

Retrofitting a Lime Doser with Automatic Siphon and MixWell System

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Special thanks to Madison Ball, FOC Monitoring Coordinator

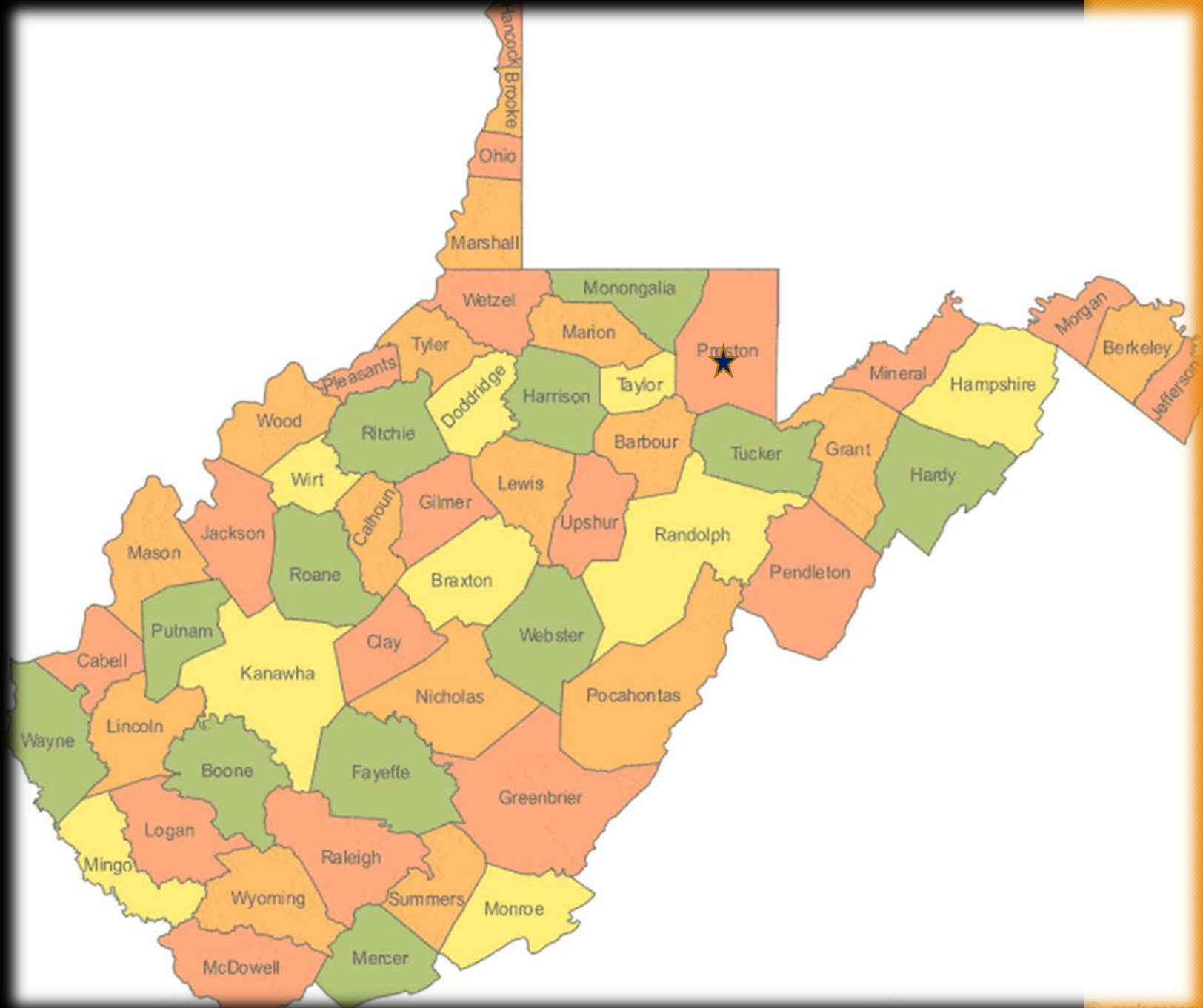
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Presentation Outline (How it works)

- Site location
- Existing treatment system overview
- Project goals & objectives
- Improved treatment design
- System operation
- System performance evaluation
- Operation & maintenance to date
- Crystal ball estimates

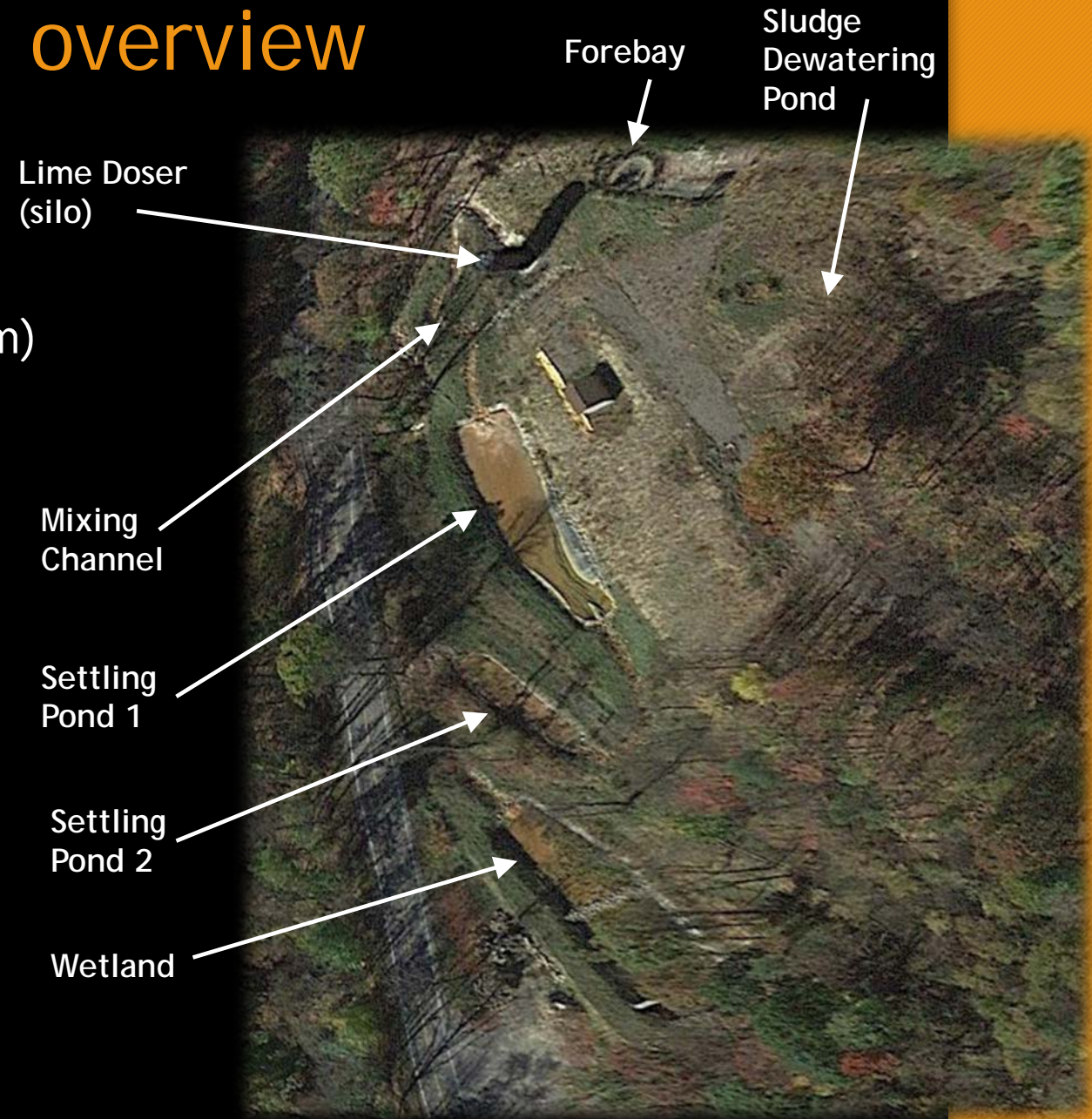
Site Location

- Friends of the Cheat
-Pase Site
-Active Treatment Improvements
- Preston County
West Virginia
Route 26
2 miles north of Tunnelton
- 39.409235, -79.763516

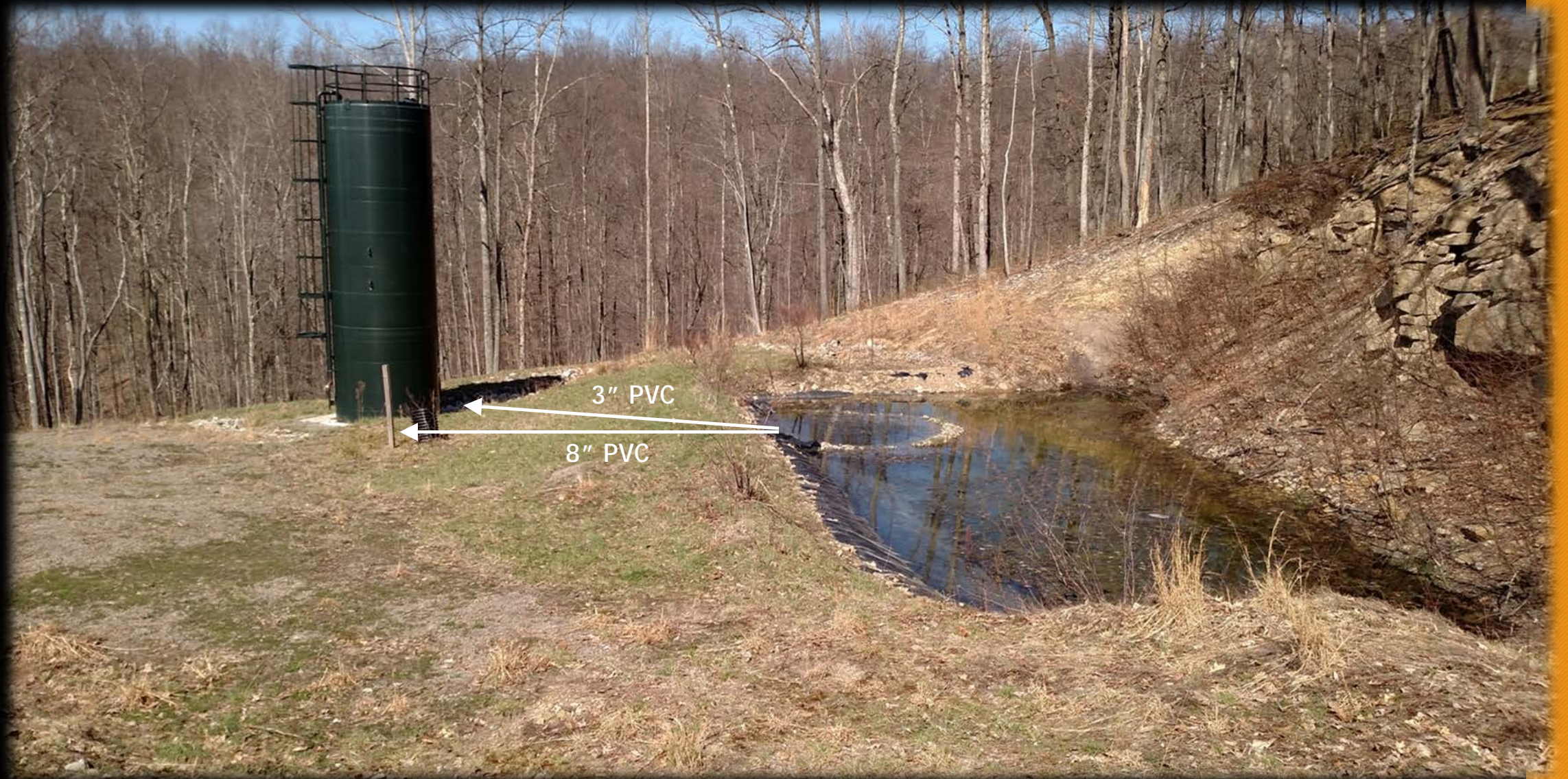


Existing treatment system overview

- 2012 Reconstruction (replaced passive system)
- Forebay (collection pond)
- Lime doser with silo
- Mixing channel
- Settling pond 1
- Settling pond 2
- Wetland
- Sludge dewatering pond



Existing Forebay & Silo



Existing Lime Doser

Feed Rate Control



Existing Mixing Channel & Settling Pond 1

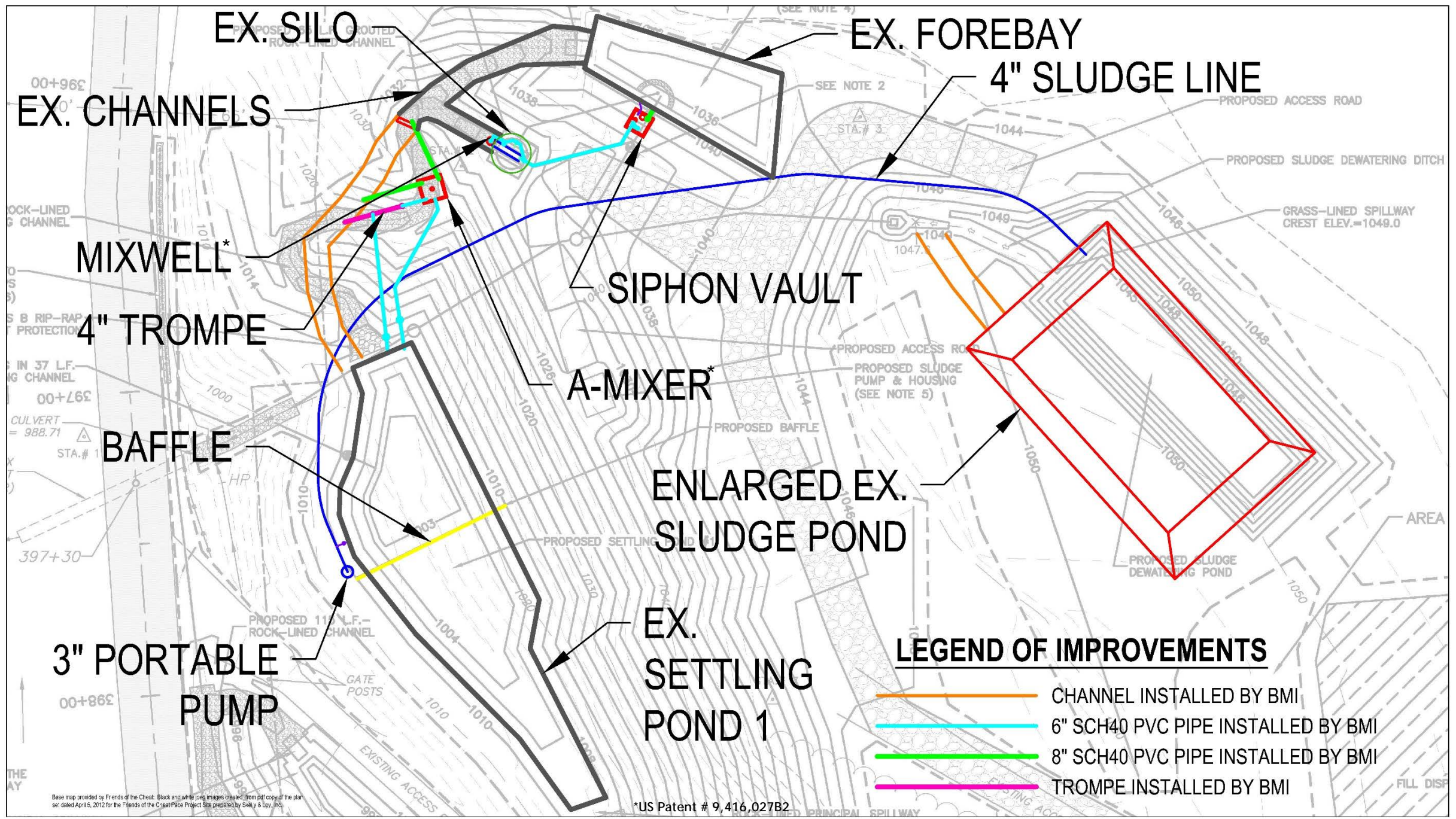


Improvement Project Goals & Objectives

- Goal: Improve treatment effectiveness
- Objectives:
 - 1) Reduce overtreatment/undertreatment (simplify operation)
 - 2) Improve lime utilization
 - 3) Reduce sludge generation
 - 4) Provide sludge removal system (rehab/clean SP1 & SP2)
 - 5) Improve existing settling ponds (including baffle & road)

Improved Treatment Design

- Forebay - Automatic dosing siphon (cycle on/off)
- “Constant Head” feed rate control
- MixWell*
- Use existing upper mixing channel (grouted)
- A-Mixer* (trompe-powered airlift mixer)
- Rebuild lower mixing channel
- Add baffle to Settling Pond 1
- Pump out Settling Ponds 1 & 2
- Permanent sludge line (with portable pump)
- Portable industrial power snake



EX. SILO

EX. FOREBAY

4" SLUDGE LINE

EX. CHANNELS

MIXWELL*

SIPHON VAULT

4" TROMPE

A-MIXER*

BAFFLE

ENLARGED EX. SLUDGE POND

3" PORTABLE PUMP

EX. SETTLING POND 1

LEGEND OF IMPROVEMENTS

- CHANNEL INSTALLED BY BMI
- 6" SCH40 PVC PIPE INSTALLED BY BMI
- 8" SCH40 PVC PIPE INSTALLED BY BMI
- TROMPE INSTALLED BY BMI

Base map provided by Friends of the Cheat. Black and white jpg images created from pdf copy of the plan set: dated April 6, 2012 for the Friends of the Cheat Place Project Site prepared by Siskiy & Loy, Inc.

*US Patent # 9,416,027B2

System Operation

- Siphon used as forebay outlet to provide periodic "constant" flow rate (cycle on/off)
- Model 523 Automatic Dosing Siphon (230 gpm minimum rated flow)
- 5" diameter
- 23" drawdown



System Operation

- Added 6" siphon bypass to facilitate calibration
- Includes 6" overflow
- Includes 1" trigger



System Operation

- Siphon outlets to silo
- Air vents at inlet and outlet of piping in silo
- Weep drain to prevent freezing



System Operation

- Small portion of water used to control tipping rate (2" PVC gate valve)
- Doser lime apertures set to maximum (limited to opening size at which lime will freely flow)



System Operation

- Majority of flow directed to 6" MixWell center pipe
- Lime is flushed into top of MixWell
- Baffle directs lime to bottom
- Center pipe nozzle outlet at bottom of MixWell restricts flow to about 140 GPM (to match trompe capacity)
- *More info on MixWells: Leavitt et al., 2012. WVMDTF*



System Operation



- Flows from MixWell* via channel to A-Mixer*
- Trompe is primary outlet of A-Mixer*
- Trompe discharges back to channel to Settling Pond 1
- A-Mixer has 8" overflow
- *More info on A-Mixer*:
Leavitt et al., 2012.
WVMDTF*

System Operation

- A-Mixer* has central 12" lift pipe held above tank floor
- Air is released from 1" pipe just above bottom of 12" pipe
- Tank has 6" drain

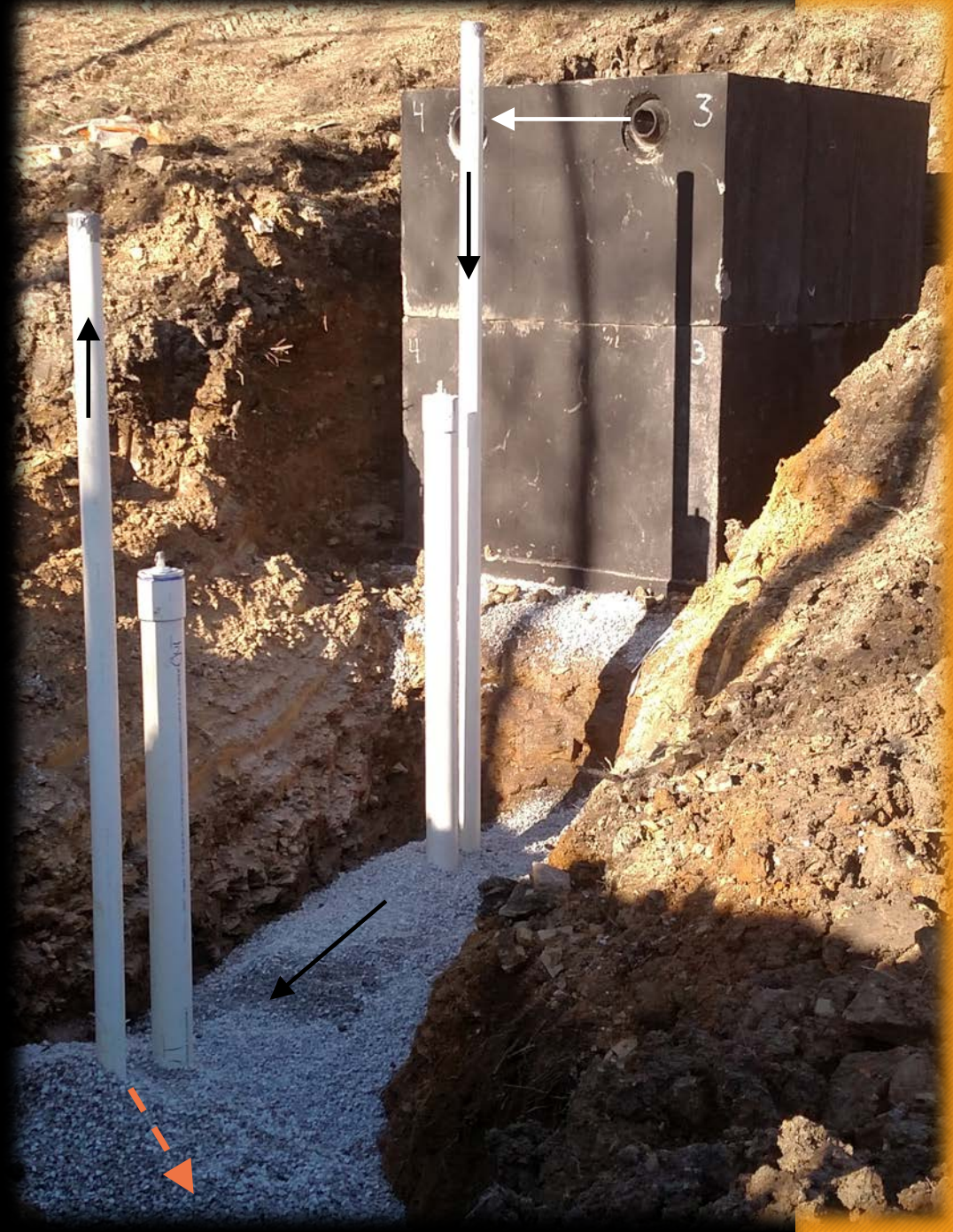


System Operation



System Operation

- 4" Trompe (downpipe size)
- Dual 6" air chambers have common 1" air line to A-Mixer*
- Includes drain extending from bottom of uppipe (outlet side)
- *More info on trompes: Leavitt 2011, WVMDTF*



System Operation



A-Mixer*

2.5 CFM air

~750 GPM water

System Operation



- Permanent 4" PVC sludge line
- Riser to hookup 3" Gorman Rupp 10D1-GX270 pump (~300 gpm at 54' TDH)
- 3" drain/chase water port

System Performance Evaluation

- Sampled: Raw, MixWell, and A-Mixer (at trompe)
- 1/24/18 – System cycling on/off (total inflow <140 gpm)
 - All flow during “on” cycle measured at trompe = 125 gpm (near end of cycle)
- 2/22/18 – System running constantly (total inflow >140 gpm)
 - Portion of water bypassing siphon and discharging via Forebay spillway
 - Mixing with treated water from MixWell before A-Mixer
 - Trompe 141 gpm + A-Mixer Overflow 55 gpm = 196 gpm
 - Confirmed flow at SP1 with 90° V-notch weir with staff gauge = 208 gpm
- System designed for ~85th percentile flow
 - When inflow >140 gpm, feed rate needs to be increased to account for Forebay overflow



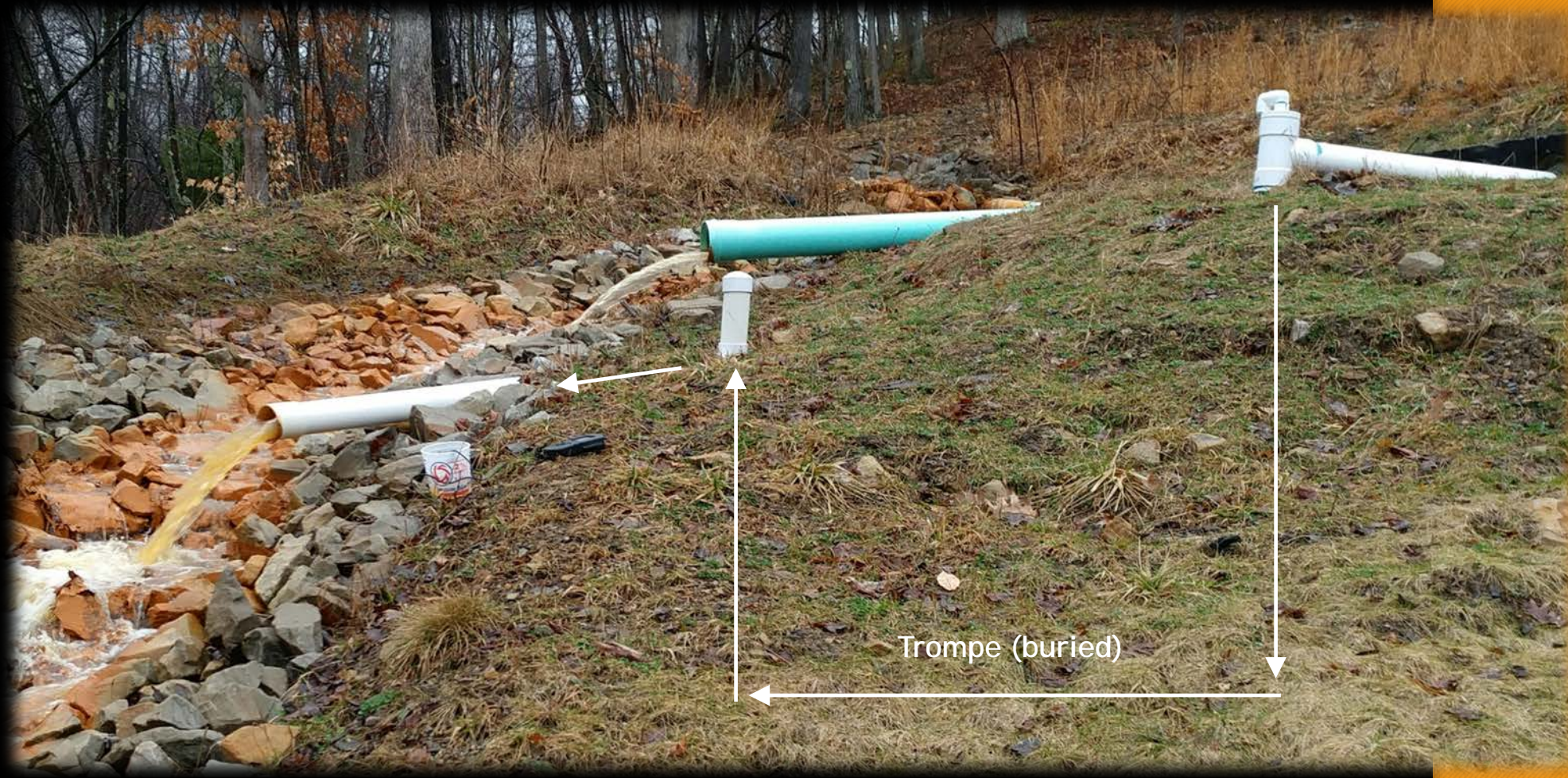
System Performance Evaluation

- Captured lime at both spouts and counted "tips" (lb/tip)
- Evacuated & sealed bags and weighed within 24 hr
- Timed tips (tip/min)



System Performance Evaluation

- Bucket & stopwatch at trompe & overflow (if flowing)
- Sampled A-Mixer at Trompe outlet



System Performance Evaluation

| Date | Point | Field pH s.u. | Lab pH s.u. | (Hot) Acidity mg/LCaCO ₃ | Sulfate mg/L | T.Fe mg/L | D.Fe mg/L | T.Mn mg/L | D.Mn mg/L | T.Al mg/L | D.Al mg/L | T.Ca mg/L | D.Ca mg/L | T.Mg mg/L | D.Mg mg/L | Acid Load lb/d CaCO ₃ | ΔAcid Load lb/d CaCO ₃ | Lime Feed lb/d CaCO ₃ | Lime Feed lb/d CaO |
|---------|---------|------------------|----------------|--|-----------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--|---|--|--------------------------|
| 1/24/18 | Raw | 3.05 | 2.80 | 238 | 419 | 9.6 | 9.1 | 2.2 | 2.1 | 22.5 | 21.9 | 35.6 | 33.4 | 27.3 | 26.7 | 357 | 0 | 459 | 274 |
| | MixWell | 5.13 | 8.76 | -78 | 390 | 9.7 | 0.0 | 2.2 | 1.7 | 24.2 | 2.6 | 204.1 | 121.9 | 28.3 | 26.9 | -116 | 473 | | |
| | A-Mixer | 10.15 | 8.56 | -52 | 400 | 10.2 | 0.2 | 2.3 | 0.1 | 23.7 | 2.3 | 157.5 | 129.4 | 29.5 | 21.9 | -78 | 435 | | |
| 2/22/18 | Raw | 3.04 | 2.63 | 461 | 628 | 52.3 | 52.2 | 4.2 | 4.1 | 36.1 | 35.8 | 31.3 | 29.6 | 31.9 | 31.2 | 1086 | 0 | 1600 | 953 |
| | MixWell | 6.41 | 6.80 | -1 | 616 | 52.3 | 1.2 | 4.2 | 3.3 | 38.7 | 15.3 | 220.9 | 146.0 | 31.5 | 30.2 | -1 | 1087 | | |
| | A-Mixer | 8.91 | 7.78 | -22 | 640 | 53.4 | 0.0 | 4.2 | 1.9 | 37.9 | 0.0 | 190.1 | 176.7 | 31.4 | 28.2 | -51 | 1137 | | |

Lime Feed CaO = Actual measured lime material [pebble quicklime (potentially partially hydrated? - last load received 8/11/17)].

Lime feed CaCO₃ = Adjusted for 94% purity and 0.56 conversion factor.

Note that the lime feed rate assumes constant flow. No lime is fed when cycle is off during Forebay refill (i.e. if actual flow was 75 gpm 1/24/18, actual feed would be 94 lb/day)

Flow measured at A-Mixer (trompe outlet & overflow): 1/24/18 125 gpm & 2/22/18 196 gpm.

1/24/18 Estimated efficiency: 95% (Δ Acid load) or 79% (Δ D. Ca/T. Ca)

2/22/18 Estimated efficiency: 71% (Δ Acid load) or 93% (Δ D. Ca/T. Ca)

“Overall estimated efficiency” about 85%

Estimated Efficiency (71% - 95% or 85% "ish")

| Date | Point | Flow gpm | Lab pH s.u. | (Hot) Acidity mg/LCaCO ₃ | T.Ca mg/L | ΔT.Ca mg/L | D.Ca mg/L | ΔD.Ca mg/L | Acid Load lb/d CaCO ₃ | ΔAcid Load lb/d CaCO ₃ | Lime Feed lb/d CaCO ₃ | Lime Feed lb/d CaO |
|---------|---------|-------------|----------------|--|--------------|---------------|--------------|---------------|--|--|---|-----------------------------|
| 1/24/18 | Raw | - | 2.80 | 238 | 35.6 | 0.0 | 33.4 | 0.0 | 357 | 0 | 459 | 274 |
| | MixWell | - | 8.76 | -78 | 204.1 | 168.5 | 121.9 | 88.5 | -116 | 473 | | |
| | A-Mixer | 125 | 8.56 | -52 | 157.5 | 121.9 | 129.4 | 96.0 | -78 | 435 | | |
| 2/22/18 | Raw | - | 2.63 | 461 | 31.3 | 0.0 | 29.6 | 0.0 | 1086 | 0 | 1600 | 953 |
| | MixWell | - | 6.80 | -1 | 220.9 | 189.6 | 146.0 | 116.4 | -1 | 1087 | | |
| | A-Mixer | 196 | 7.78 | -22 | 190.1 | 158.8 | 176.7 | 147.1 | -51 | 1137 | | |

1/24/18 Estimated efficiency: 95% (Δ Acid load) [435/459] or 79% (Δ D. Ca/T. Ca) [96.0/121.9]

2/22/18 Estimated efficiency: 71% (Δ Acid load) [1137/1600] or 93% (Δ D. Ca/T. Ca) [147.1/158.8]

- Lime Feed CaO = Actual measured lime material [pebble quicklime (**partially hydrated?** - previous load received 8/11/17)].
- Lime feed CaCO₃ = Adjusted for 94% purity and 0.56 conversion factor.

Operation & Maintenance as of May 2018

- Settling Pond 1 (SP1) & Settling Pond 2 (SP2) cleaned to about <0.5' sludge before startup
- System placed on-line 4/5/17
- Pumped SP1: n=7 (5/19/17, 7/13/17, 8/16/17, 12/7/17, 2/13/18, 3/16/18, 5/31/18)
 - 120,000 gallon total capacity (840,000 gallons)
- Pumped SP2: n=2
 - 11,000 gallon capacity (22,000 gallons)
- Oxide Delivered as of May 2018: 38.5 ton ('17 Mar 10 t, ~Jun 10 t, Aug 10 t; '18 Apr 10 t)
- Estimated hours spent on-site per week: 4 (plus about 5 hours for each pumping event)
- Pumped out MixWell once
- Drain A-Mixer during each sludge pumping event
- Other minor maintenance (brush cutting, clean MixWell nozzle, trompe inlet, etc.)

Crystal Ball Estimates

- Historic monitoring indicates average acid load: 46/31 t/year (meas/calc)
- If 85% efficiency, = 22 - 32 tons of lime per year needed (actual about 29 t delivered to operate for 12-month period)
 - Included February 2018, historically wet month (>6 inches of precipitation during February)
 - Measured acid load varied by 300% from January to February 2018

Thank you!



- Much thanks to the great folks at The Friends of the Cheat!
 - www.cheat.org
 - David Petry, Madison Ball, Amanda Pitzer
- Generosity of Charlie Pase (landowner)
- Thanks to Solid Rock Excavating, Inc., Albright WV
- In memory of Bruce Leavitt, Inventor & Trompemaster

