


Achieving Secondary Wastewater Treatment Standards using Zero-Energy Combined Treatment and Dispersal Technology

David Lentz, P.E.

Content Notice

The materials being presented represent the presenter's opinions, and do NOT reflect the opinions of NOWRA.

There are multiple combined treatment and dispersal systems approved by regulatory agencies. These products are produced by several manufacturers. Since showing all designs and performance results is not practical, this presentation depicts designs from one manufacturer.

The audience can search for "combined treatment and dispersal systems" to find additional information on the topic and information on other products within the technology group.

DID YOU KNOW?

Onsite wastewater systems are used in 30 million U.S. homes – serving 25% of the population

“…4 billion gallons of sewage is treated by onsite/ decentralized systems in the USA every day.”

USEPA

One-third of new homes built in the U.S. use onsite wastewater treatment systems

Conventional Septic System

Please note: Septic systems vary. Diagram is not to scale.

https://www.epa.gov/septic/types-septic-systems

United States Environmental Protection

Conventional Drainfield Distributes Wastewater

http://www.newhudsonvalley.com/category/building-a-passive-house/passive-house-site-development/septic-system/

What if Wastewater Treatment is Needed?

https://www.yolocounty.org/government/general-government-departments/community-services/environmental-health-division/land-use-programs/onsite-wastewater-treatment-system-program/types-of-owts-septic-systems

Electromechanical systems treat wastewater to secondary standards requiring:

- Electricity
- Maintenance
- Blower
- Separate drainfield

Separate Treatment and Dispersal Systems

+

https://www.yolocounty.org/government/general-government-departments/community-services/environmental-health-division/land-use-programs/onsite-wastewater-treatment-system-program/types-of-owts-septic-systems

http://www.newhudsonvalley.com/category/building-a-passive-house/passive-house-site-development/septic-systen

What about Treatment without Electricity?

Combined Treatment and Dispersal System

Why Combined Treatment and Dispersal?

- Two functions in one footprint
- Zero-electric passive operation
- Resilient naturally occurring microbes
- Stable, reliable performance
- High wastewater purification levels
- Design versatility for nutrient removal
- No moving parts or special maintenance
- Smaller footprint vs. legacy systems

No Special Maintenance

- Pump septic tank as needed
- If installed, clean effluent filter
- If installed, check observation ports
- Maintain vegetated system cover

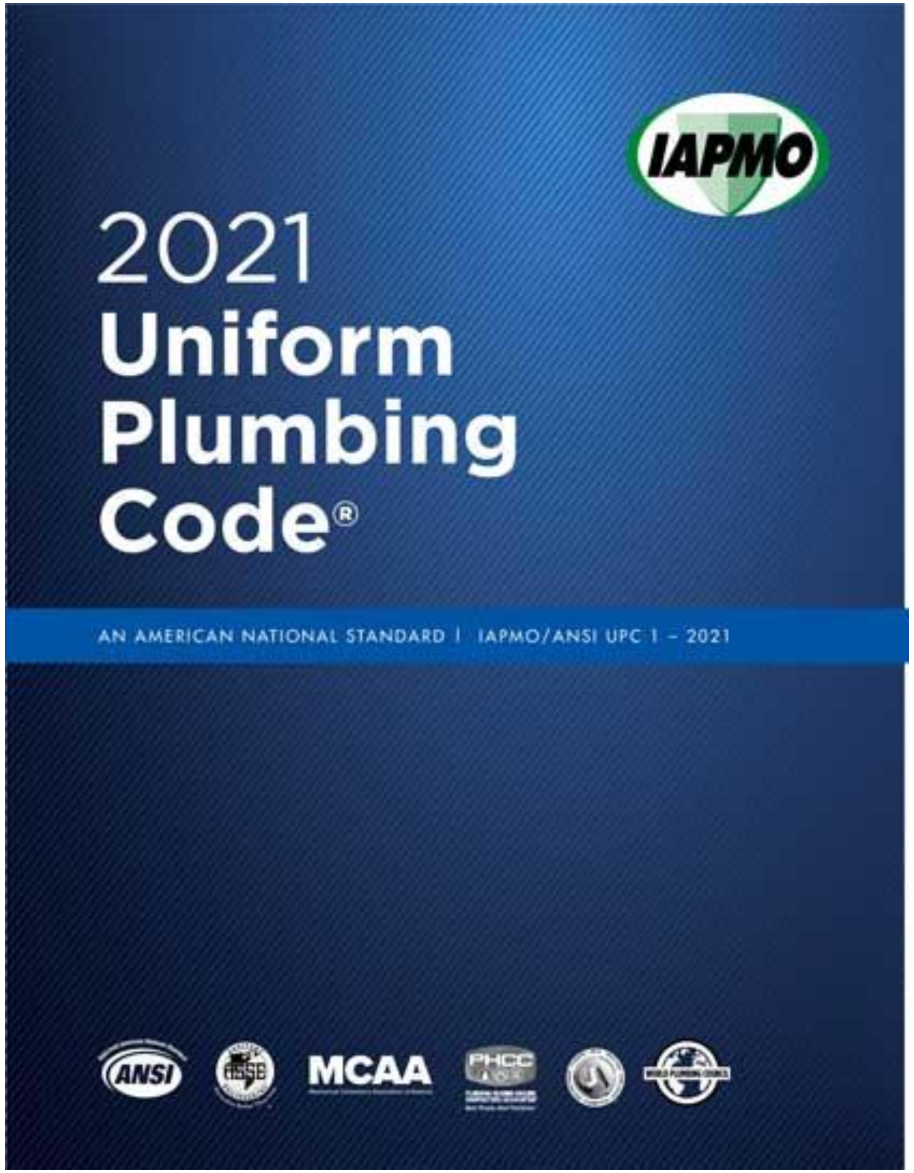
CTD Provides Another Tool in the Toolbox

CTD is an Emerging Technology

- Increasing wastewater reclamation needs
- Increasing treatment system demand
- National performance standard certification availability
- Increasing energy conservation awareness
- Improved design and manufacturing methods
- Broadening regulatory recognition

CTD in 2024 Uniform Plumbing Code

- CTD included in 2024 UPC preprint
- Appendix H – Private Sewage Disposal Systems
- 2024 UPC preprint is available:
  - www.iapmo.org
  - Hover over "Codes & Standards"
  - Click on "Code Development"



What's inside a field-installed combined treatment and dispersal system?

Integrated Technology

Manufactured CTD Product

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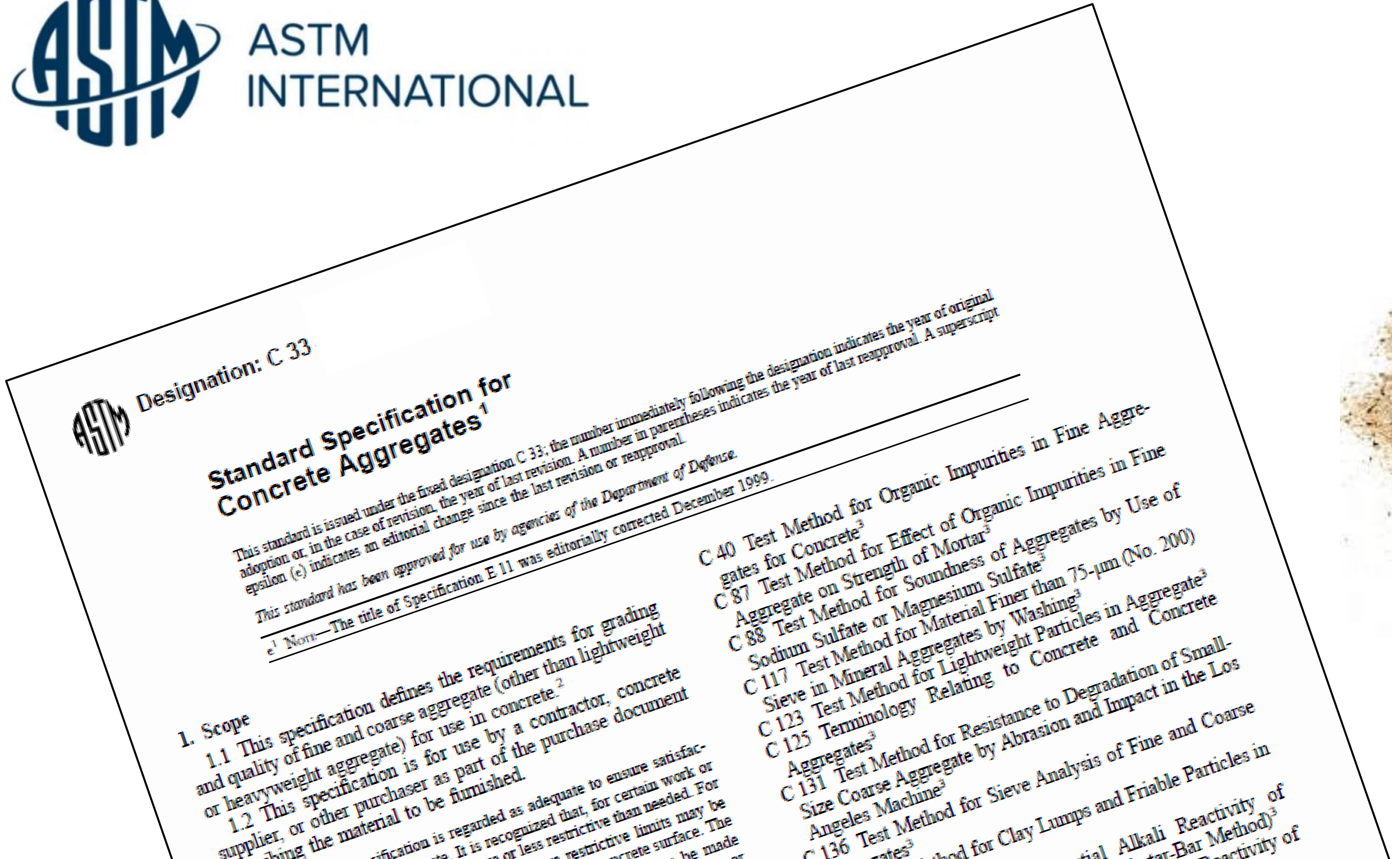
System Sand

https://www.istockphoto.com/photos/sand-pile

System Sand Specification

ASTM C33 – Standard Specification for Concrete Aggregates

ASTM INTERNATIONAL



Designation: C 33

Standard Specification for Concrete Aggregates[1]

This standard is issued under the fixed designation C 33; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ε[1] Note—The title of Specification E 11 was editorially corrected December 1999.

1. Scope

1.1 This specification defines the requirements for grading and quality of fine and coarse aggregate (other than lightweight or heavyweight aggregate) for use in concrete.[2]

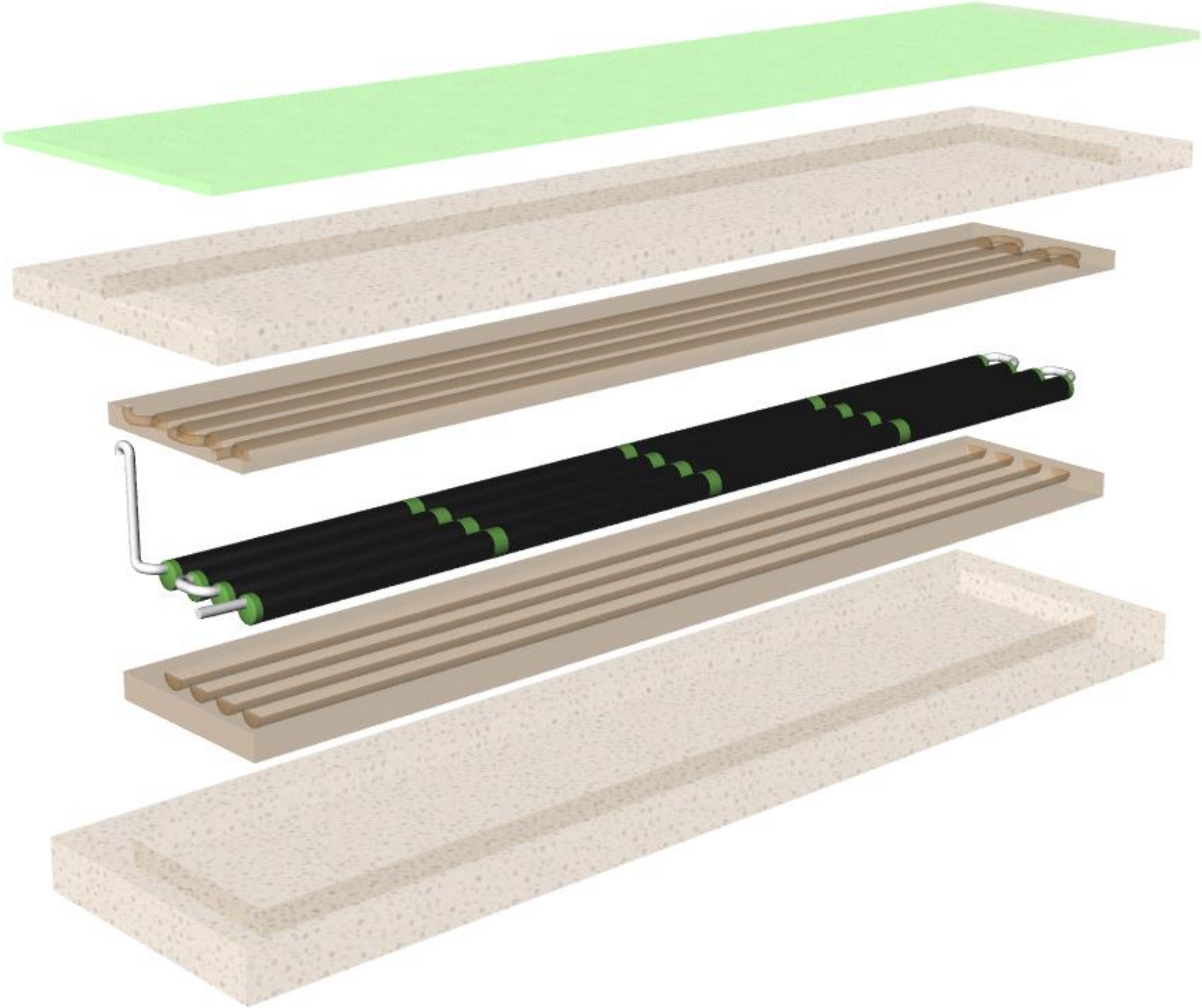
1.2 This specification is for use by a contractor, concrete supplier, or other purchaser as part of the purchase document ...ing the material to be furnished.

C 40 Test Method for Organic Impurities in Fine Aggregates for Concrete[3]
C 87 Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar[3]
C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate[3]
C 117 Test Method for Material Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing[3]
C 123 Test Method for Lightweight Particles in Aggregate[3]
C 125 Terminology Relating to Concrete and Concrete Aggregates[3]
C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine[3]
C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates[3]

System Sand

https://www.istockphoto.com/photos/sand-pile

Typical Expanded View



What are the basic steps for CTD system construction?

Sand Bed Placement

Product Segments Connection

Product Placement on Sand Bed

System May Need to be Staked

Curved Bed Layout with Spacers

Piping Connected

System Sand Placement

Finished Above-Ground System

CTD Treatment Performance
Typical Testing Results

What is Secondary Treatment?

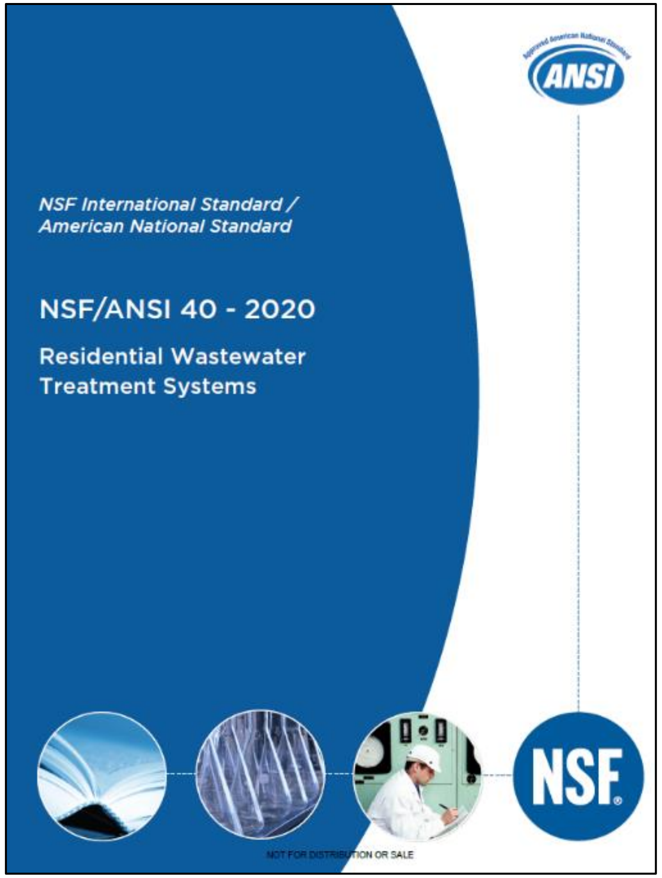
EPA

United States
Environmental Protection

EPA establishes secondary treatment standards for publicly owned treatment works (POTWs), which are minimum, technology-based requirements for municipal wastewater treatment plants. These standards are reflected in terms of ***five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS) removal, and pH****.*

NSF/ANSI 40 Secondary Treatment Standards

NSF/ANSI 40 Parameter	Requirement
5-day carbonaceous oxygen demand	<25 mg/l
Total suspended solids	<30 mg/l
pH	6 to 9



NSF/ANSI 40 Certification and Testing


WASTEWATER TECHNOLOGY

NSF/ANSI Standard 40 - Residential Wastewater Treatment Systems

Final Report:

13/09/055/0030

NSF

NSF/ANSI 40 Testing

- Consistently reduces $CBOD_5$ and TSS concentrations:
  - From day 1
  - Throughout 26-week test

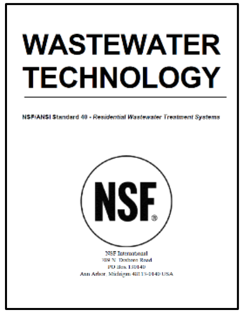
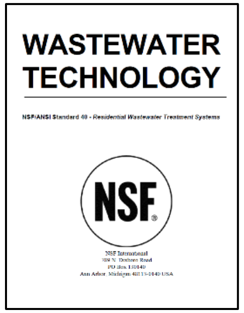


TABLE I. SUMMARY OF ANALYTICAL RESULTS

	Average	Std. Dev.	Minimum	Maximum	Median	Interquartile Range
Biochemical Oxygen Demand (mg/L)						
Influent (BOD_5)	180	52	100	430	160	140 - 200
Effluent ($CBOD_5$)	11	9	2	50	8	6- 14
Total Suspended Solids (mg/L)						
Influent	210	71	45	650	190	170- 230
Effluent	7	3	2	18	6	5 -9
pH						
Influent	-	-	6.0	7.5	6.9	6.8 – 7.2
Effluent	-	-	6.0	7.4	6.5	6.3 – 6.7
Temperature (°C)						
Influent	17	5	8	23	19	13 – 21
Effluent	16	7	2	32	18	10 - 23
Dissolved Oxygen (mg/L)						
Influent	*0.4*	0.4	0.1	2.5	0.2	0.1 – 0.5
Effluent	3.5	1.7	1.0	8.5	3.4	2.0 –4.4



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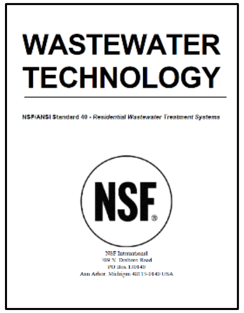

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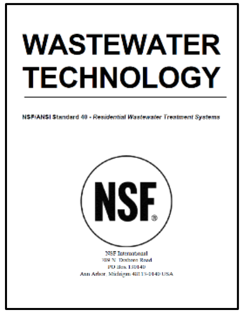
WASTEWATER
TECHNOLOGY
NSF

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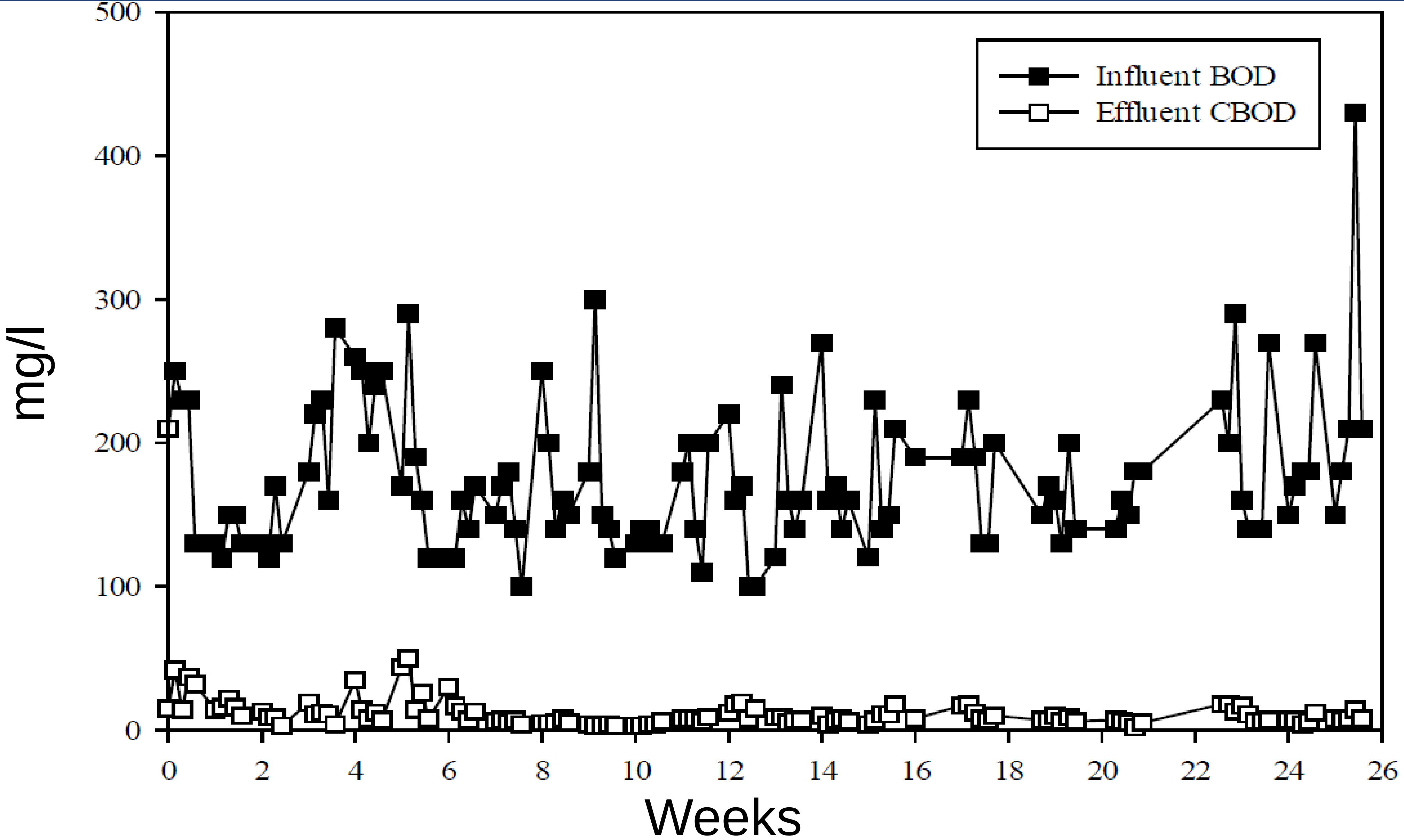
NSF/ANSI 40 Testing

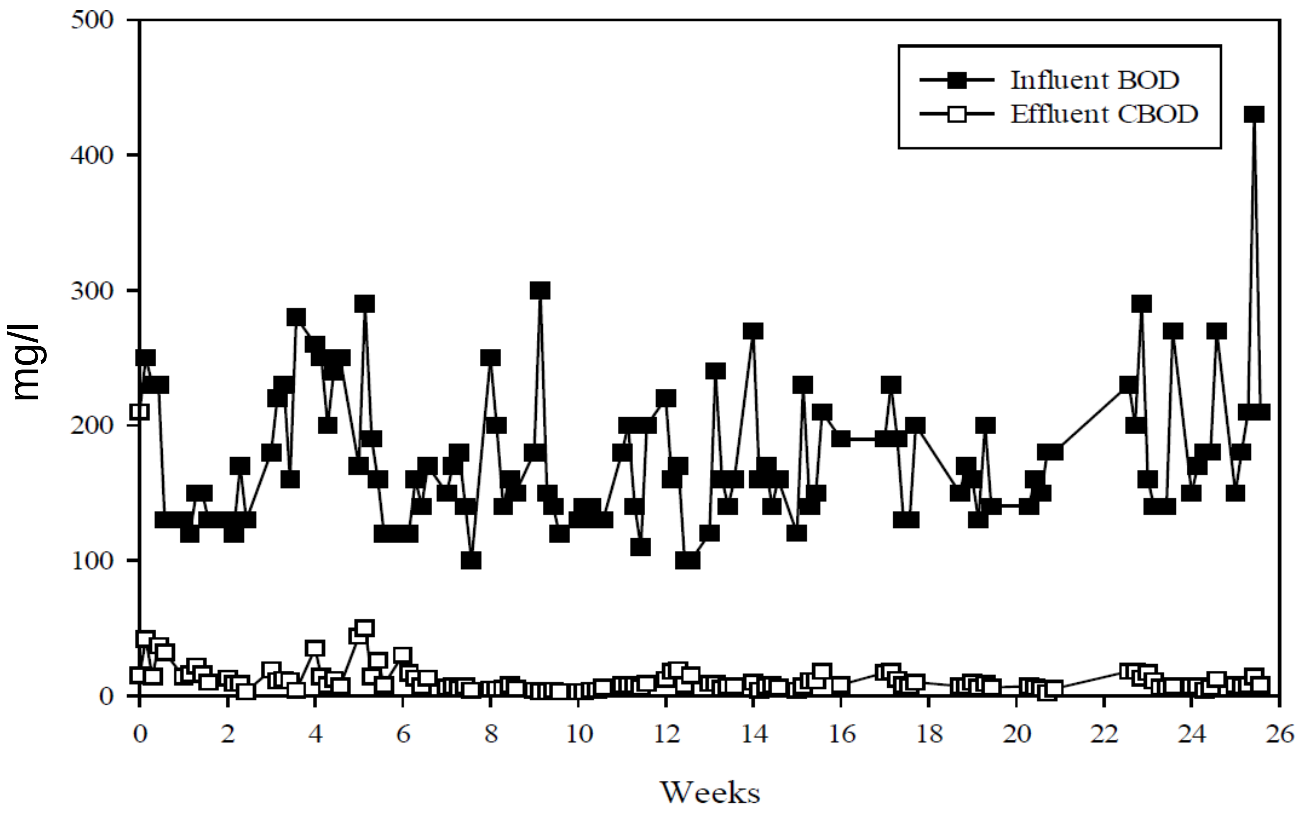
- Fluctuating influent concentrations
- Consistent effluent concentrations

$CBOD_5$ Treatment Performance

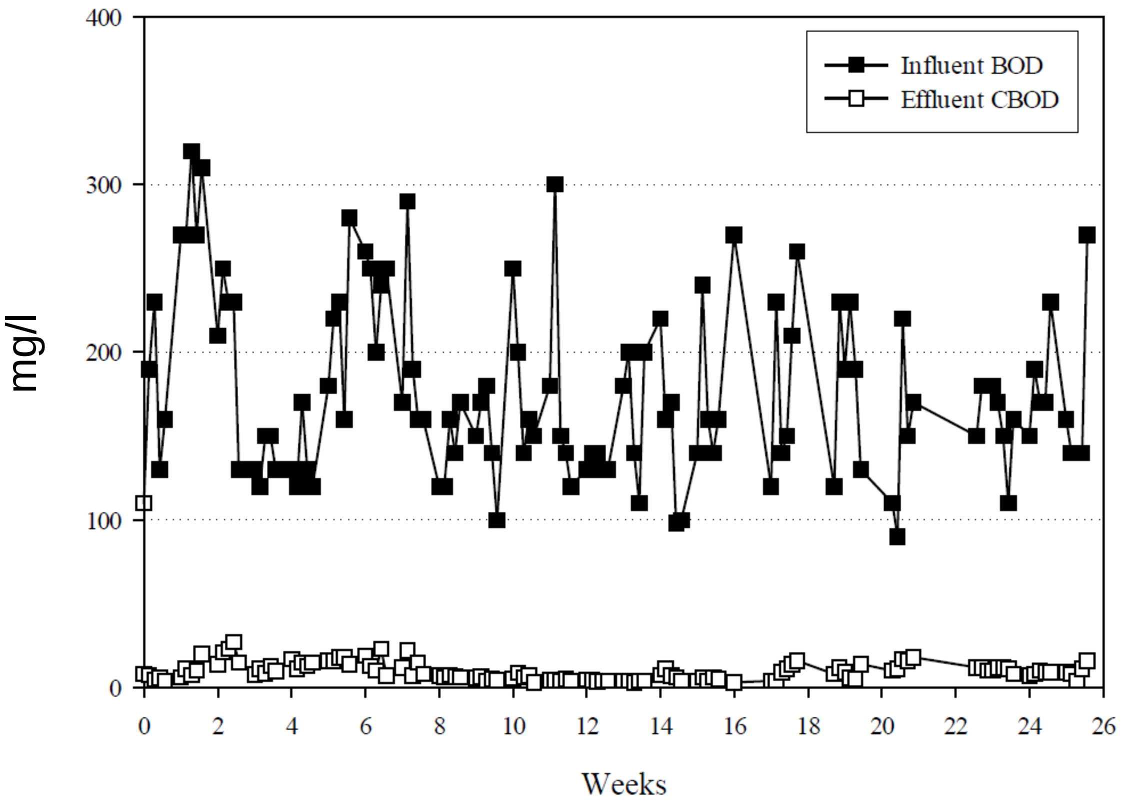


CBOD$_5$ Treatment Comparison

Product A



Product B



NSF/ANSI 40 Testing

- **No start-up period required**
- **Effectiveness is immediate**

Table II. 7- and 30-day Average Effluent $CBOD_5$ and 30-day Average Influent BOD_5

Month	Week	7-day Average Effluent $CBOD_5$ (mg/L)	30-day Average Effluent $CBOD_5$ (mg/L)	30-day Average Influent BOD_5 (mg/L)
1	1	28	17	180
	2	16		
	3	8		
	4	11		
2	5	15	14	170
	6	28		
	7	16		
	8	6		
	9	6		
3	10	3	7	160
	11	4		
	12	8		
	13	14		
4	14	7	9	170
	15	7		
	16	7		
	17	12		
5	18	14	8	160
	19	8		
	20	8		
	21	6		
	22	4		
6	23	16	10	200
	24	9		
	25	7		
	26	9		


WASTEWATER TECHNOLOGY

NSF/ANSI Standard 40 - *Residential Wastewater Treatment Systems*

NSF International
789 N. Dixboro Road
PO Box 130140
Ann Arbor, Michigan 48113-0140 USA

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	2	16		
	3	8		
	4	11		
2	5	15	14	170
	6	28		
	7	16		
	8	6		
	9	6		
3	10	3	7	160
	11	4		
	12	8		
	13	14		
4	14	7	9	170
	15	7		
	16	7		

WASTEWATER TECHNOLOGY

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	3	8		
	4	11		
2	5	15	14	170
	6	28		
	7	16		
	8	6		
	9	6		
3	10	3	7	160
	11	4		
	12	8		
	13	14		
4	14	7	9	170
	15	7		
	16	7		

Missouri Field Performance Study Results

Missouri Field Performance Study

- 30 Presby Advanced Enviro-Septic systems
- Installed principally on Missouri single-family homes
- Study required per Missouri Code of State Regulations
- Objective to assess hydraulic function
- 3- to 8-year-old installations

Missouri Field Performance Study

Three geographical areas:

- Kansas City
- St. Louis
- Branson/Table Rock Lake

Missouri Field Performance Study

- Third-party investigator was Dr. Randall J. Miles, Associate Professor Emeritus, University of Missouri
- Dr. Miles lectured on soil science and agronomy for >30 years
- A Missouri Department of Health and Senior Services representative participated in the field evaluations

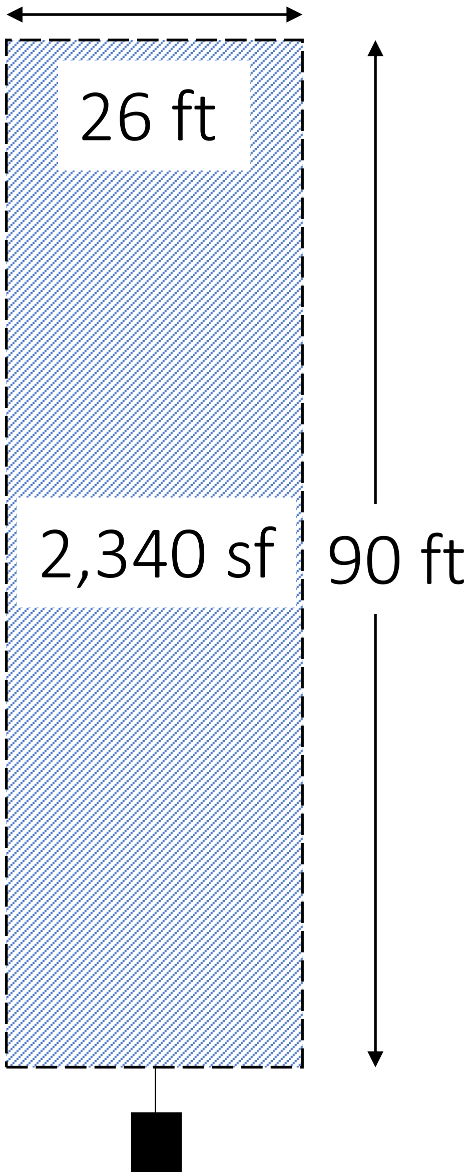
Missouri Field Performance Study

- Two product approvals led to differing installations:
  - **2012 approval** – 50 to 70 ft pipe/bedroom; system sand footprint based upon variable soil loading rates; 6 inches of system sand below pipe
  - **2015 approval** – 50 ft pipe/bedroom; system sand footprint 90% of area required based on soil loading rate; 6 inches of system sand below pipe
- Current product sizing is 70 ft/bedroom and 90% of area required based on soil loading rate (SLR)

Footprint Comparison

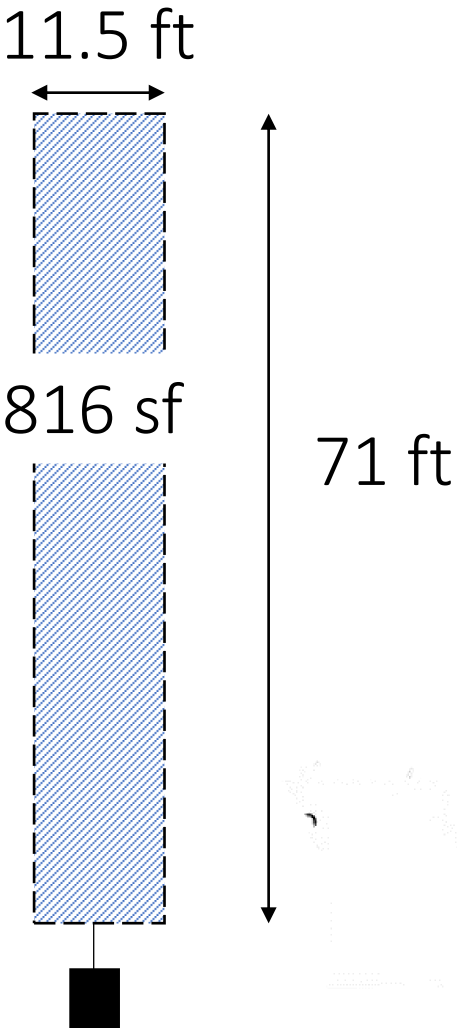
Missouri conventional gravel and pipe trench system

5 trenches
2-ft width
90-ft long
6-ft on-center
In-ground
0.4 gpd/sf soil



Missouri CTD system

1 bed
3 pipe rows
70-ft long
1.5-ft on-center
In-ground
Level site
0.4 gpd/sf soil



Missouri Field Performance Study

- Single non-intrusive, walkover visual assessment
- Assessment indicators:
    - Surfacing effluent
    - Shallow saturated soil in and around installation
    - Effluent odor and staining
- Topographical evaluation of surface flow toward installation
- Occupant interview on past system function

Missouri Field Performance Study

- DHSS requires less than 10% rate of failure
- Per DHHS approval “failure” defined as:

Failure to function properly so as to cause the discharge of untreated or partially treated wastewater onto the ground surface, or back up of effluent into the residence, due to a system design defect.

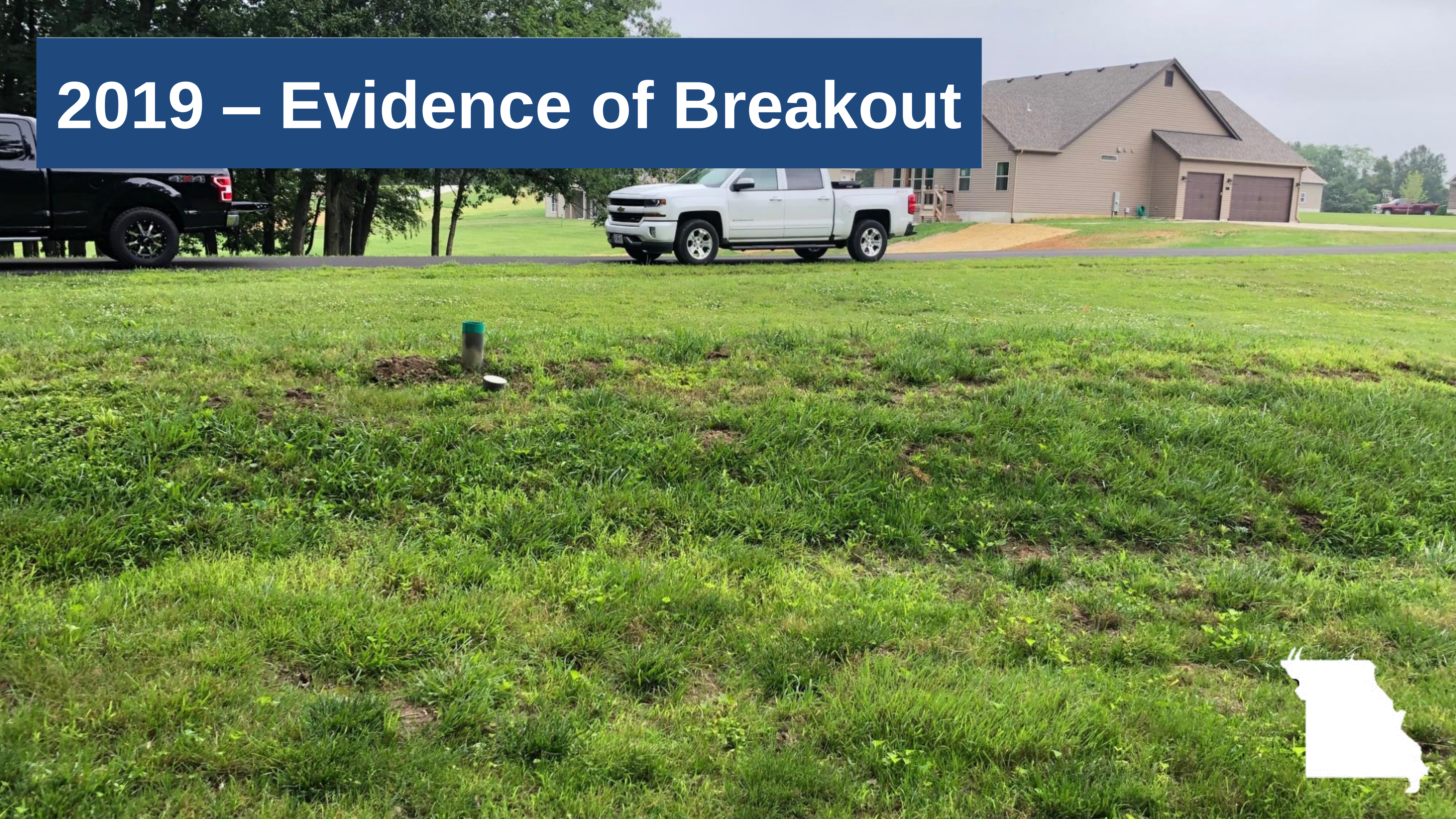
Missouri Field Performance Study

- 29 systems functioning properly
- 1 system deemed to be in a state of failure
    - Design SLR was 0.65 gpd/sf
    - Regional/area SLRs are typically 0.25 to 0.30 gpd/sf
    - System sand footprint may have been undersized
- DHSS issued general-use approval

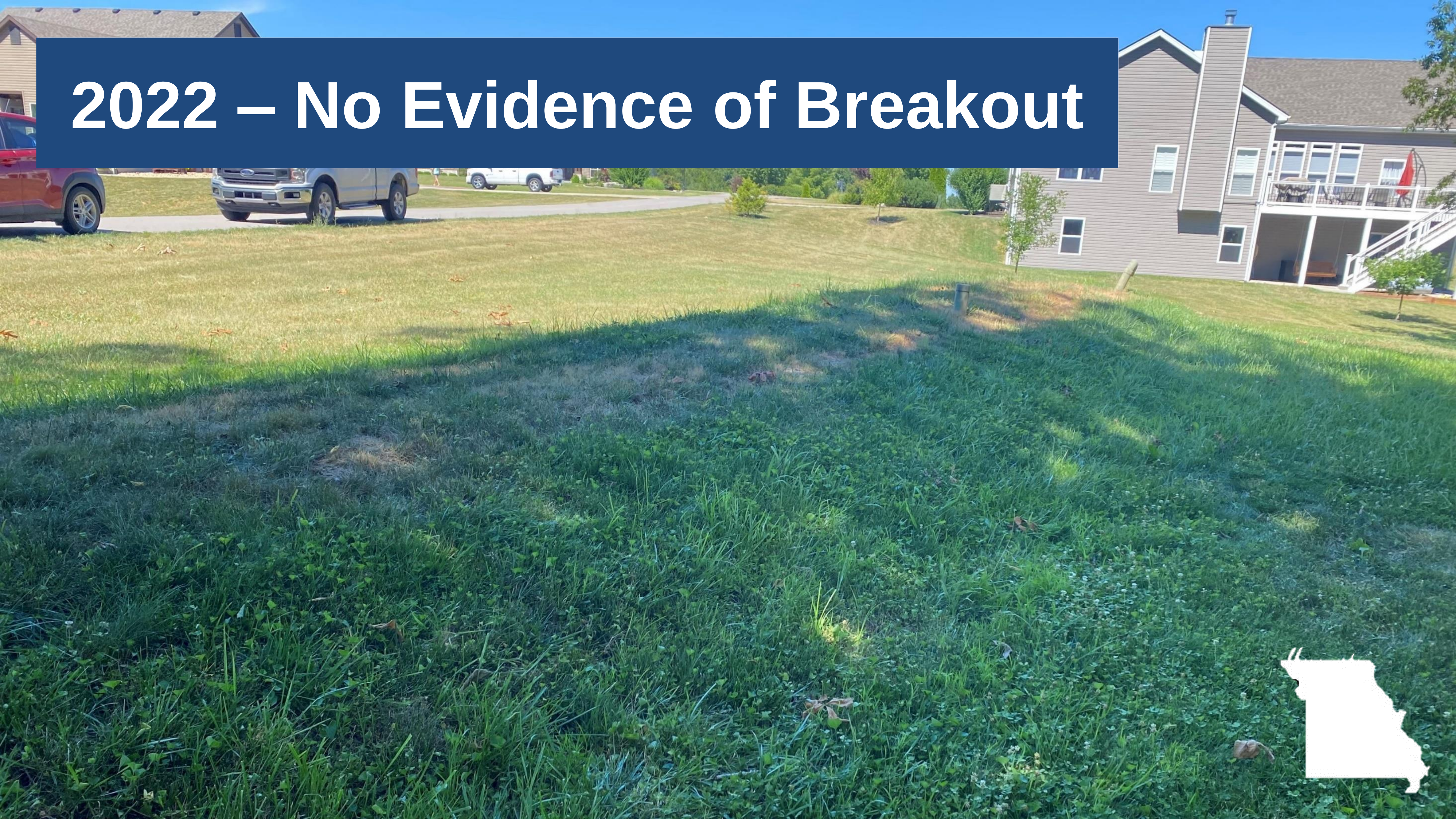
Missouri Study - Lesson Learned

- Installation quality is critical to proper function
    - Side slopes must have correct thickness and taper
    - System sand must be adequately covered with fill
    - Surrounding topography can impact system hydraulics
    - Traffic across the system can impact effluent absorption
    - Upslope vehicle parking increases flow onto system

2019 – Evidence of Breakout



2022 – No Evidence of Breakout



2019 – Improper Installation

2019 – Improper Installation

2019 – Repair Completes Installation

2022 – No Evidence of Breakout

Lessons Learned - Surface Flow Diversion

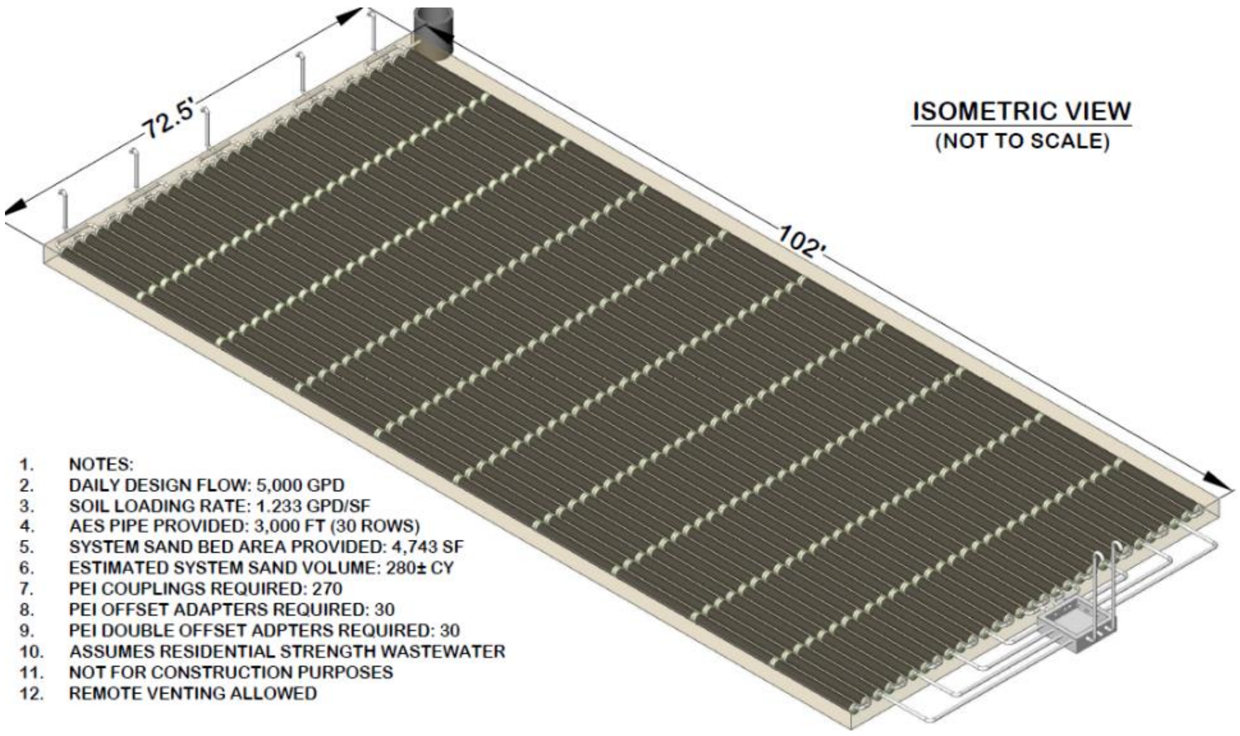
Lessons Learned - Surface Flow Diversion

Lessons Learned - Surface Flow Diversion

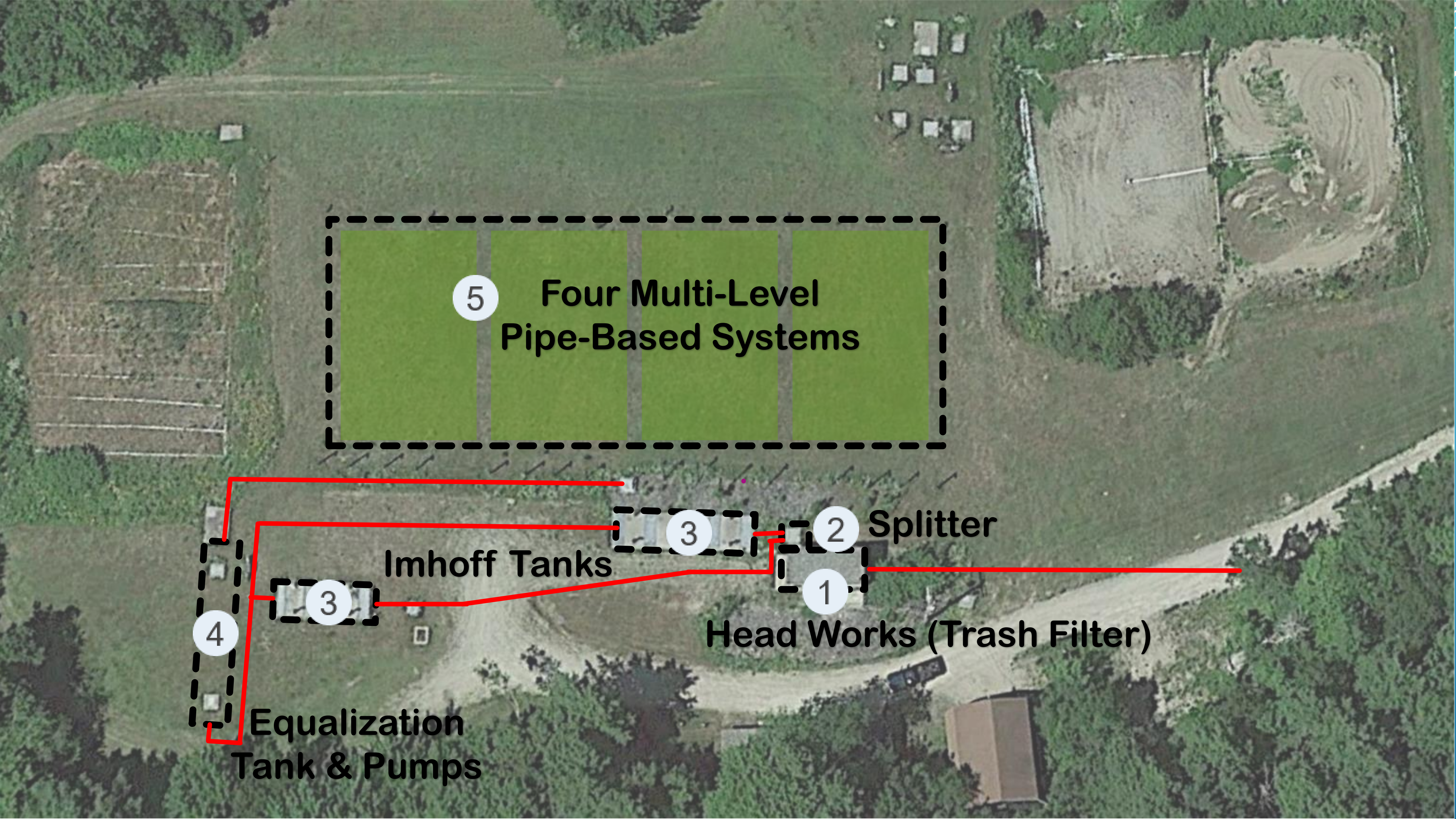
CTD System Case Studies

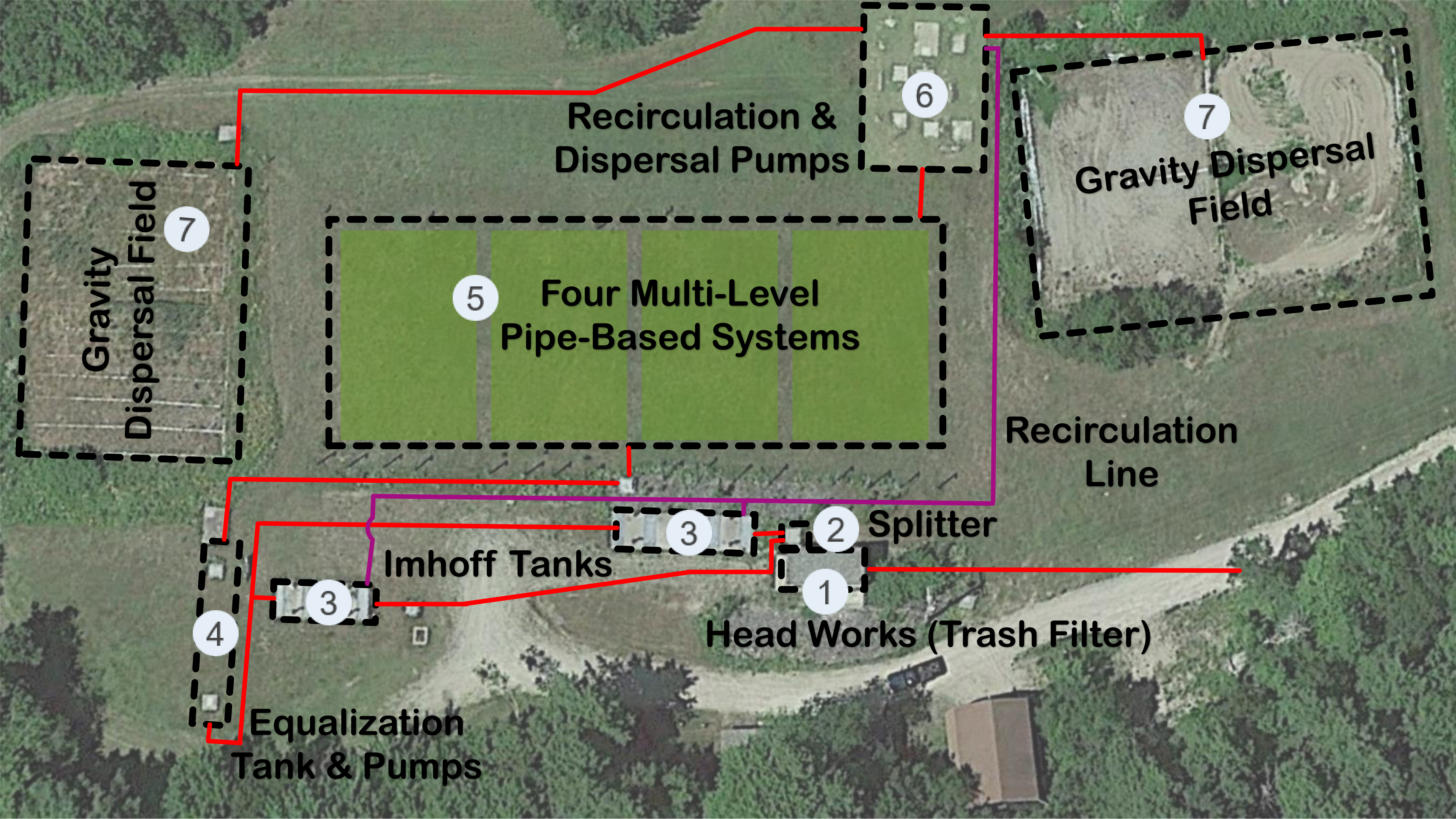
Berkshire East Ski Resort

- 9,900 Gallons Per Day
  - Two beds handling 5,000 GPD each
- Handling facility's domestic wastewater
- Designed to account for future development growth

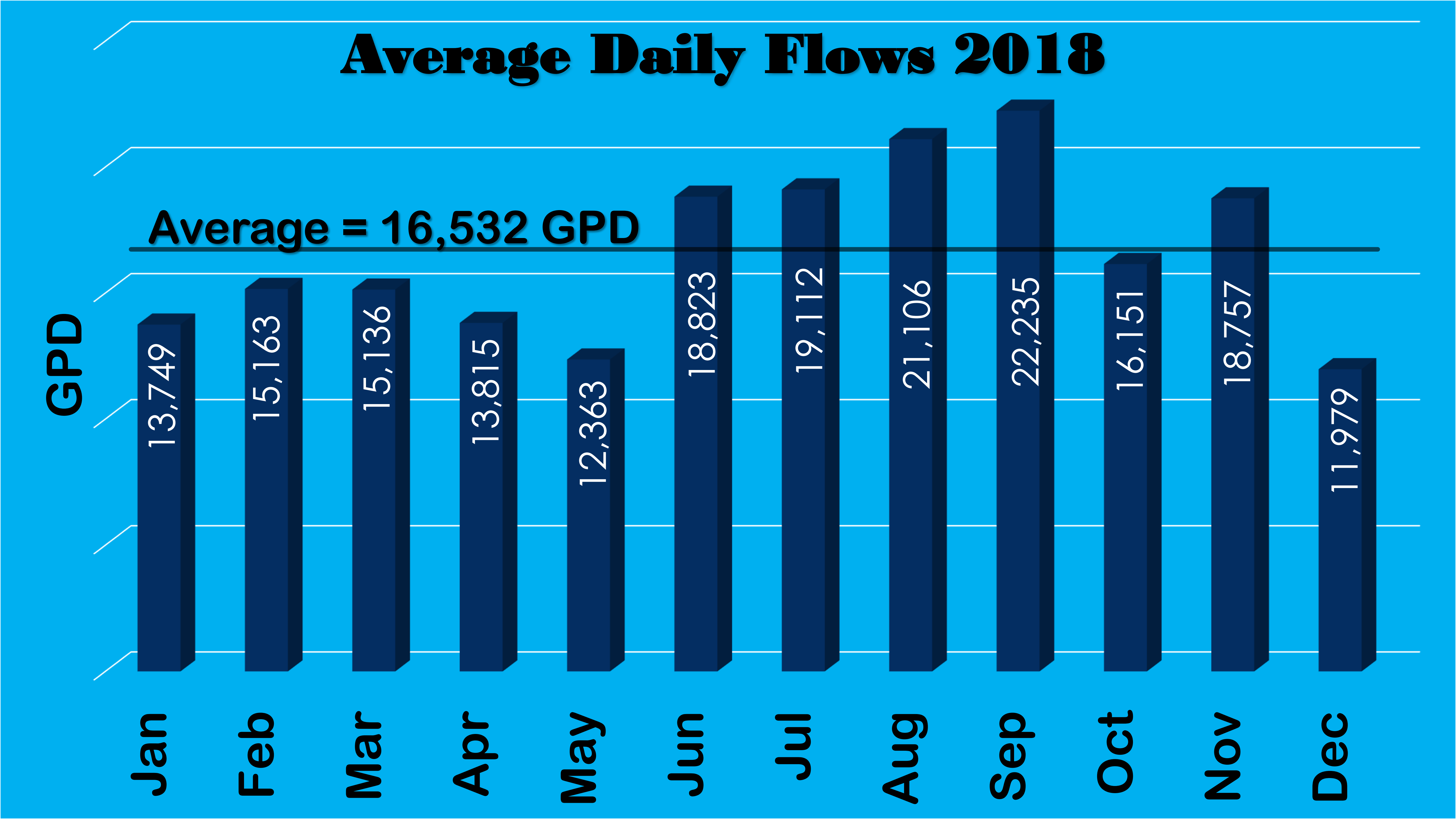


Blodgett Landing, Newbury, NH
50,000 GPD


5
Four Multi-Level
Pipe-Based Systems
2
Splitter
3
3
Imhoff Tanks
1
Head Works (Trash Filter)
4
Equalization
Tank & Pumps



Recirculation &
Dispersal Pumps
6
7
Gravity Dispersal
Field
7
Gravity
Dispersal Field
5
Four Multi-Level
Pipe-Based Systems
Recirculation
Line
3
2
Splitter
Imhoff Tanks
3
1
4
Head Works (Trash Filter)
Equalization
Tank & Pumps



Average Daily Flows 2018
Average = 16,532 GPD
GPD
13,749
15,163
15,136
13,815
12,363
18,823
19,112
21,106
22,235
16,151
18,757
11,979
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Analyte	Average	Units	Change	Analyte	Average	Units	Change
TSS - Influent	119.1	mg/L	-95.7%	Total Nitrogen - Influent	28.70	mg/L	-72.5%
TSS - Effluent	5.14	mg/L		Total Nitrogen - Effluent	7.89	mg/L	
Nitrite - Influent	0.50	mg/L	-1.8%	Total Phosphorous - Influent	4.74	mg/L	-62.4%
Nitrite - Effluent	0.49	mg/L		Total Phosphorous - Effluent	1.78	mg/L	
Nitrate- Influent	1.05	mg/L	575%	BOD5 - Influent	111.41	mg/L	-94.5%
Nitrate - Effluent	7.09	mg/L		BOD5 - Effluent	6.13	mg/L	
Ammonia - Influent	20.56	mg/L	-97.8%	Total Coliform - Influent	295,489,587	CFU/100 mL	99.997%
Ammonia - Effluent	0.46	mg/L		Total Coliform - Effluent	7,931	CFU/100 mL	
TKN - Influent	27.85	mg/L	-93.9%	Fecal Coliform - Influent	11,917,611	CFU/100 mL	99.983%
TKN - Effluent	1.70	mg/L		Fecal Coliform - Effluent	2,072	CFU/100 mL	

Analyte	Average	Units	Change	Analyte	Average	Units	Change
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Paradise, CA 100,000 GPD

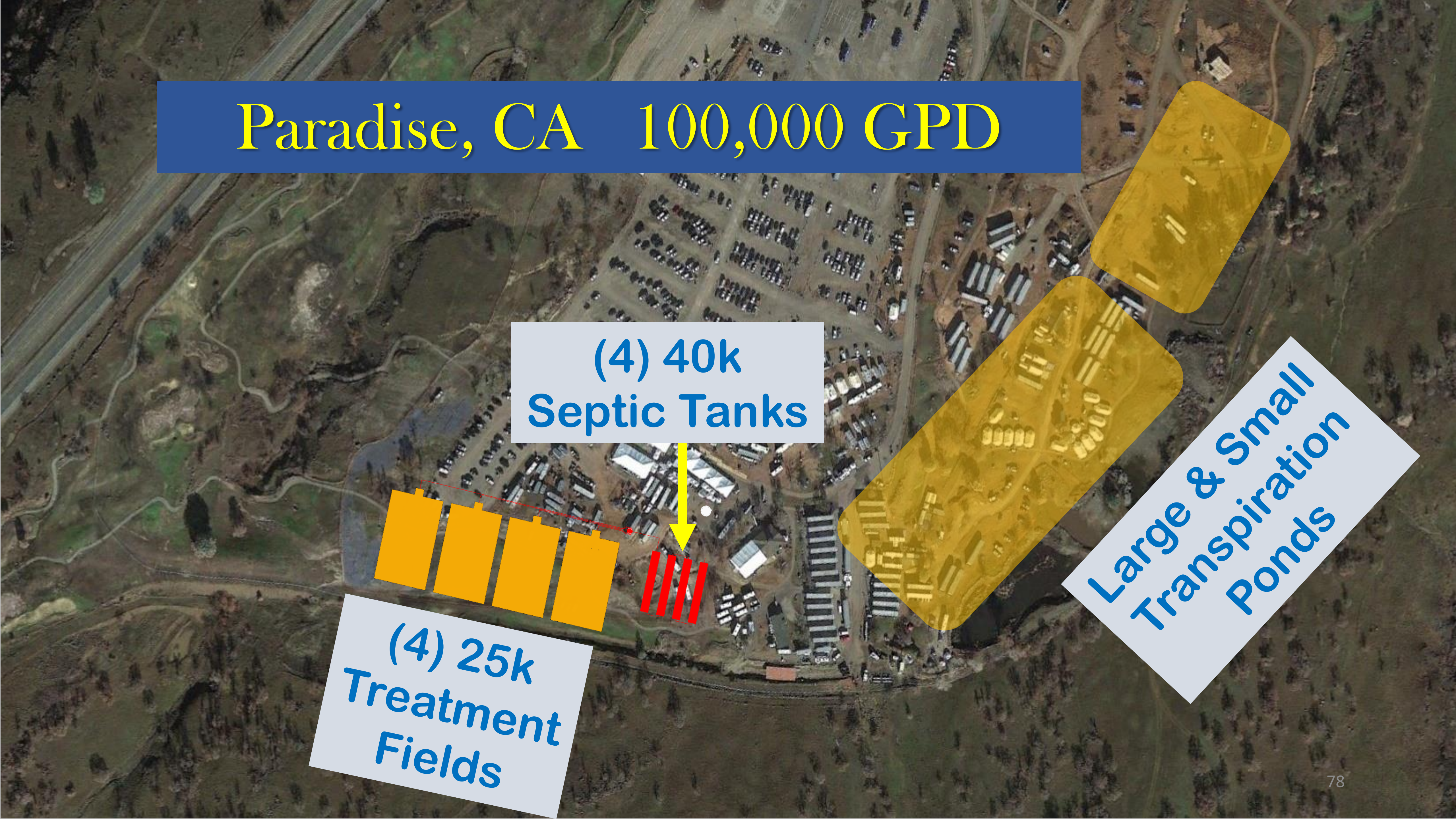
Paradise, CA

2018

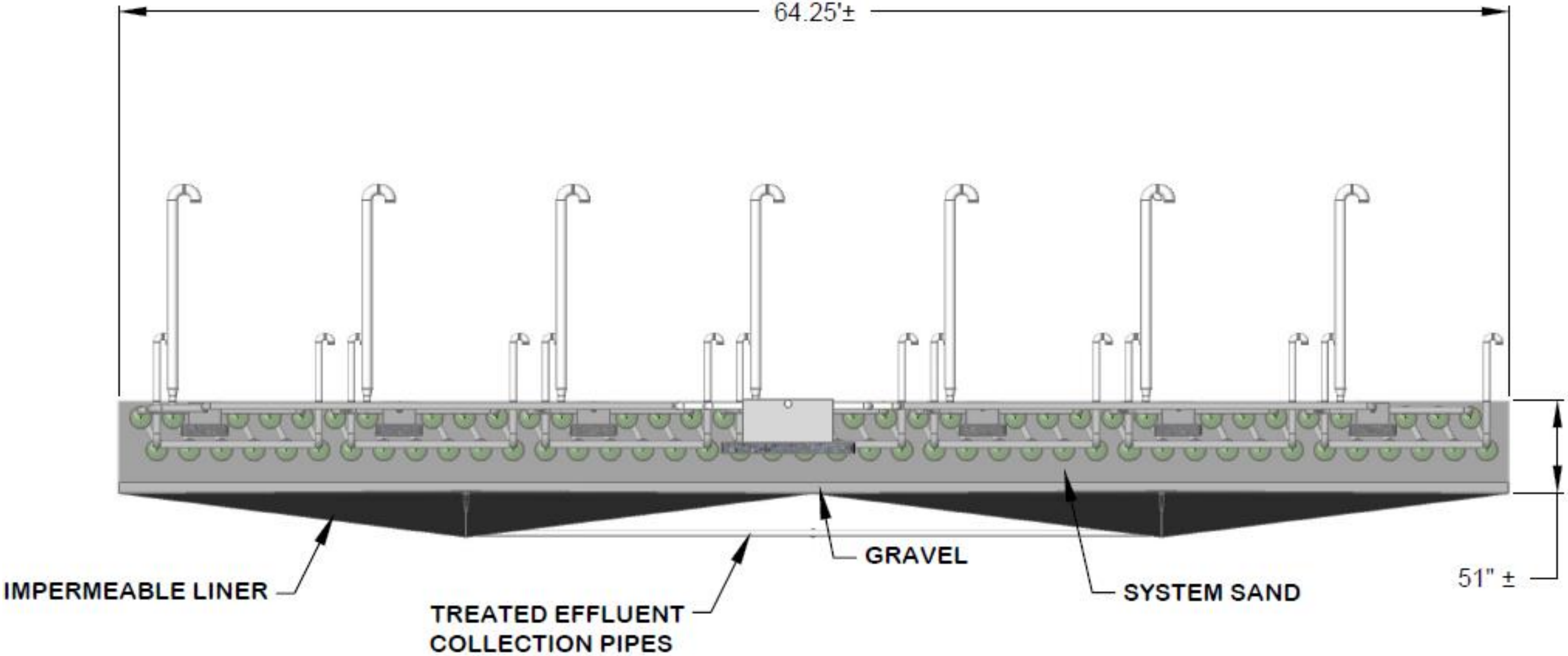
California 100,000 gpd FEMA Installation

- FEMA worker base camp
- Over 1,500 workers
- Kitchens and laundry facilities
- Largest CTD system to date
- 100,000 gallons per day
- Adapted for nutrient reduction

FEMA Base Camp

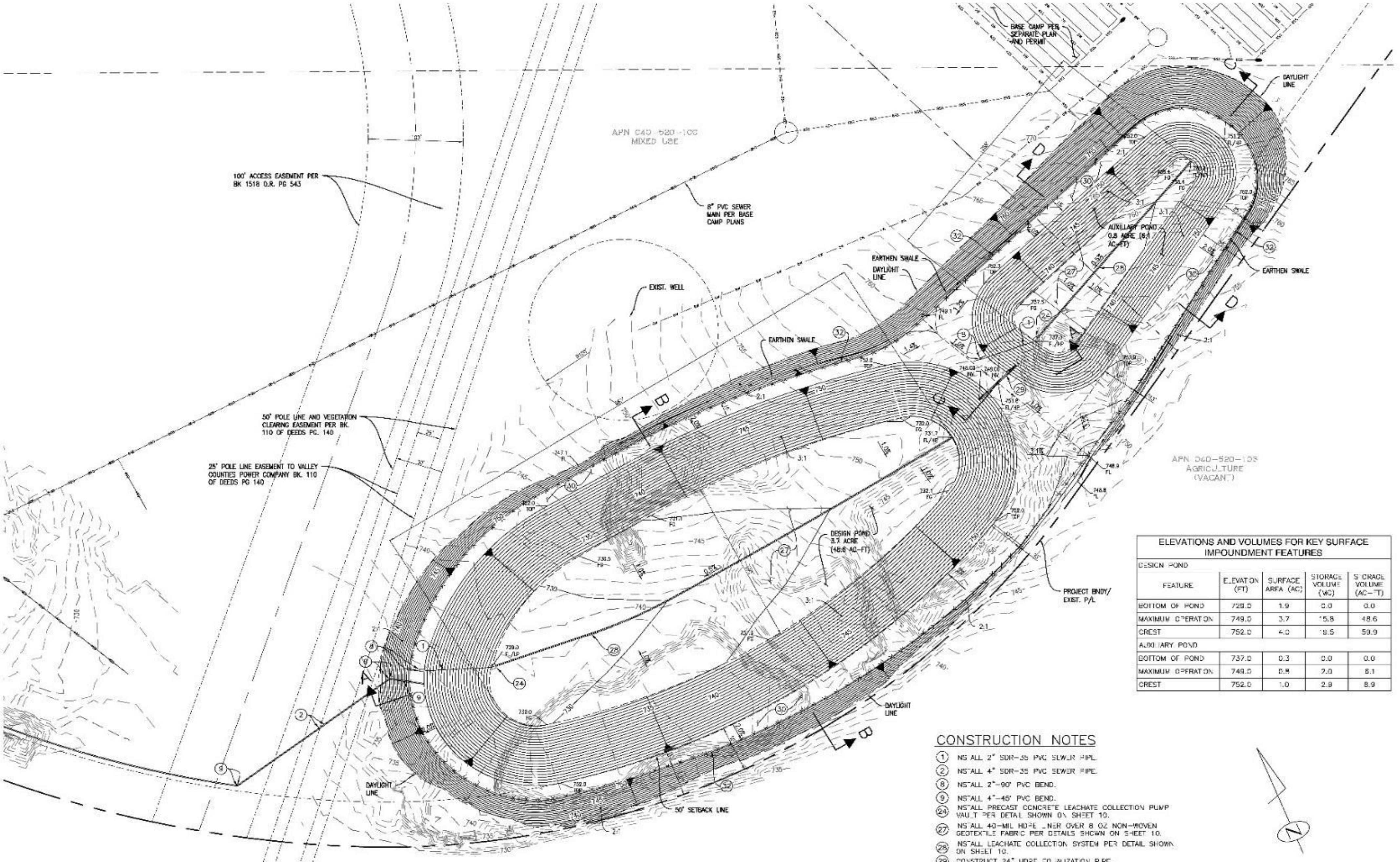


Paradise, CA 100,000 GPD
(4) 40k
Septic Tanks
(4) 25k
Treatment
Fields
Large & Small
Transpiration
Ponds



Near End View

SCALE: 1" = 100'



ELEVATIONS AND VOLUMES FOR KEY SURFACE IMPOUNDMENT FEATURES				
DESIGN POND				
FEATURE	ELEVATION (FT)	SURFACE AREA (AC)	STORAGE VOLUME (MG)	STORAGE VOLUME (AC-FT)
BOTTOM OF POND	729.0	1.9	0.0	0.0
MAXIMUM OPERATION	749.0	3.7	15.8	48.6
CREST	752.0	4.0	19.5	59.9
AUXILIARY POND				
BOTTOM OF POND	737.0	0.3	0.0	0.0
MAXIMUM OPERATION	749.0	0.8	2.0	6.1
CREST	752.0	1.0	2.9	8.9

CONSTRUCTION NOTES

(1) INSTALL 2" SDR-35 PVC SEWER PIPE.

(2) INSTALL 4" SDR-35 PVC SEWER PIPE.

(8) INSTALL 2"-90° PVC BEND.

(9) INSTALL 4"-45° PVC BEND.

(24) INSTALL PRECAST CONCRETE LEACHATE COLLECTION PUMP VAULT PER DETAIL SHOWN ON SHEET 10.

(27) INSTALL 40-MIL HDPE LINER OVER 8 OZ NON-WOVEN GEOTEXTILE FABRIC PER DETAILS SHOWN ON SHEET 10.

(28) INSTALL LEACHATE COLLECTION SYSTEM PER DETAIL SHOWN ON SHEET 10.

(29) CONSTRUCT 24" HDPE EQUALIZATION PIPE.

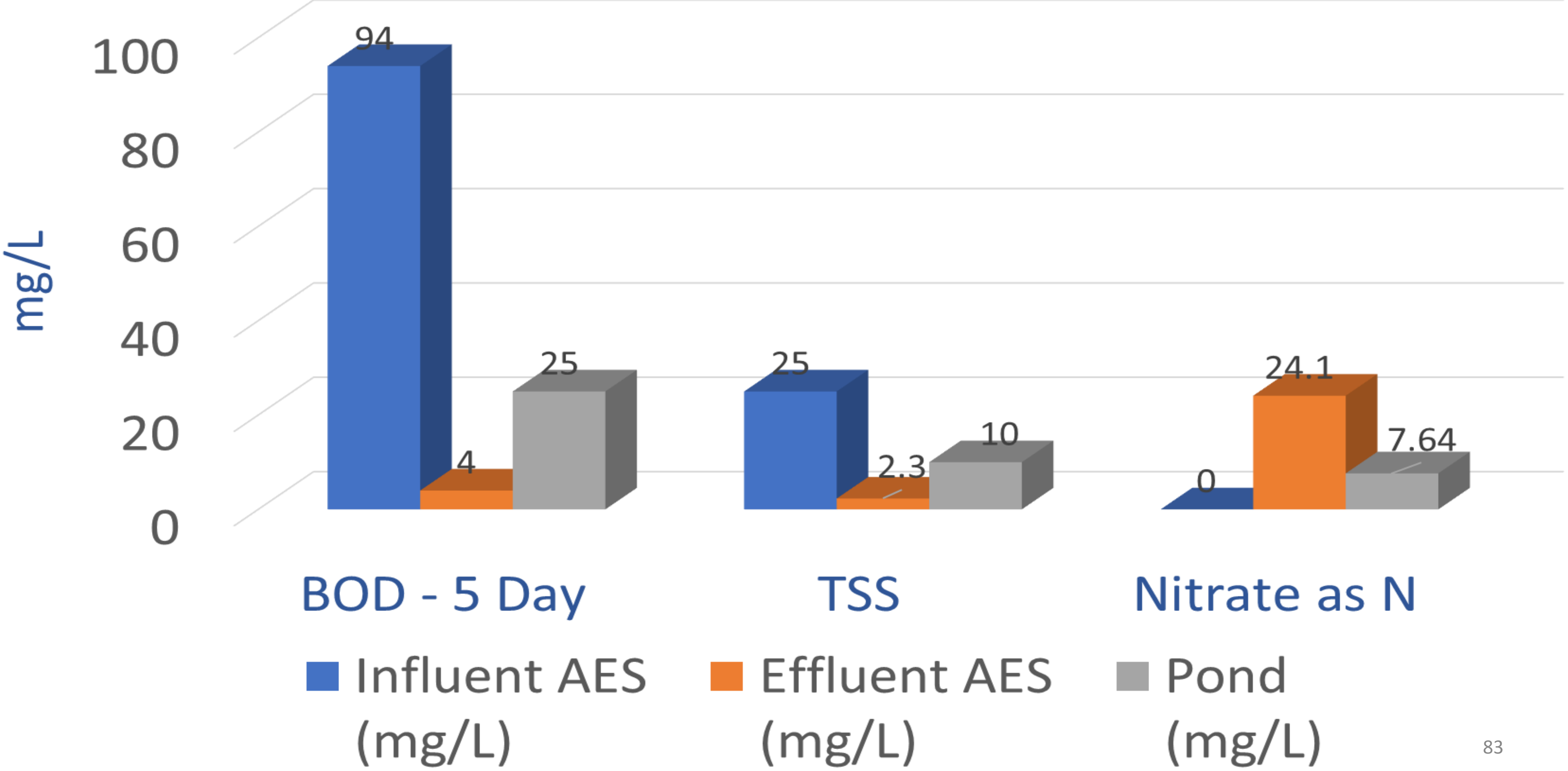
(30) CONSTRUCT 4" THICK MIN. GRAVEL ACCESS ROAD OVER COMPACTED BASE (WIDTH PER PLAN).

(32) INSTALL 6' HIGH CHAIN LINK FENCE WITH 3 ROWS OF BARBED WIRE.

(33) INSTALL 12' WIDE CHAINLINK DOUBLE SWING GATE.


SUPERIOR

System Performance Data



Thank You for Attending!

CTD Technology Summary

- Promotes wastewater reclamation
- Reduces energy demand
- Performs reliably and consistently
- Proven longevity
- Functions in all climates
- Smaller footprint vs. legacy systems

INFILTRATOR
water technologies

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