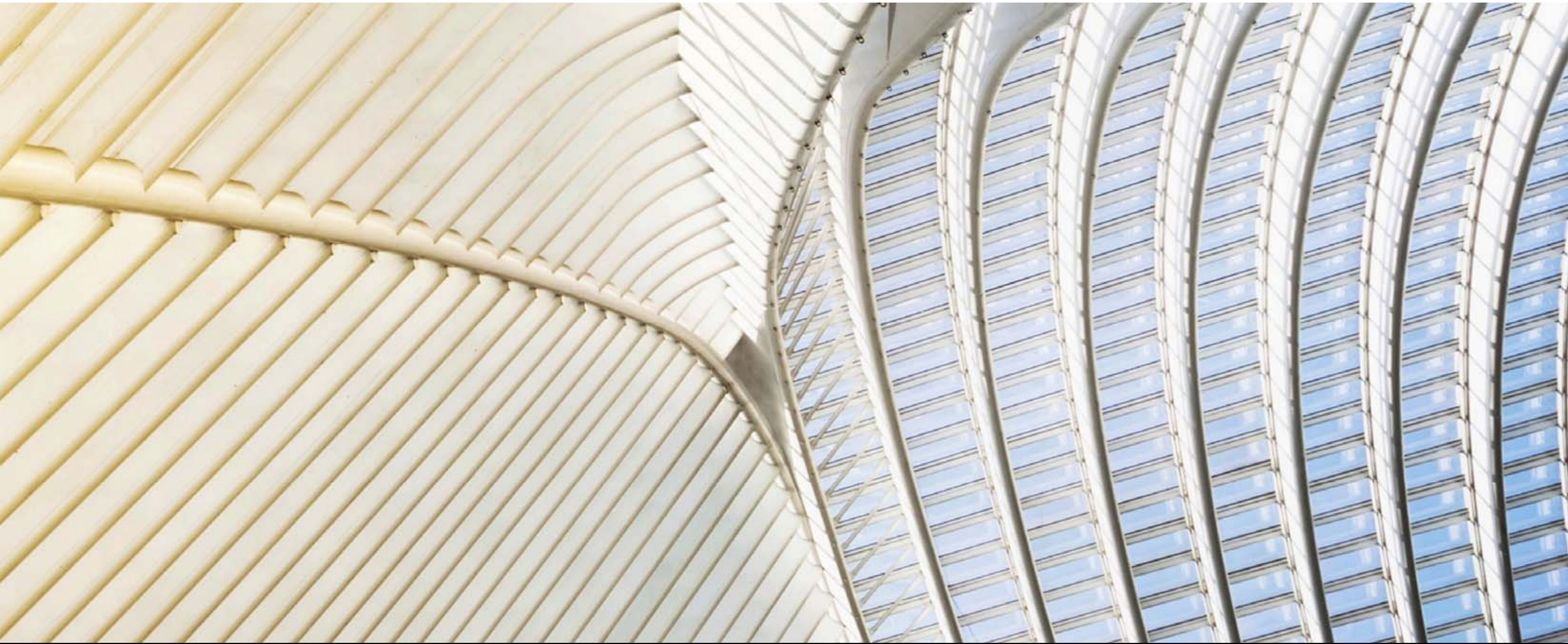


OBG | WASTE MANAGEMENT PRESENTS:

18th Annual New England Pretreatment Coordinators Workshop (October 27, 2016)
Landfill Leachate Overview

Mark Greene, Ph.D., P.E. OBG   Anne Reichert, P.E. WM

AGENDA

Leachate Characteristics

Pretreatment Technologies

WMNH-TREE

Solid Waste Landfills – Big and Small

Landfilling is a fact-of-life

- Been around for a long time
- Most economical method of solid waste disposal

Landfills were often overused

- In past, everything went into them
- Modern facilities discriminate in waste acceptance

Solid Waste Landfills – Big and Small

Municipal Landfills

- Typically able to handle their own generated leachate
- By acceptance into the headworks of their municipal WWTP

Larger Landfills Became Popular

- Municipal landfills closed under subtitle D
- Private landfills are larger, more regional…Waste Management, Republic, Casella…

What is Leachate?

"The liquid formed when rain water filters through wastes placed in a landfill. When this liquid comes in contact with buried wastes, it leaches, or draws out, chemicals or constituents from those wastes".

USEPA 2016

Typical Leachate Characteristics

Parameter	Age of Landfill		
	Young	Medium	Old
pH	5.7 - 8.0	6.4 - 8.0	6.6 - 8.3
BOD (g/L)	7.5 - 17	0.37 - 1.1	0.07 - 0.26
COD (g/L)	10 - 48	1.2 - 22	0.67 - 1.9
NH_3-N (g/L)	0.04 - 1.0	0.03 - 3.0	0.01 - 0.9
Organics (%)	0.9-2.5 VFA	5-30 VFA Humic & Fulvic	50-100 VFA Humic & Fulvic

Typical Leachate Inorganic Characteristics

Parameter	Range (mg/L)
Hardness	400 - 2,000
TDS	0 - 42,300
Calcium	100 - 1,000
Chloride	20 - 2,500
Iron	0.2 - 5,500
Lead	0 - 5
Magnesium	16.5 - 15,600
Manganese	0.06 – 1,400
Potassium	3 - 3,800
Sodium	0 - 7,700
Zinc	0 - 1,350
Mercury	0.0046 – 0.00715
Arsenic	0.10 – 0.44

Humic and Fulvic Acids

Formed from the transformation of

- Lignin derivatives (wood, paperboard, paper)
- Food scraps
- Phenolics, benzoic acids, aromatic compounds

Estimated to be > 50% of leachate organic contents

Humic and Fulvic Acids

Interference with UV Disinfection

Leachate is generally orange-brown to dark brown

UV transmittance levels can't simply be estimated by the color

Removing Humic and Fulvic Substances requires costly treatment options

- Nanofiltration and RO, advanced oxidation

How Do We Treat Leachate?

Most leachate can be treated successfully by
a combination of physical-chemical and biological methods

Technologies In Play

Leachate Recirculation

- Least expensive
  - Treatment plant is not required
  - Promotes degradation of buried mass
  - Moist, warm, gas production increases
- Known as “Biocells”

Technologies In Play

Combine with Municipal Wastewater

- Common when municipal WWTP can accommodate waste load
- May need pre-treatment to reduce load
- Humic and fulvic substances
  - Could cause interference with UV disinfection of WWTP effluent

Technologies In Play

Biological Treatment

- Very effective at reducing high-strength biodegradable components
- Both aerobic and anaerobic technologies available

Technologies In Play

Biological Treatment (Aerobic/Anoxic)

- **Fixed-film**
  - Trickling-filters, RBC, MBBR, IFAS, BAF
- **Suspended-growth**
  - CAS, **SBR**, MBR
- **Specialized bacterial systems**
  - Annamox™
    - subject to COD/N ratio applicability

Technologies In Play

Biological Treatment (Anaerobic)

- Subject to inhibitory evaluation
- Configured in either fixed-film, or suspended growth systems
- Always will require an aerobic polishing step as part of process

Technologies In Play

Physical-Chemical Methods

- Air Stripping
- Precipitation/Coagulation/Flocculation
- Chemical Oxidation
- Activated Carbon
- Membrane Technology – micro-, ultra-, nano-, RO
- Ion Exchange
- Electrochemical
- Flotation
- Heat Exchange
- Evaporation / Crystallization

Operational Challenges

Typical Operational Challenges:

- **Variable** Loads and Flow: drought to seasonal precipitation
- **Inhibitory** compounds: numerous
- Poor **performance** of physical-chemical pre-treatment systems: i.e., high solids to membrane systems
- Elevated **temperatures**: 75-115^0 F to as high as > 175^0 F

Operational Challenges

Not So Typical, but **Real** Operational Challenges:

- Owners may not appreciate the **skills required** to adequately operate and maintain a high-tech treatment system
- **Hard to find** skilled and experienced operators
- Leachate treatment systems are generally **not fitted with redundant treatment systems** like municipal systems – pro-active and planned maintenance is very important

Future Challenges

Tighter ***total nitrogen*** *regulatory environment - Design needs to consider modularity and footprints for future upgrades*

Reliance on biological system to reduce ***nitrate*** *to a target concentration that minimizes impact to POTWs*

Leachate Treatment at WMNH Turnkey Recycling and Environmental Enterprise (TREE) Facility

WMNH TREE

Original Treatment System 1991

PACT system – 80K GPD capacity; targeting BOD/COD, Ammonia, and TSS Removal

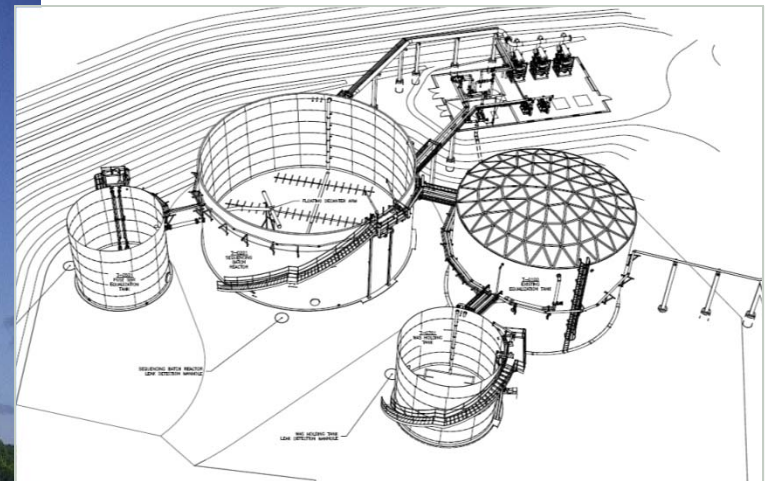
50% Raw/50% Treated – 160,000 gpd blend to POTW – Circa 2002

(1) 500,000 gal EQ, (1) 120,000 gal PACT Aeration Tank, (1) 20,000 gal WAS Holding Tank

Stage I Expansion Planning - 2009

Key Drivers

- Support 80 to 160K GPD treatment capacity expansion
- Pretreat 100% of leachate (discontinue 50% treated/50% raw)
- Treat for BOD, COD, TSS, Ammonia
- Aging infrastructure requiring replacement
- Approved landfill expansion airspace



Stage I Biological Treatment - 2011

SBR system – 130K GPD capacity; targeting BOD/COD, Ammonia, and TSS Removal

Design blend (70% leachate / 30% LFG Condensate)

(1) 500,000 gal EQ, (1) 680,000 gal SBR reactor / (1) 90,000 gal post SBR EQ / (1) 90,000 gal WAS holding tank

Stage 1B Expansion Planning - 2010

Key Drivers

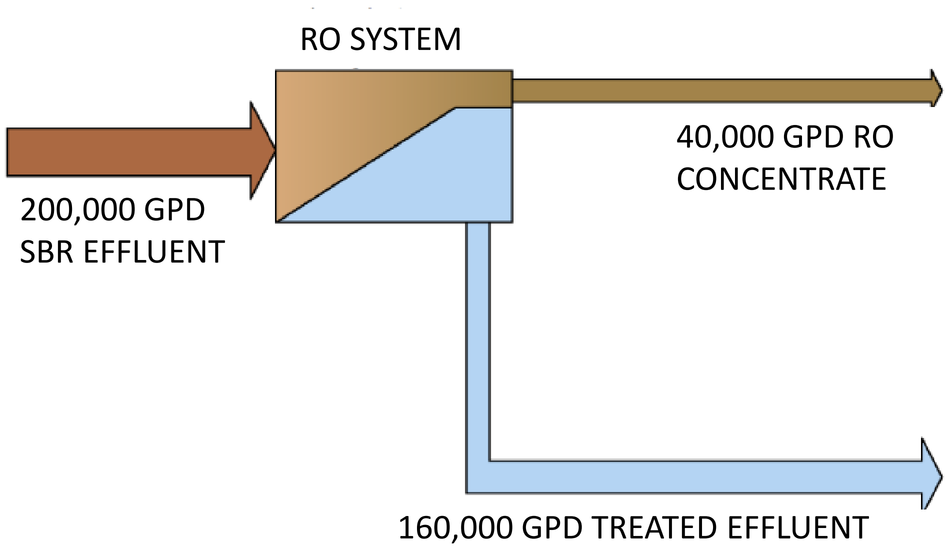
- City of Rochester, NH - performance issues with new UV Disinfection System
- WMNH Effluent –25-40% UVT when diluted 20:1
- Post Biological Treatment of Leachate Required - > 65% UVT required
- Technologies Considered – Fenton’s Reagent, HIPOX, Adsorption, UV Catalyst, CoMag, NF, RO
- RO Shortlisted – reliability/cost
- On Site RO Pilot Program Conducted - > 65% UVT achieved

Post Biological Treatment

Stage 1B - Effluent Treatment - 2012

Spacer Tube RO (STRO) System constructed downstream of SBR for removal of compounds inhibiting UV transmittance (fulvic and humic acids)

Driver: attain 65% UV transmissivity on RO permeate with no dilution



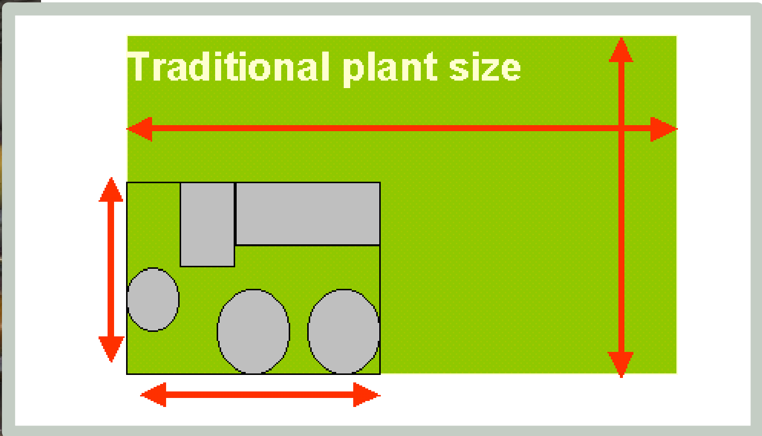
Effluent Treatment Building

Stage II Expansion Planning - 2015

Key Drivers

- Support 130K GPD to 240K GPD capacity expansion to support ongoing airspace growth
- Protect against increased strength in influent characteristics (BOD, COD, Ammonia)
- Improve process stability and resiliency – Increase Upfront Equalization (varying loads and blends – condensate / DWL)
- Improve feed quality to RO System
- Utilize limited footprint
- Maximize use of existing assets

MBR Technology – External Ultrafilter



MBR plants are typically 1/3 to 1/4 the size of conventional activated sludge-type treatment plants

MBR produce significantly less sludge, operate at high MLSS & long SRT

MBR technology combines the functions of a clarifier and filter

MBR technology provides consistent solids free effluent

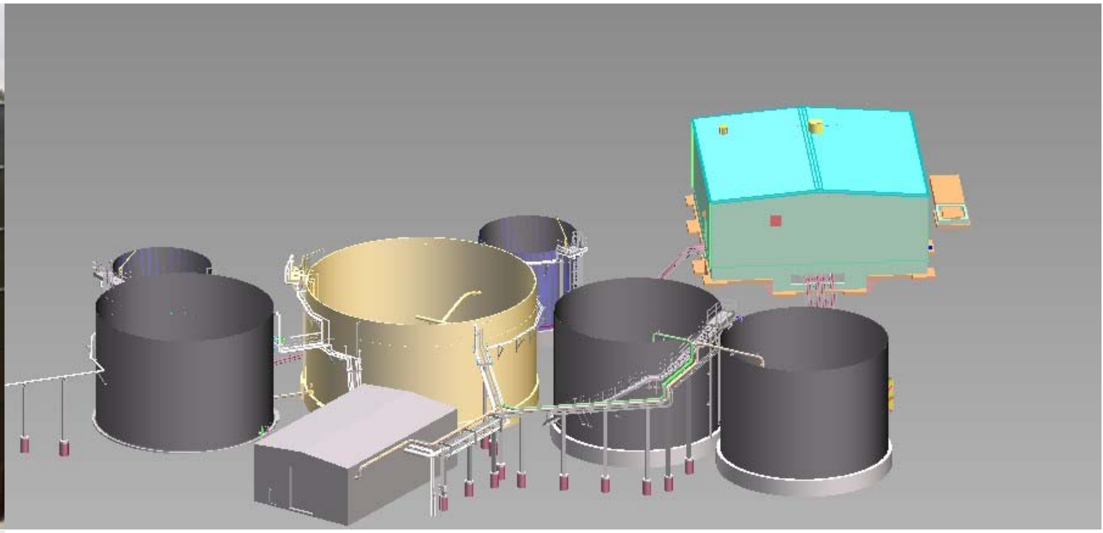
Why Conduct Pilot?

General Benefits

- Obtain site specific information and validate performance
- Identify proof of concept at small scale
- Demonstrate treatment performance for permitting
- Select proper design parameters; minimize over design ($$$) and under design ($$$)

Site Specific Objectives

- Main treatment objectives – COD, TSS, Ammonia, UVT
- Investigate MBR performance under varying load (COD reduction, nitrification, UF flux)
- Measure RO performance (flux, recovery, and UVT rejection) downstream of UF
- Expose operations staff to new technology at a small scale.



Stage II - Biological Treatment - 2016

MBR system – 240K GPD capacity; targeting BOD/COD, Ammonia, and TSS Removal

Design blend (65% leachate / 35% DWL)

(1) 500,000 gal EQ, (1) 680,000 gal EQ Tank/ (2) 450,000 gal Bioreactors/ (4) UF Trains/ (1) 90,000 gal Eff holding tank/ (1) 90,000 gal WAS holding tank

Downstream RO to be expanded at later date

Current Construction Progress

Summary

Not all "Leachate" is created equal…

Leachate characteristics change over time…. constituents, age, and leachate management practices

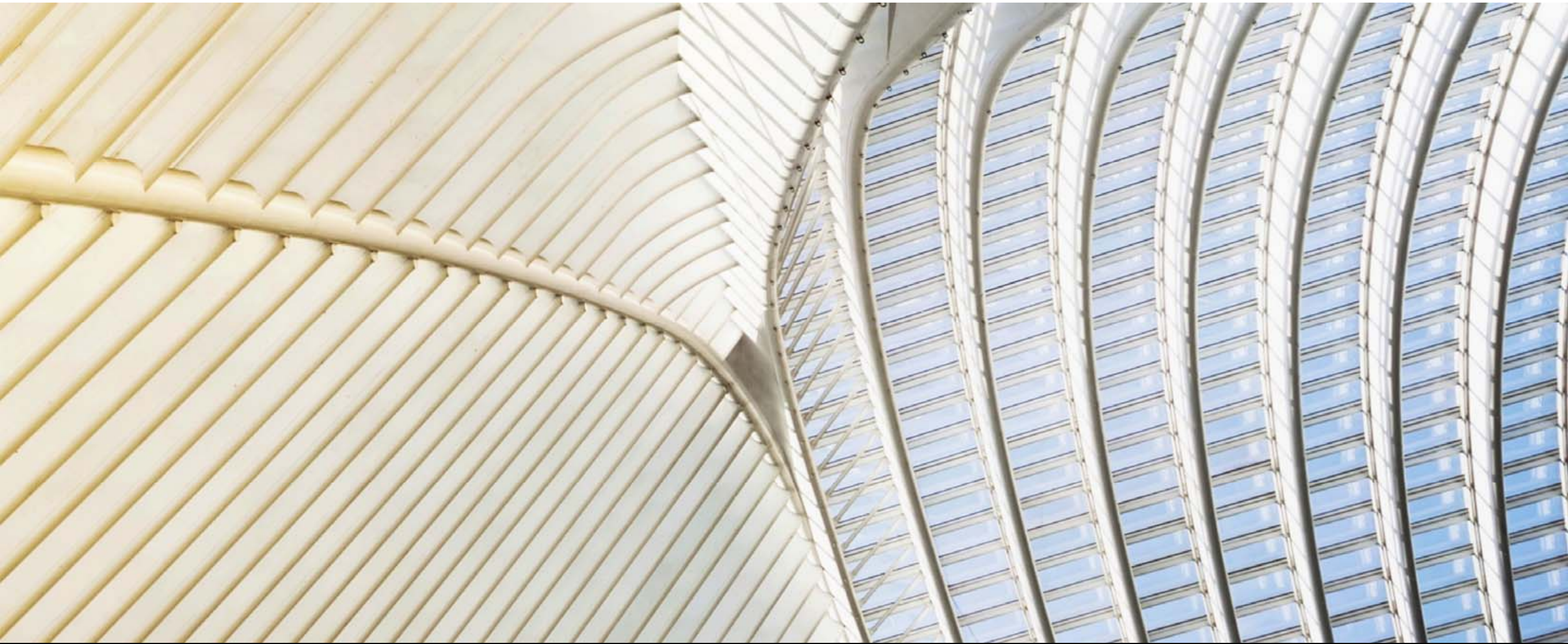
Treatment approach needs to be flexible……account for varying load conditions

Leachate Treatment is not a "one size fits all" solution…..each site is unique

Application of simplest but reliable technology

WMNH Site Specific Approach

- MBR – COD, TSS, and Ammonia Removal
- RO – final polishing (% Transmissivity, Nitrate)



Thank you!

Mark.Greene@obg.com Areicher@wm.com