

Small Community Wastewater Collection and Treatment Alternatives

*A Case Study on a Water & Wastes Digest “2015 Top Projects” Award Winning System at
Christiansburg, OH*

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Introduction

- Christiansburg, Ohio
- Champaign County
- Located in Midwestern Ohio
- 515 people, 250 connections (residential and commercial)
- Town is bounded within a highly urbanized area.
 - ~ Densely populated adjacent municipalities; Springfield, Dayton, Troy, Urbana, etc.
- No existing centralized wastewater collection or treatment infrastructure.
 - ~ Nearby Creek tested high for bacteria
- Small community, with limited resources



Christiansburg, OH

Existing Wastewater Infrastructure

- Residences had failing septic systems
- Existing parcels were small
 - ~ Many were less than .15 acres
 - ~ Typical Village setting
- Environmental issues
 - ~ Contamination
 - West Fork Honey Creek runs next to town
 - ~ Odors most of the time
 - Especially after rainstorms
 - ~ Health hazards



Christiansburg, OH Problem and Challenges

- Relatively low density
 - ~ Denser village center
 - ~ Vacant lots
 - ~ Some large lots on outskirts
- Slow growth rate
- Part time operators, limited experience
- No money
- Low median household income
- Strict discharge permits



Christiansburg, OH Solution

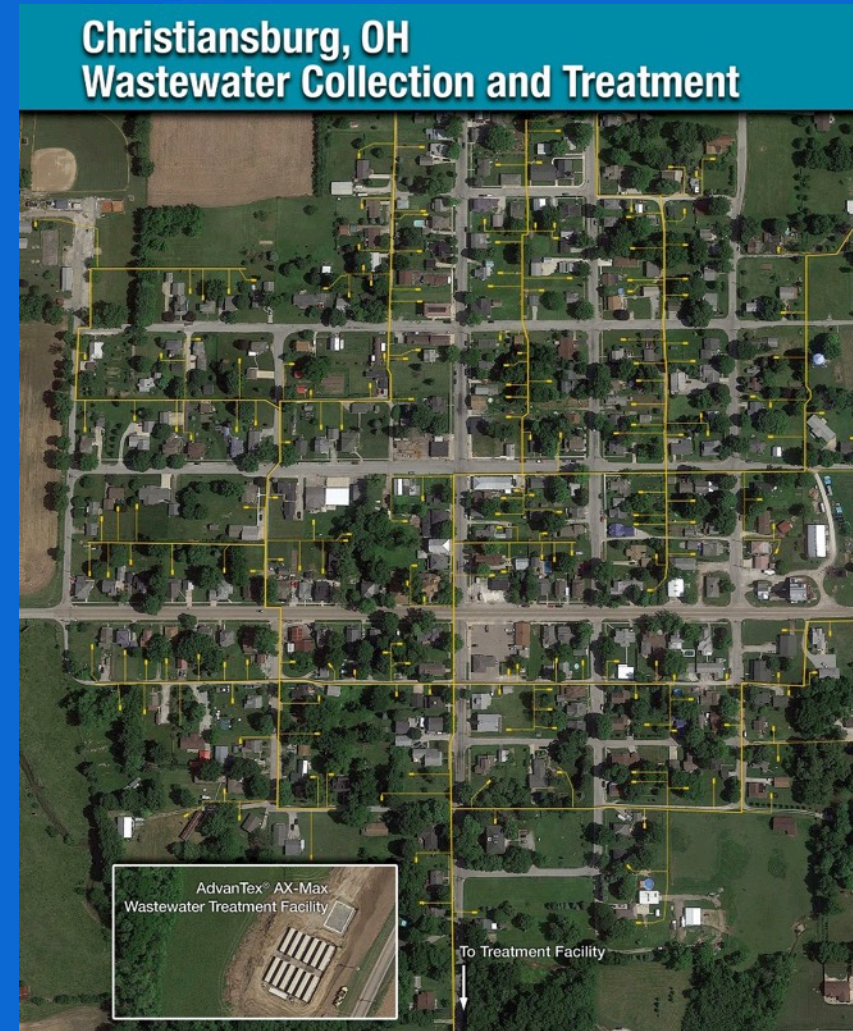
- System needed to have:
 - ~ Low up-front capital costs
 - ~ Affordable operation & maintenance costs
 - ~ Ability to connect more users as needed without expanding WWTP
- Council woman did research and discovered Orenco
 - ~ Engineer, Town and Orenco toured existing facilities
- Orenco Effluent Low Pressure Sewer followed by AdvanTex® treatment met all system requirements
- NPDES permit obtained from Ohio EPA
- AdvanTex® treatment layout designed to meet limits



Christiansburg, OH

Project Scope

- 250 Total Connections Installed
- Ohio EPA Permit Limits
 - ~ 10 mg/L BOD₅
 - ~ 12 mg/L TSS
 - ~ 1 mg/L NH³-N summer
 - ~ 3 mg/L NH³-N Winter
 - ~ 161 CFU/100 ml E. coli
- 65,000 gpd average flow
- 85,000 gpd maximum daily flow



Why Was Conventional Sewer not Cost Effective?

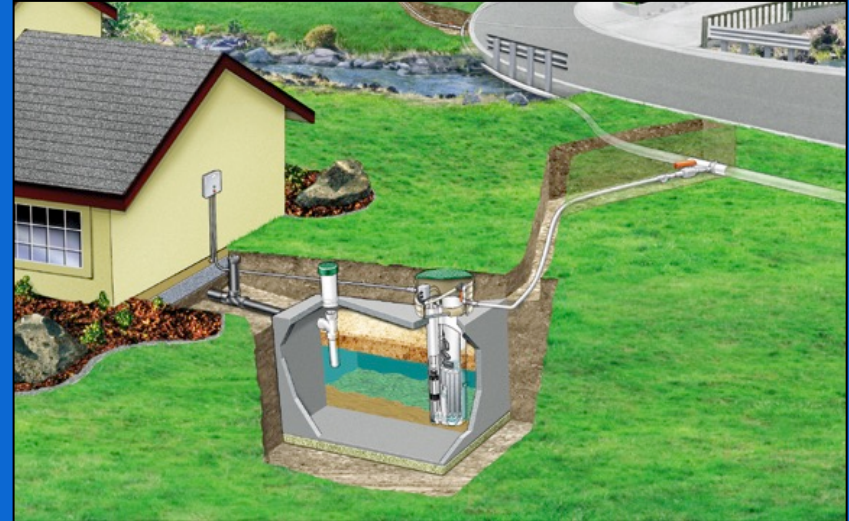
- Gravity collection
 - ~ Recommended Standards for Wastewater Facilities (2004 Ed.)
 - Minimum 8" dia pipe
 - Minimum slope of 0.4ft/100ft
 - Manholes at 400ft intervals, terminal ends, and changes in grade, size, or alignment
 - Multiple pumps shall be provided
- All of this results in HIGH installation costs



Christiansburg, OH

Collection System Overview

- Septic Tank Effluent Pumping (STEP) Collection
- Components
 - ~ Watertight interceptor tank (1000, 1500, or 2000) gallon
 - ~ Biotube® pump vault
 - ~ Effluent screen
 - ~ High head effluent pump, 115VAC, ½ Hp, 10 gpm
 - ~ Control panel
 - ~ Splice box
 - ~ Hose and valve assembly



Christiansburg, Ohio

Low Pressure Effluent Sewer

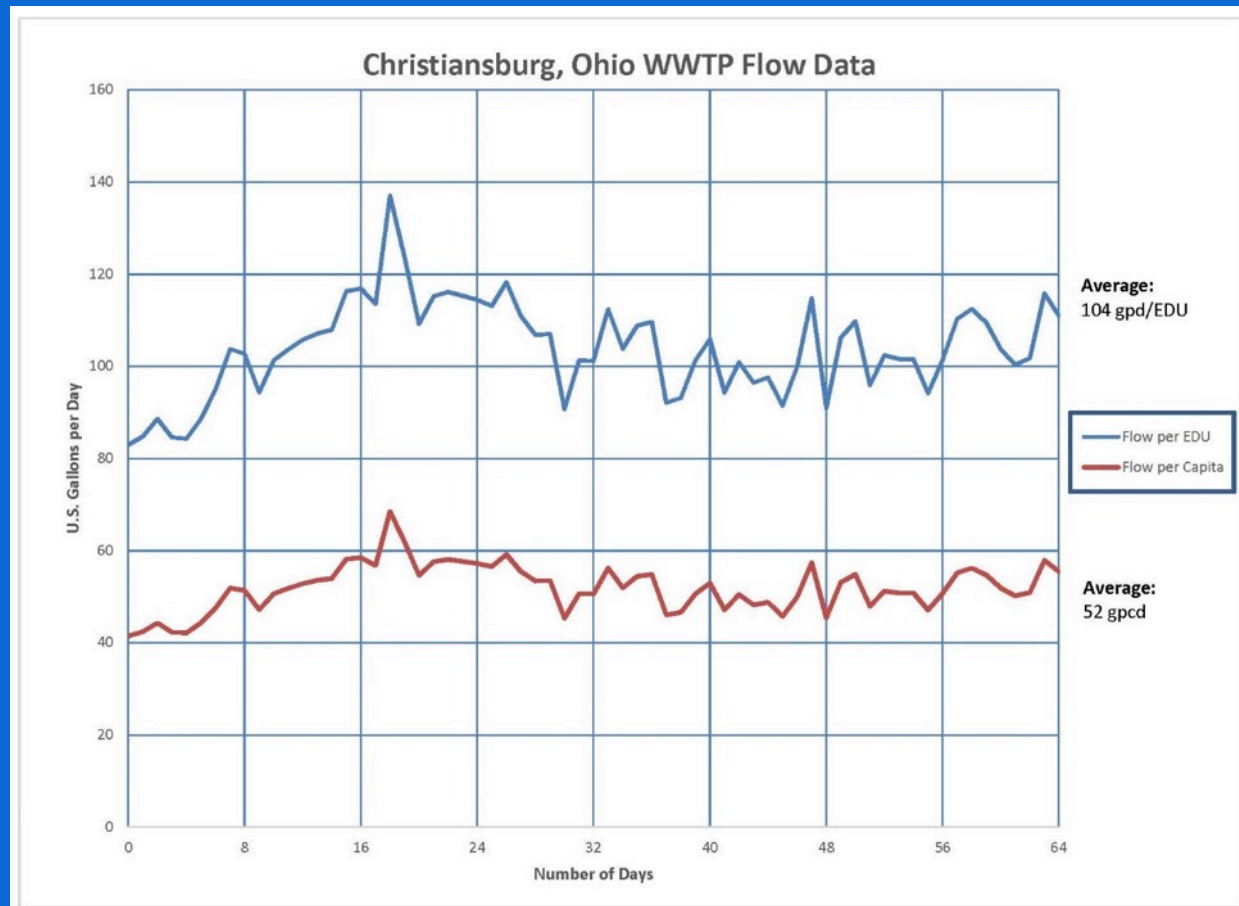
Collection System Force Mains

- ~ Small diameter lines, 2 to 4" diameter
- ~ Follows contour of land
- ~ No manholes or lift stations
 - Cleanouts at terminal ends of mainlines, etc.
- Largely immune to I&I and leakage



EDUs	Qp	Pipe Size, Inches	Head Loss, ft/ 1000 ft
10	20	1 1/4	35 ±
100	65	2	54 ±
500	265	4	32 ±
1000	515	6	16 ±

Christiansburg, Ohio WWTP Flow Data



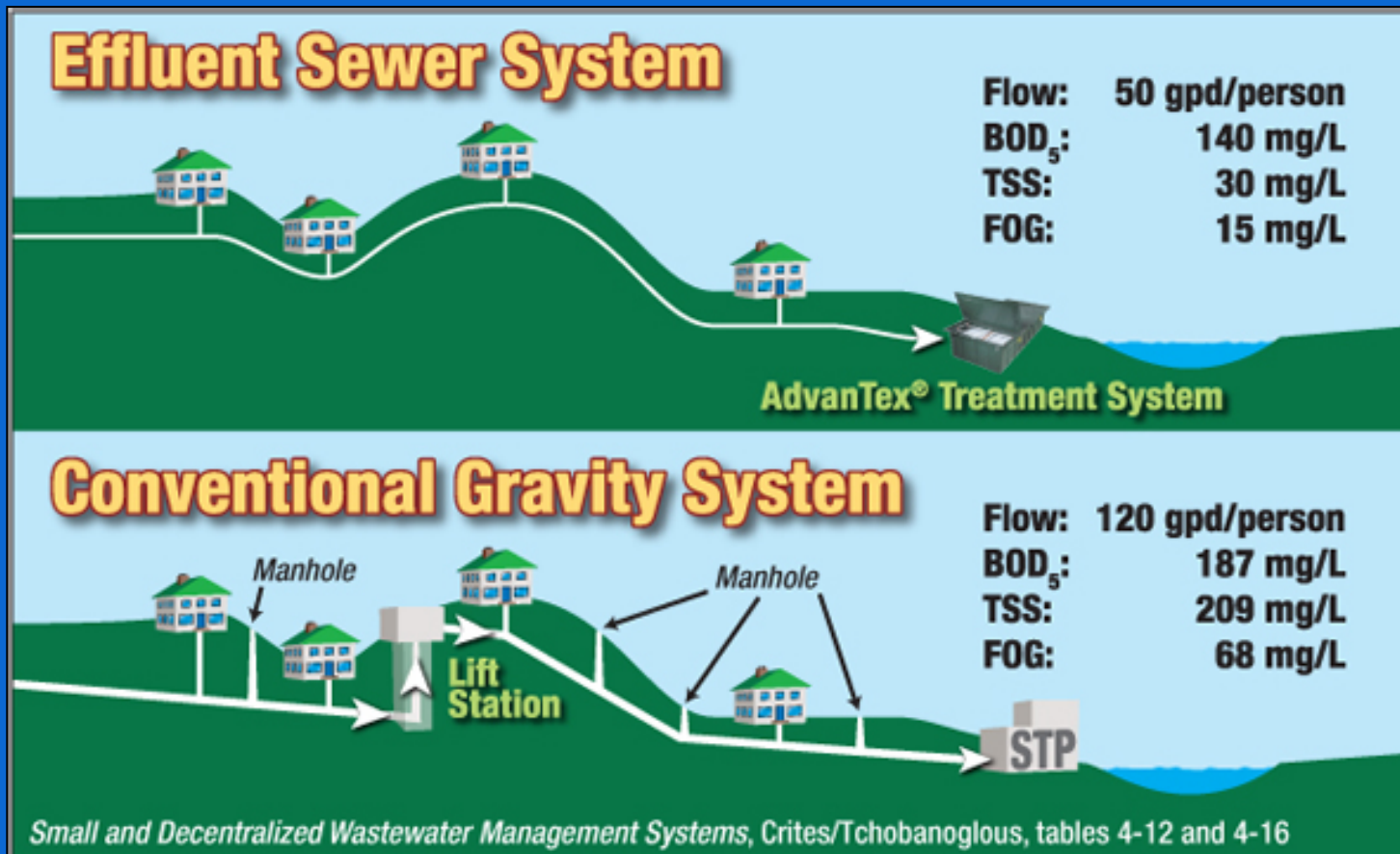
Christiansburg, OH On-Lot Description

- 250 STEP Tanks
 - ~ 1,000 gallon tanks for residential
 - ~ 1,500 or 2,000 gallon tanks for commercial
- Roth Polyethylene tanks
 - ~ 2 risers per tank
- One Orenco MVP panel per STEP tank
- Small excavated footprint (~100 sf)



Collection System Comparison

- Effluent Sewer compared to Gravity Sewer



Collection System Cost Comparison

- On average, Oreco Effluent Sewers have construction costs that are 41% less than gravity sewers for communities of similar size
- STEP systems integrate primary treatment into collection system which eliminates influent screening, and primary clarification at the WWTP
- Pressure sewers (STEP and grinder) are low pressure and watertight, therefore nearly eliminating I/I which enables smaller secondary and advanced treatment process

Type	Average	Median	Minimum	Maximum
STEP	\$9,702	\$9,283	\$6,666	\$15,687
Gravity	\$16,394	\$15,304	\$10,247	\$25,112
Grinder	\$11,468	\$11,258	\$6,488	\$15,693

NOTE: All costs are USD/connection.

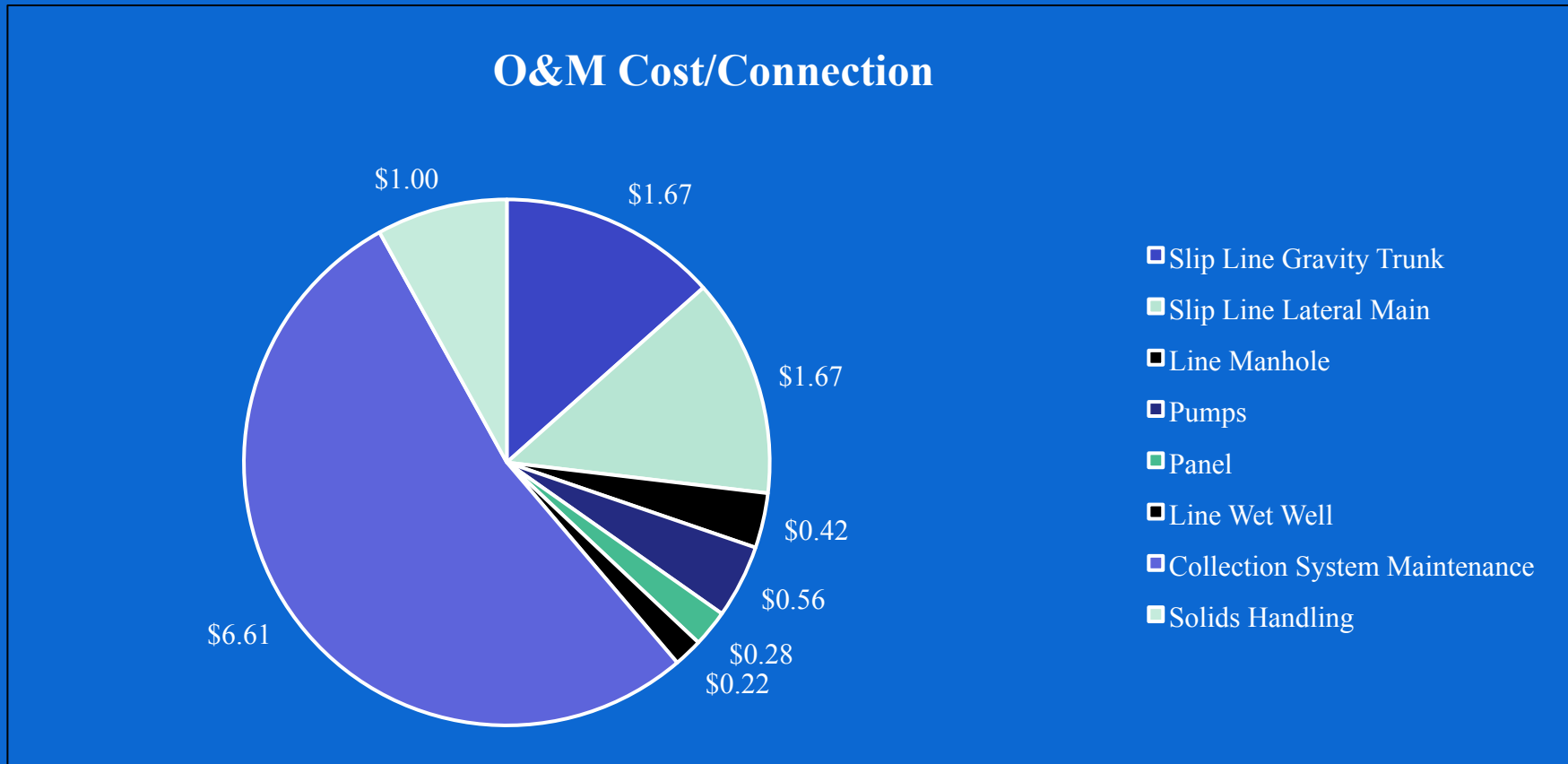
STEP Versus Grinder O&M Costs (\$/Month/Connection)

System Type	Proactive Maintenance	Reactive Maintenance	Equipment Repair & Replacement	Solids Management
Grinder Sewer	\$1.60	\$1.90	\$13.41	@ WWTP
Orenco Effluent Sewer	\$1.60	\$0.60	\$2.81	\$2.04

System Type	Total Equivalent Monthly Costs
Grinder Sewer	\$16.91
Orenco Effluent Sewer	\$7.05

Collection System Cost Comparison

Estimated Gravity O&M



Why Not Conventional Treatment?

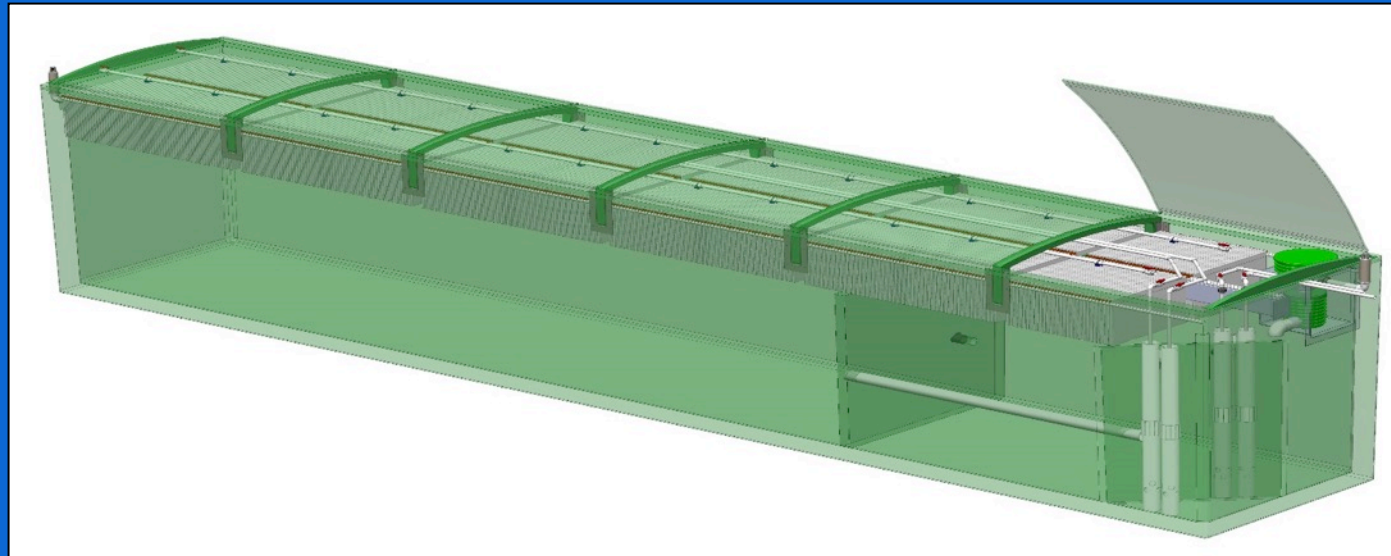
- Activated sludge
 - ~ Recommended Standards for Wastewater Facilities (2004 Ed.)
 - Process requires close attention and competent operating supervision, including routine laboratory control ...Full time oversight/operation.
 - Process requires major energy usage to meet aeration demands High power costs.
 - Traditional style package plants and variations on activated sludge process do not solve the problem either



AX-MAX Treatment Systems

Packed Bed Filter System

- AX-MAX (7 ft to 42')
 - ~ AX-MAX100-14, AX-MAX150-21, AX-MAX200-28, AX-MAX250-35, AX-MAX300-42
- Integrated recirculation tankage and packed bed media filter
 - ~ Lower installation costs, reduced construction oversight

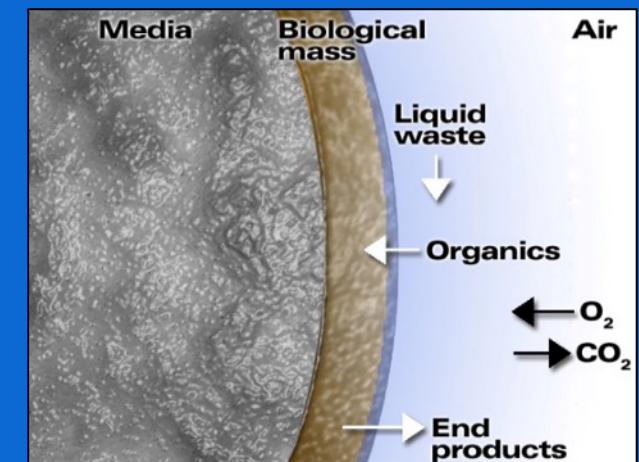
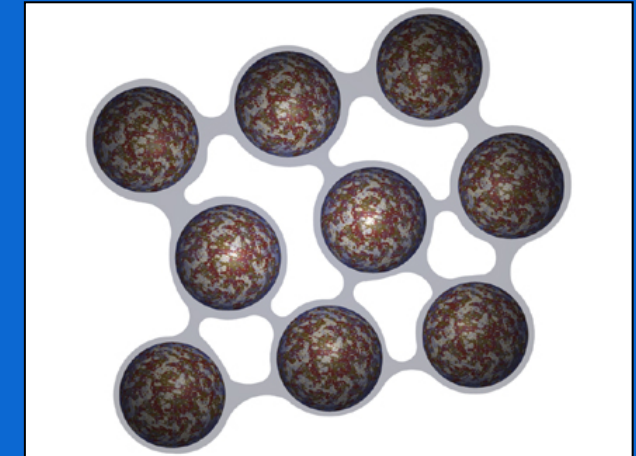
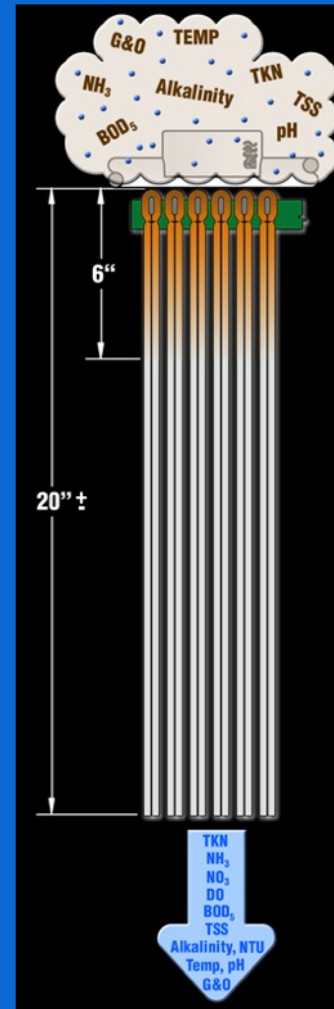


AdvanTex Media

- Textile is specifically engineered for wastewater treatment applications and was designed to maximize surface area
- The more surface area, the more area for bacterial colonization
- High Oxidation
- Treats cBOD and converts Ammonia into Nitrates

AdvanTex® Textile Treatment

- Biological Nutrient Removal
 - ~ Attached growth process
 - ~ Aerobic microbes attach and grow on media
 - ~ Wastewater flows across a zoogeal film created by microbes
 - ~ Microbes extract and digest soluble organic matter in wastewater
- Wastewater is applied in small doses and percolates over media in a thin film
 - ~ Unsaturated conditions
 - ~ Uses low hp, energy efficient pumps
- Low O&M, highly stable, reliable



Christiansburg, OH AdvanTex® Treatment Facility

- 1st stage
 - ~ 9 Orenco AX-MAX units
- 2nd stage
 - ~ 3 Orenco AX-MAX units
- Small footprint
 - ~ Approximately 10,000 sf



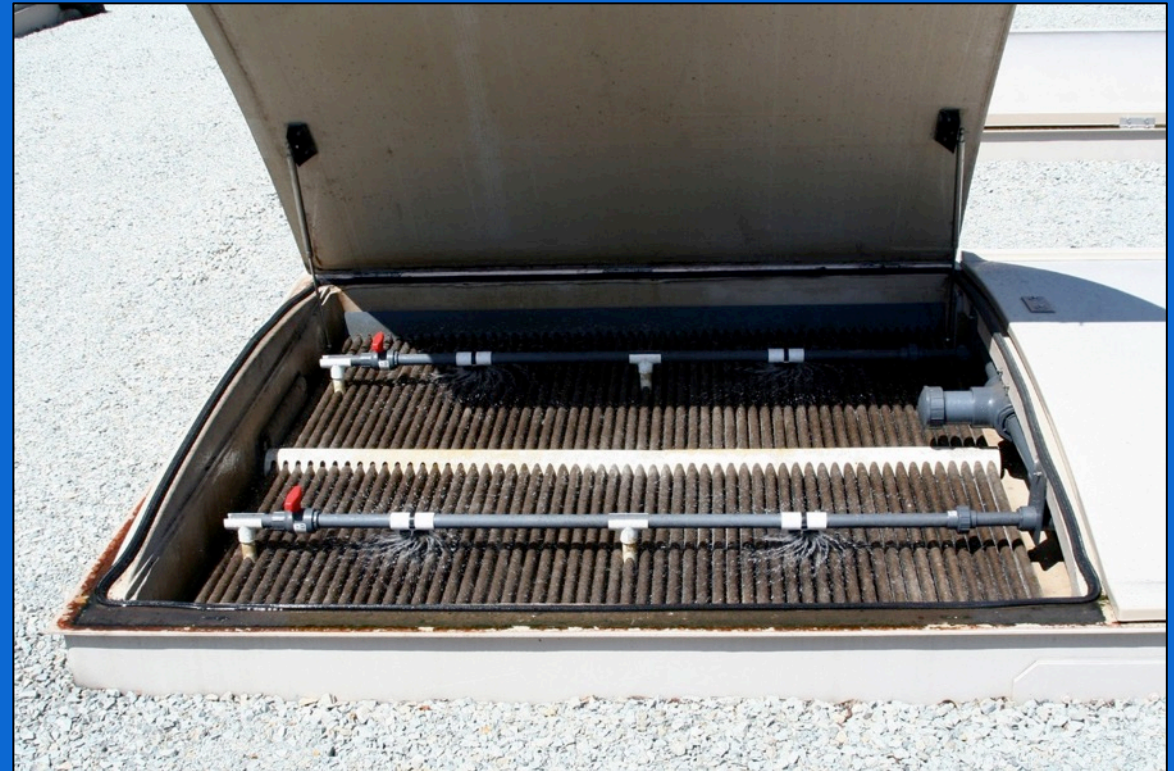
Ancillary Equipment

- Components
 - ~ Automatic Alkalinity Feed
 - (Eagle Microsystems)
 - ~ UV disinfection
 - (Aquionics)
- Dispersal
 - ~ Surface discharge into West Fork Honey Creek
 - ~ Strict Ammonia Limits (<1 mg/L)



Christiansburg, OH AdvanTex® Treatment Results

- Far exceeds NPDES requirements
- Recorded Effluent Quality (summer 2015)
 - ~ 3.6 mg/L cBOD₅
 - ~ 1.7 mg/L TSS
 - ~ < 0.1 mg/L NH³-N
- Operator Time ~6 hrs/week
- Energy Use ~10kWh/day
- Plant Electricity Bills ~\$700/month



AdvanTex® Treatment Comparison

Energy Requirement Comparison

Unit Process	Average Flow (MGD)	kWh per Million Gallons
AdvanTex®	0.25	2170
	0.5	1790
Activated Sludge	0 to 1	5440
	1 to 5	2503
	> 5	2288
Aerated Lagoon	0 to 1	7288
Oxidation Ditch	0 to 1.2	6895

*Energy intensity values for AdvanTex® treatment systems (Jex, 2014)

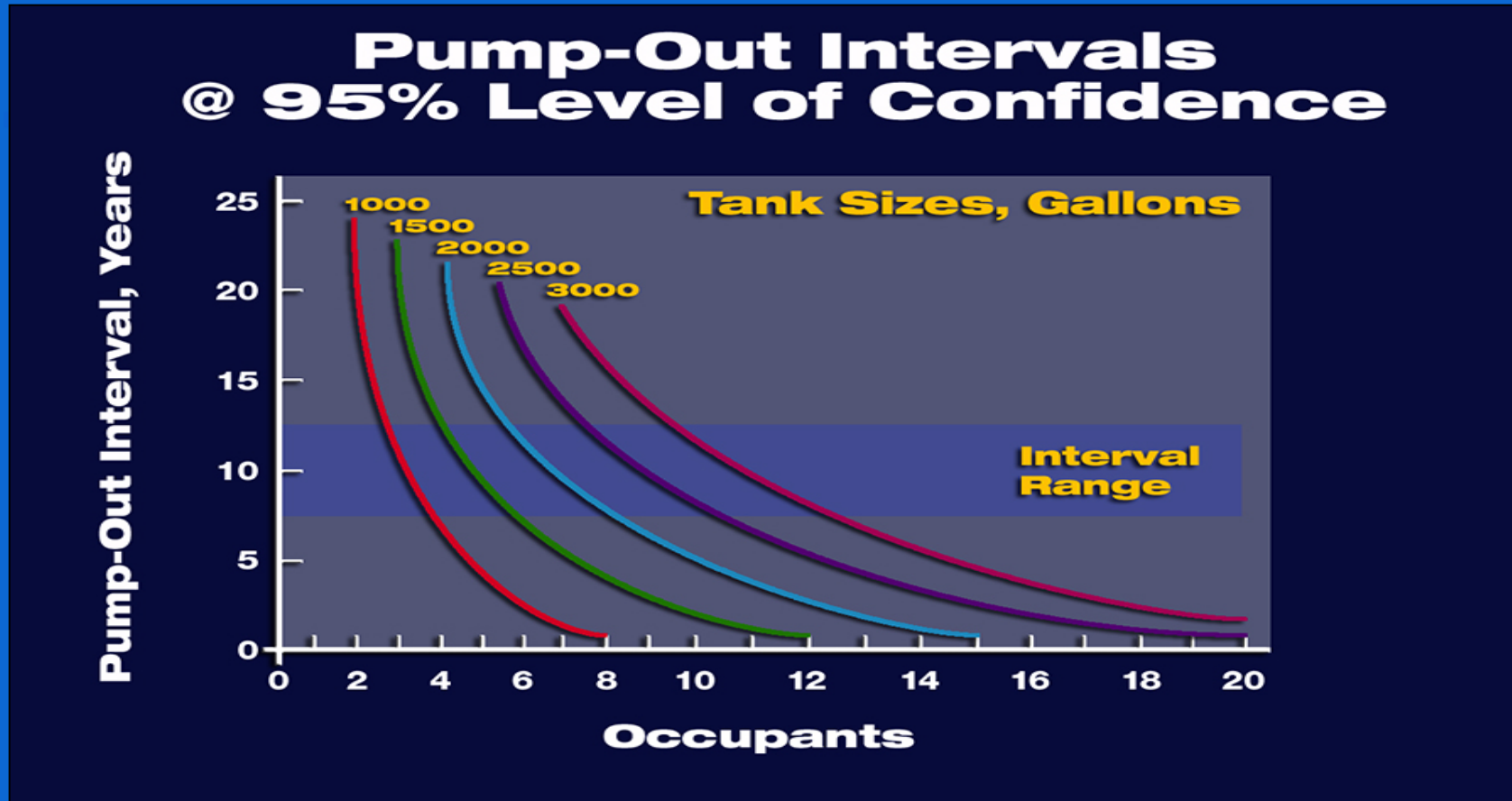
*Energy intensity values for various WWTPs (Science Applications International Corporation, 2006)

Operation and Maintenance Collection

- Conveyance System O&M
 - ~ Inspection, exercising valves, replacement of odor control filters
- On Lot System O&M
 - ~ Proactive (every 3 to 5 years)
 - Tank effluent screen cleaning, pump and controls inspection, sludge and scum measuring
 - ~ Reactive (~1.4 hours/EDU/Month/100 EDU's)
 - ~ Equipment repair and replacement (pumps ~20 years)
 - ~ Tank pump outs (~10 years)



Properly Sized Tanks Reduce Pumping



The pumping interval for properly sized and managed watertight tanks is about 8 to 12 years.

Operation and Maintenance Treatment

- Activities
 - ~ System operation and pump monitoring
 - ~ Annual lateral, nozzle and pump cleaning
 - ~ Reactive maintenance
 - ~ Media Cleaning (~10 years)
 - ~ Electrical panel
 - Remote monitoring and telecommunication with TCOM panel



Christiansburg, Ohio

Total Project Costs (Constructed – From House Plumbing to Discharge)

- Orenco On-Lot STEP (Residential & Commercial)
~ \$5,070 per EDU
- Service Laterals
~ \$1,038 per EDU
- Tank Abandoning
~ \$400 per EDU
- Site Restoration
~ \$706 per EDU
- Force Mains
~ \$956 per EDU
- AdvanTex® Treatment & WWTP Accessories including Building
~ \$6,714 per EDU
- Misc. (i.e. tree removal, storm, etc.)
~ \$1,473 per EDU
- **Total Constructed Costs**
~\$16,358 per EDU



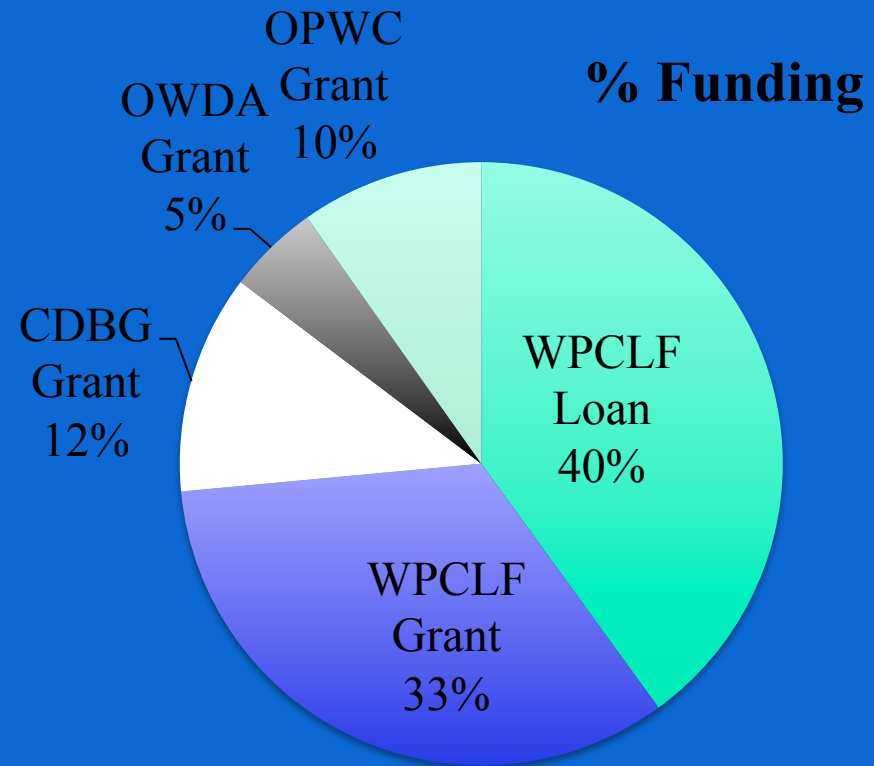
Project Constituents

- Engineering
 - ~ Randy VanTilburg, P.E. (Manik Smith Group)
 - ~ Brice Schmitmeyer, P.E. (Access Engineering)
- Permitting
 - ~ Ohio EPA
- Funding
 - ~ Ohio EPA, Ohio Water Development Authority, Ohio Public Works Commission, Community Development Block Grant program.
 - ~ Approximately 60% grants and 40% loans



Funding Overview

- Overall Funding
 - ~ \$2,040,000 Loan (40% Loan)
 - ~ \$3,060,000 Grant (60% Grant)
- CDBG
 - ~ \$600,000 Grant
- Ohio Public Works Commission
 - ~ \$500,000 Grant
- OWDA
 - ~ \$250,000 Grant
- WPCLF (EPA)
 - ~ \$1,710,000 Grant
 - ~ \$2,040,000 Loan



Consumer Rates

- Residential base rate
 - ~ \$60.00/month/residence
- On-lot packages were installed at no up front cost to the residential or commercial consumers – only paid for package connection



Conclusion

- Won 2015 Top Project Award from Water and Waste Digest
- Small community limitations
- STEP effluent sewer and AdvanTex treatment offers:
 - ~ Low O&M requirements
 - ~ Low energy usage
 - ~ Stable treatment process
 - ~ Ease of operation
 - ~ Low present worth costs
- Consumer fees are low
- Increased health and safety for the community
- Exceeds NPDES permit limits

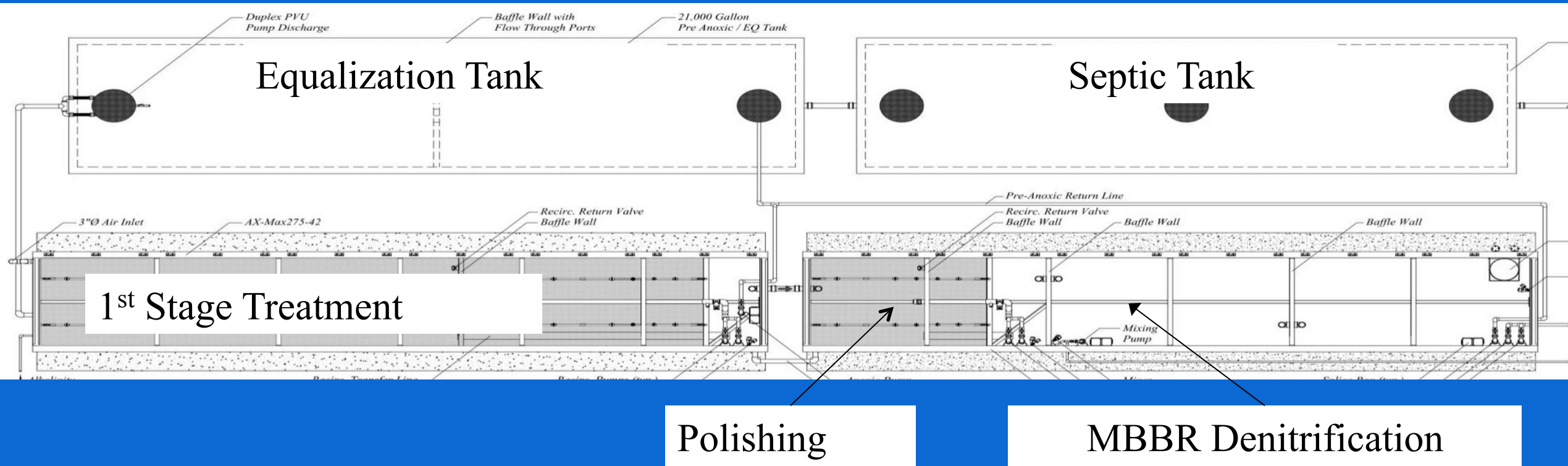


Questions?

Presentation Q&A

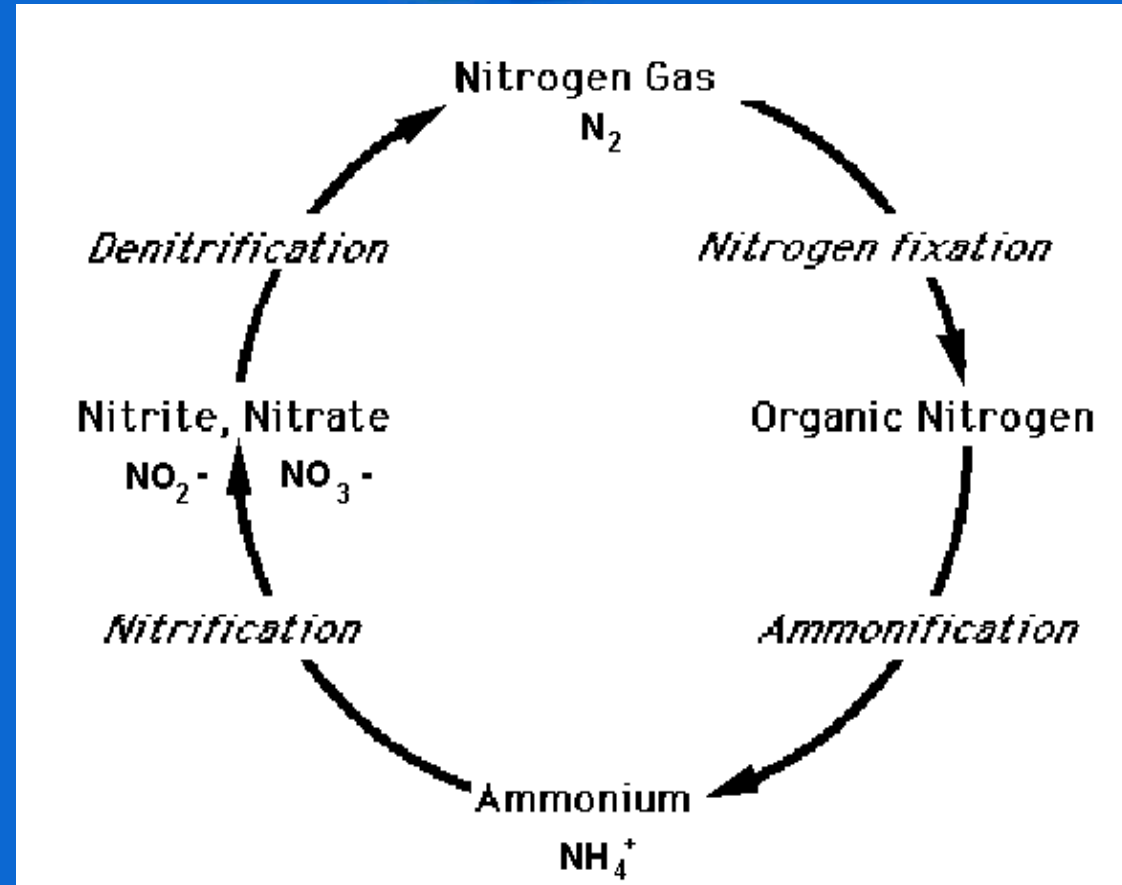
- What is the mean time between pump outs (pump-out interval) of septic tanks in a STEP system?
 - ~ 10 years at 95% confidence level
- T or F: STEP systems are the only collection system that provide primary treatment.
 - ~ True
- What are some of the benefits of packed bed filter treatment
 - ~ Low O&M, low energy use, reliable, stable, do well with varying and low flows
- T or F: Packed bed filters can meet strict effluent limitations - NH₃ less than 1 mg/l, BOD/TSS less than 5 mg/l - when configured properly.
 - ~ True

WWTP Flow Path



Nitrogen Cycle

- Ammonia
 - ~ Nitrification
- Nitrite / Nitrate
 - ~ Denitrification
- Nitrogen Gas
 - ~ Cycle Continues







Questions?

Christiansburg, OH

Wastewater Alternatives Investigated

- Engineering Report Evaluated
 - ~ Conventional gravity collection system to traditional package WWTP
 - Cost prohibitive
 - Concerns about lack of operation experience
 - ~ Conventional gravity collection system pumped to neighboring community
 - No control on what nearby town would charge for treatment

