Leachate Pretreatment Options for Landfills

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What is Leachate?

- **"Garbage juice" or highly contaminated waste water**
- **Water percolates through waste materials**
- **Leaching of organic and inorganic compounds**
- **Usually contains high concentrations of**
  - **Organic matter (biochemical oxygen demand or BOD)**
  - **Nitrogen (ammonia)**
  - **Phosphorous**
  - **Inorganics (metals)**

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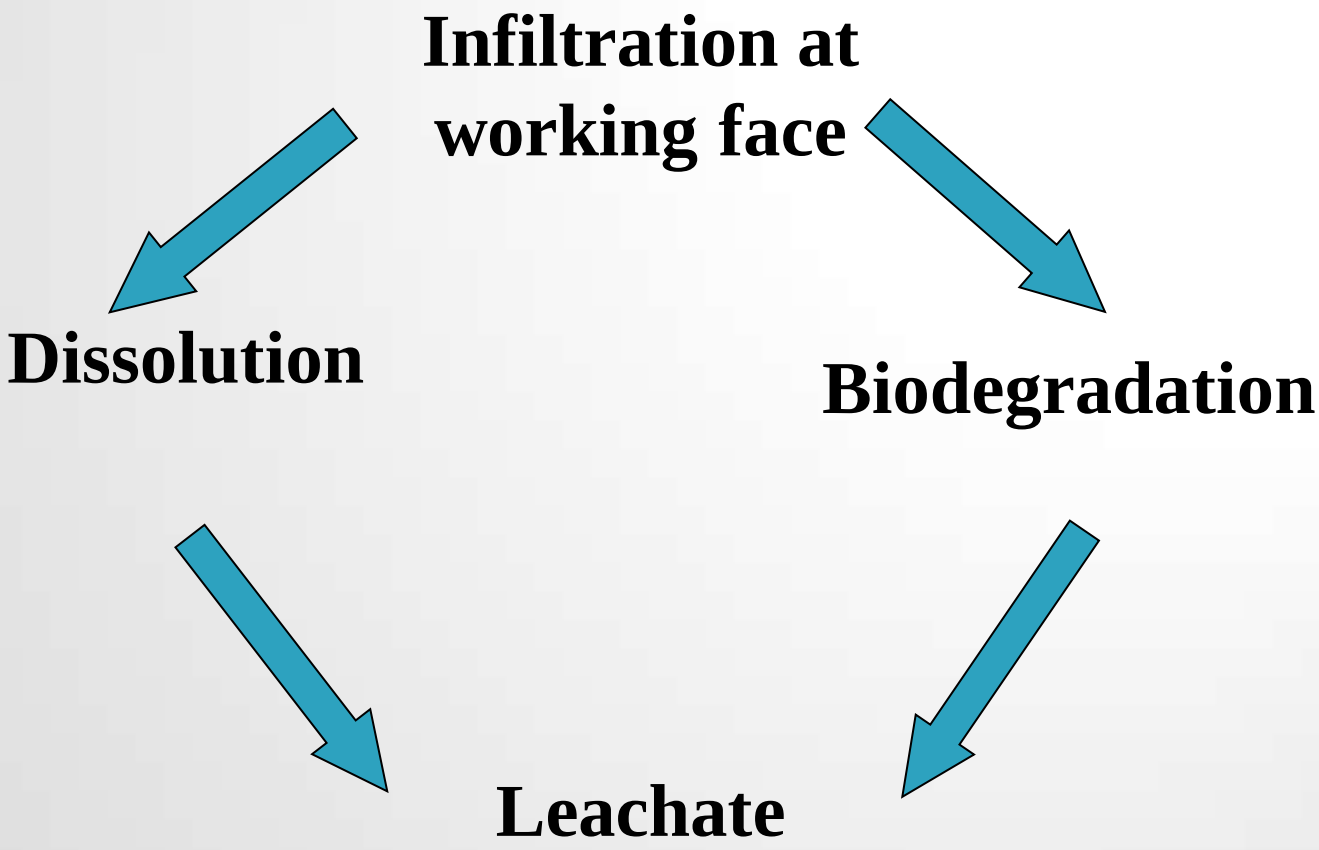
What is Leachate?



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Why is Managing Leachate Important?

- **Direct releases may contaminate:**
  - **Surface water**
  - **Groundwater**
  - **Land**
- **Potential risks and hazards to public health and ecosystems**
- **High concentrations may require an efficient, affordable and relevant pretreatment method**

How does this affect my facility?

- **Treatment, transportation and disposal costs for leachate will increase**
- **More stringent regulation of surface water (Total Maximum Daily Load or TMDLs) for typical leachate constituents in effect**
- **Wastewater Treatment Plant (WWTP) capacity will be scarce and at a premium**

How does this affect my facility?

- **Competing for WWTP capacity with other users**
- **WWTPs will charge more and be selective of what they accept**
- **May add surcharge fees to both weak and strong leachate**
- **May not accept your leachate at all!**

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New Standards - TMDLs

- **What are TMDLs? Total Maximum Daily Loads (“TMDL”)**
- **Maximum amount of a pollutant that can be discharged to an impaired water**
  - **Stream Specific Standard**
- **Section 303(d) of the Clean Water Act**
  - **Requirement to identify impaired waters.**
  - **Requirement to develop Total Maximum Daily Loads (“TMDL”) when technology based effluent limits are insufficient**

New Standards - TMDLs

- **TMDL for a particular pollutant represents a cap on total daily discharges into that water body.**
- **States then regulate discharges of that pollutant sufficient to comply with the cap.**
  - **These are reductions from point sources or non-point sources.**

New Standards - TMDLs

- **In the interim, what do landfill operators do?**
  - **Landfills that use upgraded WWTPs can continue to use that option**
  - **Pay surcharge fees?**
  - **Facilities that don't have WWTP to discharge leachate?**

How does this affect my facility?

- **Local ordinances will restrict the volume and concentration of leachate to meet County or regional standards for nutrients**

- **Bottom Line:**
  - **Discharging leachate will get more expensive**
  - **Pretreating your leachate may make financial sense**

How far reaching are the TMDLs?

- **TMDLs will affect other states (besides VA)**
- **Will affect point sources (existing wastewater treatment plants) and non-point sources**
- **Other point and non-point sources from agricultural operations**

Leachate Phases in the Landfill

Waste Decomposition

- Phase I
  - Aerobic
- Phase II
  - Anaerobic
  - Facultative
- Phase III
  - Methanogenic

Leachate Characteristics

Treatment Will Depend on Phase of Decomposition

- **Phase I**
  - Very short time period
  - High CO_2
  - High H_2
- **Phase II**
  - Months to Years
  - High BOD
    - >10,000mg/L
  - Low pH
    - 5-6
  - High Ammonia
    - 500-1000 mg/L
- **Phase III**
  - Many Years
  - Anaerobic
  - High CH_4 and CO_2
  - Low BOD
  - High Nitrogen/ Phosphorus

Leachate Composition Factors

- **Solid Waste Composition**
- **Age of Refuse**
- **Operation of Landfill**
- **Climate**
- **Conditions within Landfill**
  - **Chemical & Biological Activities**
  - **MC %, Temperature, pH, Degree of Stabilization**

Textbook Leachate Values

- **These general numbers are VERY deceptive. Leachate is rarely 'typical'.**
- **Two case studies will illustrate the variability of constituents in landfill leachate**

Table 1 Concentration (mg/L)			
Constituent	**1 Year**	**5 Years**	**15 Years**
BOD	**20,000**	**2,000**	**50**
TKN	**2,000**	**400**	**70**
Ammonia-N	**1,500**	**350**	**60**
Phosphorous	**150**	**50**	**-**

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Leachate Treatment Challenges

Treatment

- Full On-Site (no discharge)
- Partial On-Site
- Transport Off-Site (pay any applicable fees)

Challenges

- Bioreactor Landfill?
- Sewer nearby?
- Distance to Pump / Haul?
- Pump System Costs
- WWTP Capacity?
- Leachate Strength?
- Local Sewer Use Laws?
- Sewer Surcharges?
- Surface Water Discharge Standards (TMDLs)?

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Leachate Minimization

- **Through design and operations, the objective is to minimize leachate**
- **Reduce generation by:**
  - **Minimizing active working face area**
  - **Cover waste daily**
  - **Grade intermediate slopes to shed water**
- **What can we do with the leachate we do generate?**

Leachate Treatment Considerations

- **Treatment technologies will depend on the strength (concentration) and volume of the leachate**
- **High strength leachate? Low strength leachate?**
- **TMDLs in place to "regulate" nutrients discharged into a stream or under a WWTPs discharge permit?**
- **Every leachate is different. There is no "one size fits all" model of treatment.**

Common Leachate Pretreatment

- **Anaerobic or Aerobic Biological Treatment**
- **Constructed Wetlands**
- **Physical & Chemical Treatment**
- **Leachate Recirculation**
- **Leachate Evaporation Technologies (have a permit pending in Nevada)**
- **Additional Innovative Technologies**

Traditional WWTP Methods

- **Traditional biological pretreatment methods:**
  - **Changes the form of organic constituents**
  - **Removes BOD_5, SS,NH_3-N, Organic-N & Metals**
  - **Generates large quantities of biomass (sludge)**

Anaerobic Treatment

- **SBR**
- **MLE**
- **Two-Stage Reactor**
- **Fixed Film Filters**

Aerobic Treatment

- **Lagoons**
- **Activated Sludge**
- **RBCs/Trickling Filters**

Traditional WWTP Methods

- **Organic matter (BOD) is degraded by microorganisms**
- **Use BOD as food in order to degrade other constituents (metals, nutrients)**
- **These "traditional" wastewater methods are extremely expensive, large and O&M intensive**

Traditional WWTP Methods

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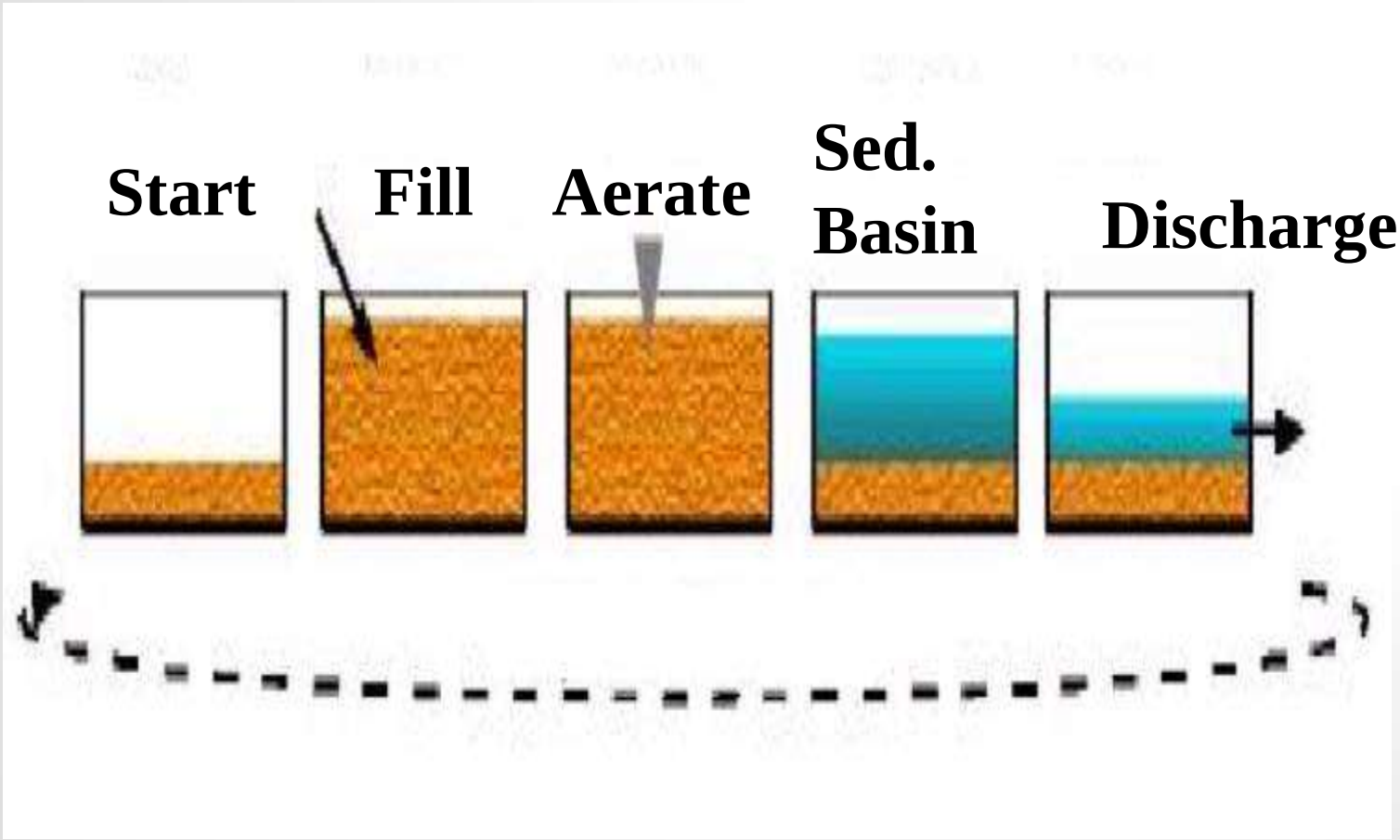
Sequencing Batch Reactor (SBR)

- **Phases of aeration and non-aeration take turns in same activated sludge basin.**

- **One basin for nitrification (phase of aeration) and denitrification (phase of non-aeration).**

Sequencing Batch Reactor (SBR)



One Cycle of a SBR-reactor

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SBR System

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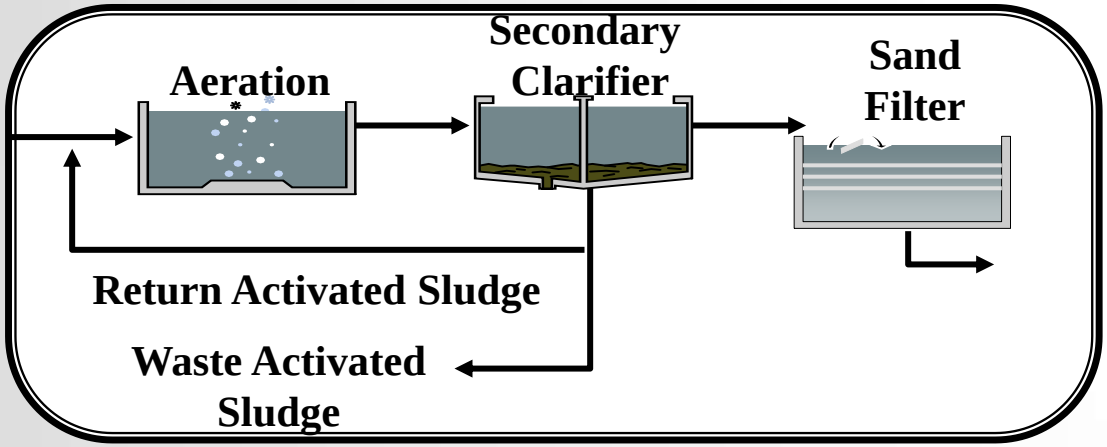
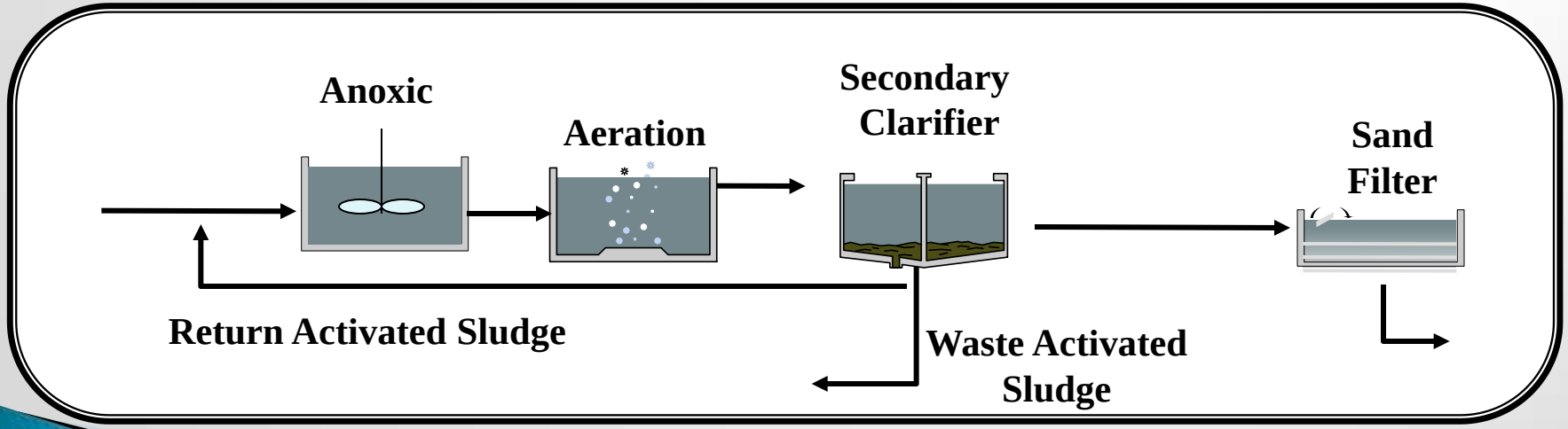
Modified Ludzack-Ettinger (MLE)



TRADITIONAL



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What Other Technologies can be Used?

Additional Pretreatment Technologies

Bioreactor Landfills

- **Leachate is collected and returned to the working face of the landfill**
- **Accelerates the stabilization of organic materials present in the MSW**
- **Spray Irrigation or Trench Injection**
- **Evapotranspiration**

Aerated Ponds at Landfills

Aeration in Pond

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Constructed Wetlands

- **Constructed in combination with lagoons and aeration ponds.**
- **Planted with various plant species**
  - **Phragmites austalis**
  - **Typha latifolia**
- **Organic Removal**
  - **N, P, Fe & pathogens ~70-95%**

Constructed Wetlands

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Case Study #1

Virginia MSW Landfill

- **Leachate was low in COD/BOD but high in nutrients**
- **Several pre-treatment options were reviewed to pre-treat a high nutrient, low carbon leachate**

The goals were to:

- **Reduce leachate disposal costs**
- **Comply with proposed (and to reduce the uncertainty associated with) wastewater effluent standard for nutrients (TMDLs etc.)**

Case Study #1

- Confirmed design criteria and site conditions
- Reviewed landfill leachate data (carbon source was needed)
- Evaluated two treatment alternatives:
  - Two-stage Modified Ludzack-Ettinger (MLE) biological activated sludge treatment system
  - Sequencing batch reactor (SBR) to remove TKN to below a final effluent standard (County) to below 40 mg/L.
- Preliminary design included identifying a carbon source and laying out the system.
- Best remedy estimated to cost $1.50 per ton of waste

Case Study #2

Virginia CDD Landfill

- Leachate costs were $0.11 / gallon ($0.04 for hauling and $0.07 for treatment)
- County ordinance would decrease the standards for metals and nutrients
- Several pretreatment options reviewed. The goal was to eliminate the discharge of leachate off-site (zero discharge)
- On-site constructed wetland selected

Case Study #2

- **Confirmed design criteria and site conditions**
- **Reviewed landfill leachate data**
- **Designed two submerged treatment wetlands to remove metals and nutrients**

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In Conclusion…..

- **Review your leachate concentrations**
- **Meeting effluent limits will drive level of pretreatment**
- **Treating to the appropriate level is important**
- **Determining the desired effluent level of BOD, total nitrogen and phosphorous will allow for optimizing costs**
- **As TMDLs cause costs of transportation and disposal increase, on-site pretreatment becomes cost effective**

In Conclusion…..

- **Thank you very much for your attendance.**
- **Please visit our booth (#40) if you have any questions or would like to learn more.**

QUESTIONS?

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