will cause a higher than normal flow?

A. Excessive water use
B. Leaking fixtures (dripping sinks, leaking toilets)
C. Ground water infiltrating the septic or pump tank
D.

Biological parameters for residential wastewater.

A. **BOD_5** Biochemical Oxygen Demand is a measure of the oxygen required by microorganisms to break down organic matter over a five day period. It includes chemical demand and is measured in mg/l.

B. **TSS** Total Suspended Solids is a measure of the organic or inorganic material larger than a specific size reported in mg/l.

C. **FOG** Fats, Oil, and Grease may be made up of animal fats, vegetable oils and other cooking shortening. Body lotions, laundry discharge, shampoos, various hygiene products, and dead microorganisms will also show up as FOG. Results are reported in mg/l.

D. **DO** Dissolved Oxygen is the amount of oxygen in the liquid. It is influenced by; temperature, barometric pressure (altitude), organic loading and salinity and is measured in mg/l.

E. **pH** A term used to describe the relative Hydrogen Ion concentration in a system. A low pH value indicates a high concentration of ions (acidic condition). A high pH value indicates a low concentration of ions (basic condition). A pH of 7 is neutral.

F. **Temperature** Measure of the degree of hotness or coldness of the liquid. Expressed in degrees Celsius (C) or Fahrenheit (F).

Typical residential waste strength values

Parameter	Range	Typical
BOD_5	110 to 250 mg/l	140 mg/l
TSS	20 to 155 mg/l	40 mg/l
FOG	10 to 20 mg/l	15 mg/l
DO	0 to 1.0 mg/l	0.5 mg/l
pH	6.5 to 7.2	7.0

Temperature	48 to 70 F	59 F

What will cause a low BOD_5?

A. Low organic load
   1. Number of persons living in the home less than the system is designed for.
   2. Family doesn't eat at home often
   3. Higher than normal flow
      a. Long showers
      b. Jacuzzi tubs
      c. Leaking fixtures
      d. Leaking septic and/or pump tanks (infiltration)

B. Sample collection method – see sampling section

C.

What harm will a low BOD_5 have on a system?

A. No harm unless caused by flows higher than the system is designed to treat (hydraulic overload)

B.

***** Although a low BOD_5 does not have a harmful effect on the system it is a good indicator of how the system is working.

What will cause a high BOD_5?

A. High organic load
   1. Number of persons living in the home higher than the system was designed for.
   2. Low flow fixtures
   3. Kitchen practices
      a. Garbage grinder
      b. Type of foods cooked
      c. Kitchen clean-up practices

B. Common chemicals which effect microorganism growth
   1. Bleach
   2. Detergents
   3. Disinfectants
   4. Cleaners
   5. Toilet cleaners
   6. Medication
   7.

C. Sample collection method – see sampling section

D.

What harm will a high BOD_5 have on the system?

A. It places a greater biological treatment demand on the downstream components

(drainfields, mounds, sandfilters, ATUs, etc)

B. May shorten the life of the downstream components

C.

What will cause a low TSS?

A. Low organic/inorganic loads
   1. Number of persons living in the home less than the system is designed for
   2. Higher than normal flow
      a. Long showers
      b. Jacuzzi tubs
      c. Leaking fixtures
      d. Leaking septic and/or pump tank (infiltration)

B. Sample collection method – see sampling section

C.

What harm will a low TSS have on a system?

A. No harm unless caused by flows higher than the system is designed to treat

B.

***** Although a low TSS may not have a harmful effect on the system it is a good indicator of how the system is working.

What will cause a high TSS?

A. High organic and inorganic loads
   1. Number of persons living in the home higher than the system is designed for.
   2. Low flow fixtures
   3. Kitchen practices
      a. Garbage grinder
      b. Types of foods cooked
      c. Kitchen clean-up practices

B. Laundry habits
   1. Fibers from clothes
   2. Clays soils washed off clothes

C. Dead organisms caused by excessive chemical use
   1. Bleach
   2. Detergents
   3. Disinfectants
   4. Cleaners
   5. Toilet cleaners
   6. Medication

D. Sample collection method – see sampling section

E. Excessive use and disposal of toilet paper

F.

What harm will a high TSS have on the system?

A. It can place a greater biological demand on the downstream components (drainfields, mounds, sandfilters, ATUs, etc)
B. Adds to the bio-mat. The material may be inorganic, which will not readily break down and may even plug the media-soil interface, shortening the life of the downstream components.

What will cause a flow FOG?

Same as BOD_5

What harm will a low FOG have on a system?

None, it should be an indicator of either proper system performance or proper use through the management of wastes. The sewage system benefits from low levels of Oils and Greases.

What will cause a high FOG?

A. Cooking habits
    1. Kitchen clean-up practices – Garbage grinder
    2. Type of foods cooked
    3.
B. Laundry habits
    1. Amount of laundry detergents used
    2.
C. Bathing
    1. Bath oils, lotions, and shampoos
    2.
D.

What harm will a high FOG have on a system?

Same as a high BOD_5 and TSS although it takes much more energy to break down FOG than normal BOD_5 depending on the type of material.

What will cause a low DO?

A. Low oxygen level in the water source
B. High biological load, BOD_5, TSS, & FOG
C.

What harm will a low DO have on a system?

A. Mainly an indicator
B. The biomat at the interface of the disposal or treatment system may build up faster than normal. Low DO indicates aerobic conditions, where breakdown does not occur as quickly or as effectively as it would under aerobic conditions.
C.

What will cause a high DO?

A. Leaking fixtures
B. Water leaking into the septic tank or pump tank (infiltration)
C. High DO in a water source
D. The sample method
E. Dead sample
F.

What harm will a high DO have on a system?

A. Mainly an indicator. Depends on the cause.
B. May be beneficial to the system. May be used to recover a system where the biomat is slowing the flow through the system.
C.

What will cause a low pH?

A. Cooking habits
    1. Above normal use of dairy products, extensive baking or home canning can cause a low pH
B. Water supply
C. Acid based cleaners
D.

What harm will a low pH have on a system?

A. As the pH drops, the microbial population changes to organisms less efficient in the breakdown of wastewater. Normally a pH below 6 is significant.

B.

What will cause high pH?

A. Laundry
B. Some cleaners
C. Photo developing
D. Alkaline based cleaners
E.

What harm will a high pH have on a system?

A. As a pH rises, the microbial populations change to organisms less efficient in the breakdown of wastewater. Normally a pH above 8 is significant.
B.

What will cause a low temperature?

A. Leaky tank
B. Leaky plumbing
C. Climate
D. Low temperature laundering
E.

What harm will a low temperature cause?

A. Low temperature will slow the biological activity within the system
B.

What will cause a high temperature?

A. Long, hot showers, "Jacuzzi" tubs
B. Excessive laundering using hot water
C. Leaking hot water tanks
D. Hot water heat in a home that is leaking into the wastewater system
E.

What harm will a high temperature cause?

A. Though organisms may live within a certain range, they are more efficient at the higher portion of the range.
B. Temperatures over 100˚F can dissolve greases and oils held within the tank, passing them to the next component.
C. With large hot water flows, it is possible to short circuit flow within the septic tank, allowing treated or partially treated waste to pass to the drainfield.
D.

How big an effect can a leaking tank have on a system?

Leaky Septic Tanks

Residential Infiltration Example

Date	Cycle Counter Reading (GPD)	Water Meter Reading (GPD)	Additional GPD
9-16-93	420	374	55
11-14-90	675	344	331

11-21-90	675	214	461
11-27-90	1,980	240	1.740
12-5-90	1,316	240	1.076

How do I calculate the biological load on a system?

Pounds of BOD_5 = Flow (GPD) X BOD_5 (mg.l) X 0.00000834 (conversion factor)

Example:
Flow = 300 GPD, BOD_5 = 140 mg/l

300 GPD X 140 mg/l X 0.00000834 = 0.35 lbs/day

The BOD_5 may not drop as fast as flow volume increases due to shortened detention time and the amount of mat and sludge held in the tank. If water is added to a system, it will not proportionately lower the loading rate unless the treatment component is adequately sized for the flow. If not sized properly, shorten the detention time or flush biological matter from the tank into the disposal system.

Waste Strength and Flow Volume Comparison
Residential example #1 – Groundwater Infiltration

Condition	Flow	BOD_5	lbs/day
Design Value	450	250	0.94
Expected Flow (family of four)	200	140	0.23
Groundwater Infiltration January No Storm	675	90	0.51
Groundwater Infiltration January Heavy Storm	1,980	70	1.20

Waste Strength and Flow Volume Comparison
Three Bedroom Home with High Organic Loading

Condition	Flow	BOD_5	lbs/day
Design Value	450	250	0.94
Expected BOD_5 (family of four)	200	140	0.23
Low BOD_5	243	344	0.71
Highest BOD_5	243	724	1.50

While all states specify a design flow, few stipulate biological loading parameters…

How to collect samples?

A. Understand what you want to sample for and why.
B. Discuss testing needs, experience, dates, times, and procedures with the lab.
C. Use the proper containers, and recommended methods of collecting samples.
D. Label all samples.
E. Record relevant field data such as time, temperature, site conditions and whether the system is in a low or high flow period.
F.

How do interpret the results?

A. Does the information make sense?
B. Do the results appear consistent?
C. Potential errors
D. Review the relationships between the parameters tested.
E. What do the microbial results show? Do they compare to other findings?
F.

Sample Collection, Preservation & Shipping Instructions

1. Before collecting samples refer to the Standard Methods for the Examination of Water and Wastewater -- Sample Collection and Preservation Table, or call the laboratory for instructions. Ask questions if the instructions are not clear!
2. Sampling equipment should be clean and in proper working condition before using.
3. Be sure to have the proper sample container, these can be provided by the lab. Some analysis requires sterile sample containers or the addition of acid for preservation – handle these containers with care. Consider bringing along an additional set of sample containers.
4. If multiple samples will be collected from one site, collect the cleanest sample first. To avoid cross contamination, remember to clean the sampling device with distilled water before collecting the next sample.

The O&G sample should be an aliquot from the sample collected for BOD_5/TSS, or representative split samples. The BOD_5/TSS sample should be collected first, next thoroughly, and then decanted into the O&G container.

5. Collect samples first, then make any required field measurements (pH, Temp, DO, etc.

If a DO is performed, take the measurement at the point of sample origin, not from the sample container.

6. Make sure sample bottles are properly labeled with name, collection date, time and that they match the chain of custody form. The person collecting the samples is responsible for their validity.
7. Make sure lids are tightly sealed & bottles are kept in an upright position for transport.
8. Once samples have been collected keep them iced. This assures that there are no significant changes in composition before the analysis is performed. If shipping samples, use ice, "blue paks", or other ice substitutes generously. Fill the void areas inside the cooler with shredded paper or "peanuts" to help lock in the cold.
9. If shipping samples, make sure they are shipped "next day guaranteed". If the analysis holding time is less than 24 hours, samples must be delivered to the lab immediately after collection.
10. Check with the lab to make sure when samples can be brought in. Ask about turnaround time and analysis availability.

When and Where to Sample

Surge/pump tank: Make sure sample collection takes place during the pump's mid-cycle stage (during the off time). The sample will be invalid if collected immediately after the pump has cycled. To determine where the pump is at in it's cycle, inspect the water marks on the tank walls in relation to the current liquid depth.

Septic tank: Samples from the septic tank should be collected from the baffle on the outlet side of the tank.

It is very important that when a sample is collected from a baffle or test port, any loose bio-growth be dislodged from the sidewalls first. This can be done by inserting the sampling device in the baffle or test port and gently moving it around (stirring). You must then let the sloughed bio-growth settle before the sample is collected.

Errors Due To Sampling

Date: 8-13-96
Customer: Construction
Collection Date: 8-6-96 11:00 AM
Received to Lab: 8-6-96 2:30 PM
Project ID:

ANALYSIS	Septic Tank 2nd Compartment Effluent
BOD_5 (mg/l)	620
TSS (mg/l)	257
O & G (mg/l)	185
pH	6.54

Date: 9-6-96
Customer: Construction
Collection Date: 8-28-96 11:45 AM
Received to Lab:
Project ID:

ANALYSIS	Septic Tank 2nd Compartment Effluent
BOD_5 (mg/l)	387
TSS (mg/l)	73.0
O & G (mg/l)	52.7
pH	6.73
Temperature (centigrade)	20
DO	1.3

What information is needed to evaluate a residential system?

Residential Questionnaire and evaluation sheets. Questionnaire is included at the end of this paper.

How to correct the problem?

In many cases the solution is very obvious once the problem is determined. The first step is to look at flow related problem.

A. Leaking toilet – fix the toilet.
B. Groundwater infiltration into the tanks – seal the tanks, replace them, or lower the groundwater table.
C. Groundwater infiltration into the drainfield – move the drainfield, raise the drainfield, or lower the groundwater table.
D.

Other problems may have more than one solution.

High Waste Strength – Depending on the cause of the high waste strength, you can:

1. Encourage the homeowner to put less food related items down the drain.
2. Remove the garbage disposal
3. Is the waste strength related to medications or poisoning of the system?
4. Stop the offending practice if possible.
5. Pre-treat effluent from the septic tank.
6.

AquaTest
aquatestinc.com

EVALUATION CHECKLIST
USE PRIOR TO REPAIRING ONSITE SYSTEM

NAME _____ PHONE _____

SITE ADDRESS _____ PHONE _____

_____ PHONE _____

MAILING ADDRESS (If Different)_____

DATE _____ Sun Mon Tue Wed Thur Fri Sat TIME OF DAY_____

1. # OF PEOPLE LIVING IN HOME:_ADULTS: ___M __F _____CHILDREN (Total inc. Teenagers)
TEENAGERS:____M_____F

2. LAUNDRY HABITS: MAX. _____LOADS / DAY CONSECUTIVE LOADS: YES / NO
TOTAL_____LOADS/WEEK

3. BRAND OF LAUNDRY DETERGENTS USED:_____WITH / WITHOUT BLEACH
POWDER / LIQUID

4. BLEACH USED: YES / N0 POWDER / LIQUID USE: _____CUPS/LOAD _____LOADS/WEEK

5. HOT OR COLD WATER USED:_____

6. LIQUID FABRIC SOFTNER USED:_____

7. NUMBER OF ROLLS OF TOILET PAPER USED PER WEEK:_____

8. GARBAGE DISPOSAL: YES / NO USE: _____TIMES/DAY _____TIMES/WEEK

9. DISHWASHER: YES / NO USE: _____TIMES/DAY _____TIMES/WEEK

10. IS A WATER SOFTENER USED: YES / NO SALINE CHLORINATION: YES / NO

11. IS A DRAIN CLEANER USED: YES / NO BRAND_____ FREQUENCY:_____

12. LIST ANY ANTIBACTERIAL PRODUCTS USED (ie: hand cleaner, soaps, cleaning products):_____
_____
_____

13. IS ANY RESIDENT USING A (LONG TERM) PRESCRIPTION DRUG OR ANTIBIOTICS: YES / NO

14. IS THIS THE FIRST HOME YOU HAVE LIVED IN THAT HAS A SEPTIC SYSTEM: YES / NO

15. HOW OLD IS THE SYSTEM: _____YEARS

16. HAS THE SYSTEM EVER BACKED UP: YES / NO DAY OF WEEK Sun Mon Tue Wed Thurs Fri Sat

17. HAS EFFLUENT EVER SURFACED: YES / NO
IF YES: WINTER: YES / NO SUMMER: YES / NO DAY OF WEEK: Sun Mon Tue Wed Thurs Fri Sat

18. HAS PLUMBING EVER BACKED UP INTO HOME: YES / NO
IF YES: WINTER: YES / NO SUMMER: YES / NO DAY OF WEEK: Sun Mon Tue Wed Thurs Fri Sat

19. WATER SOURCE: (circle) PUBLIC PRIVATE WELL COMMUNITY WELL OTHER_____

20. TYPE OF SYSTEM: GRAVITY / GRAVITY WITH PUMP / PD / MOUND / SAND FILTER / ATU OTHER _____

21. CONTROL SYSTEM: DEMAND / TIMED

22. SCREENED OUTLET BAFFLE: YES / NO HAS SCREEN EVER PLUGGED: YES / NO

23. DATE OF LAST PUMPOUT: _____

24. SLUDGE LEVELS IN SEPTIC TANK: 1^{ST} COMPT ACCUM. _____" FLOATING MAT _____"
2^{ND} COMPT ACCUM. _____" FLOATING MAT _____"

25. SLUDGE LEVEL IN PUMP TANK: ACCUM. _____"

26. FLOWS: _____GPD (Design) _____GPD (Average) _____GPD (Peak)

27. SOIL TYPE WITHIN BOTH 12" HORTIZONALLY AND 12" BELOW THE BOTTOM OF THE DISPOSAL FIELD:
_____1 2 3 4 5 6 (circle) _____ OR _____MPI (perc rate)

28. WATER TABLE: (use same soil log hole used above) DEPTH: (measured from bottom of hole)_____

29. MOTTLING: DEPTH (measured from bottom of disposal system) _____

30. DRAINFIELD: DEPTH (measured from bottom of disposal system) _____

31. DEPTH OF SLUDGE: (if present, measured from bottom of disposal system)_____

32. DRAINFIELD FLOODED: YES / NO IF YES: # OF LINES FLOODED_____

33. IS SYSTEM CURRENTLY SURFACING: YES / NO LOCATION : (circle) Septic Tank / Pump Tank / Sand Filter / Mound / Drainfield / ATU / Other_____

34. WASTE CHARACTERISTICS: TEMP_____ DO_____ pH_____

35. WASTE STRENGTHS: BOD_5 _____ TSS_____ FOG_____

36. DETAILS OF WHERE AND HOW SAMPLES WERE COLLECTED:_____
_____
_____
_____