Challenges of Designing and Building a Passive Treatment System with Limited Topography, Hydraulic Head and Available Land Area

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Study Site/
Challenges


Preliminary Designs


Design Innovations


Performance

Study Site/Challenges

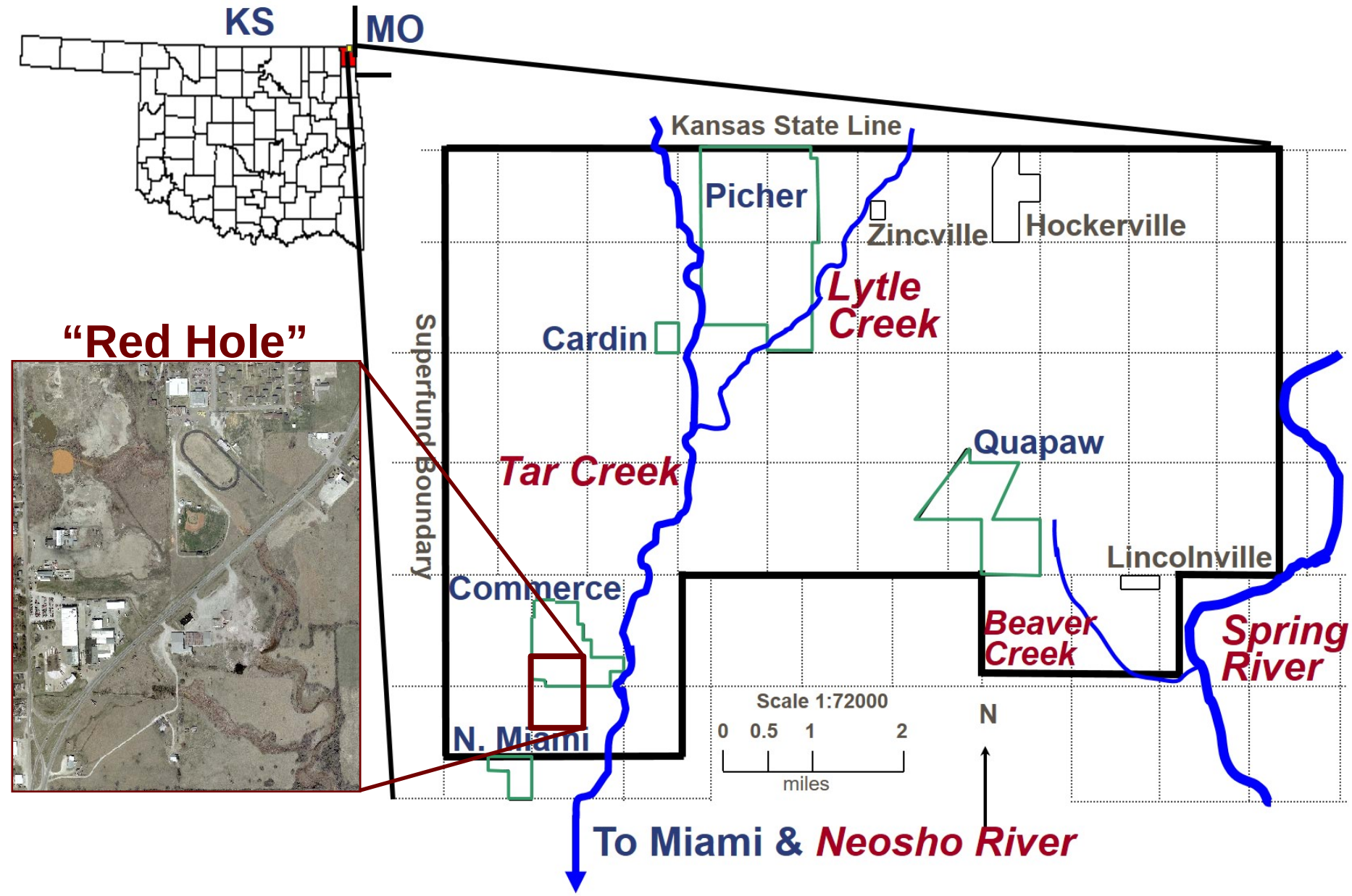
Tri-State Lead-Zinc Mining District

- Extensive underground workings
- Massive surface processing operations

Tri-State Lead-Zinc Mining District

- Extensive underground workings
- Massive surface processing operations
- Elevated Fe, Zn, Cd, Pb, As in water, chat, soils and biota
- Four USEPA Superfund Sites

Tar Creek Superfund Site



SE Commerce

- "Red Hole" and "Green Hole" collapses
- Water discharges into Unnamed Tributary
- Collapses filled and surface reclaimed 2006

SE Commerce

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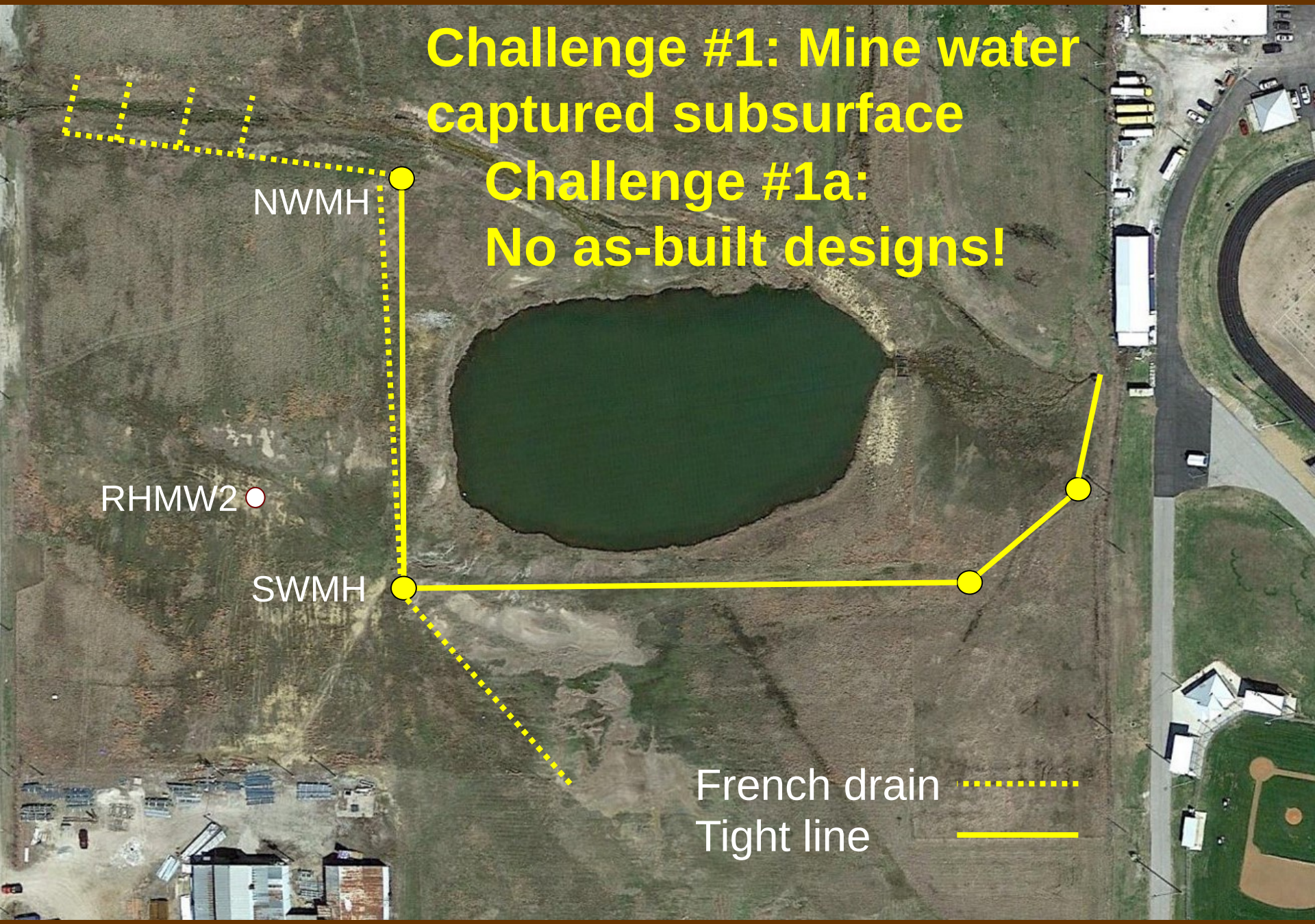
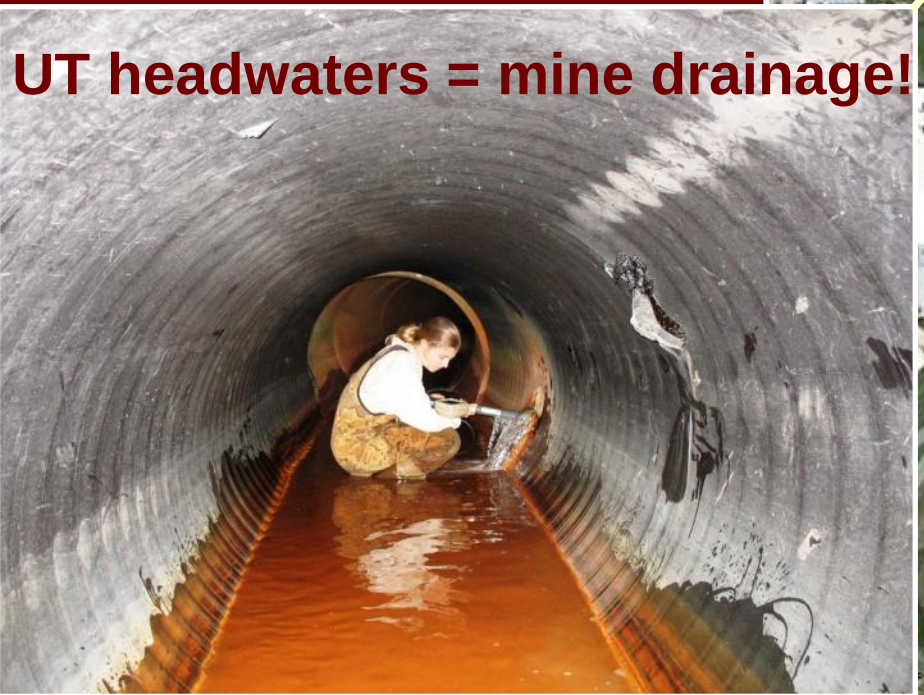
July 2006


Challenge #1: Mine water captured subsurface
Challenge #1a:
No as-built designs!
NWMH
RHMW2
SWMH
French drain
Tight line

SE Commerce

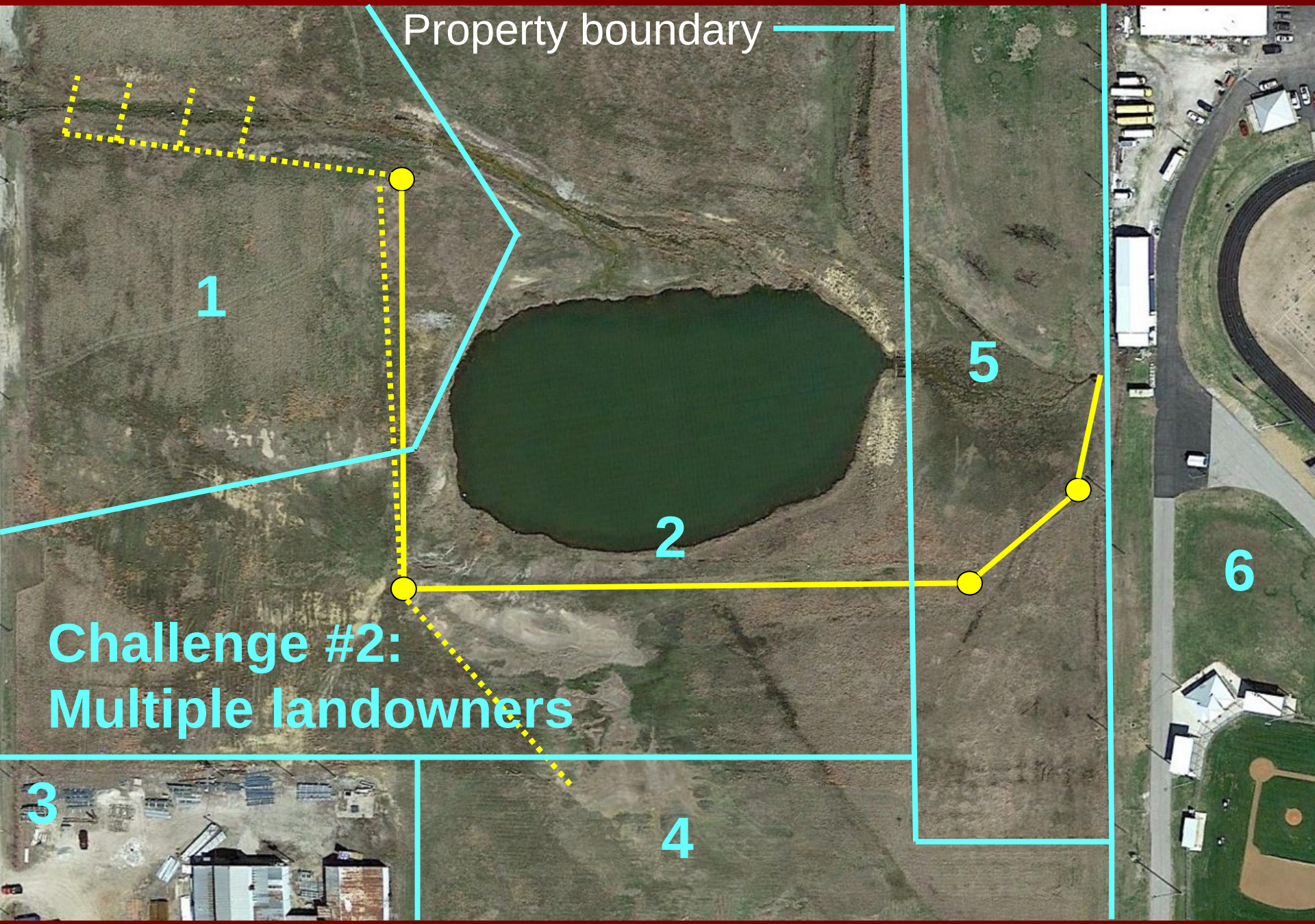
- Flow: 100 gpm
  - Fe: 138 mg/L
  - Zn: 6 mg/L
  - Pb: 81 μg/L
  - Cd: 20 μg/L

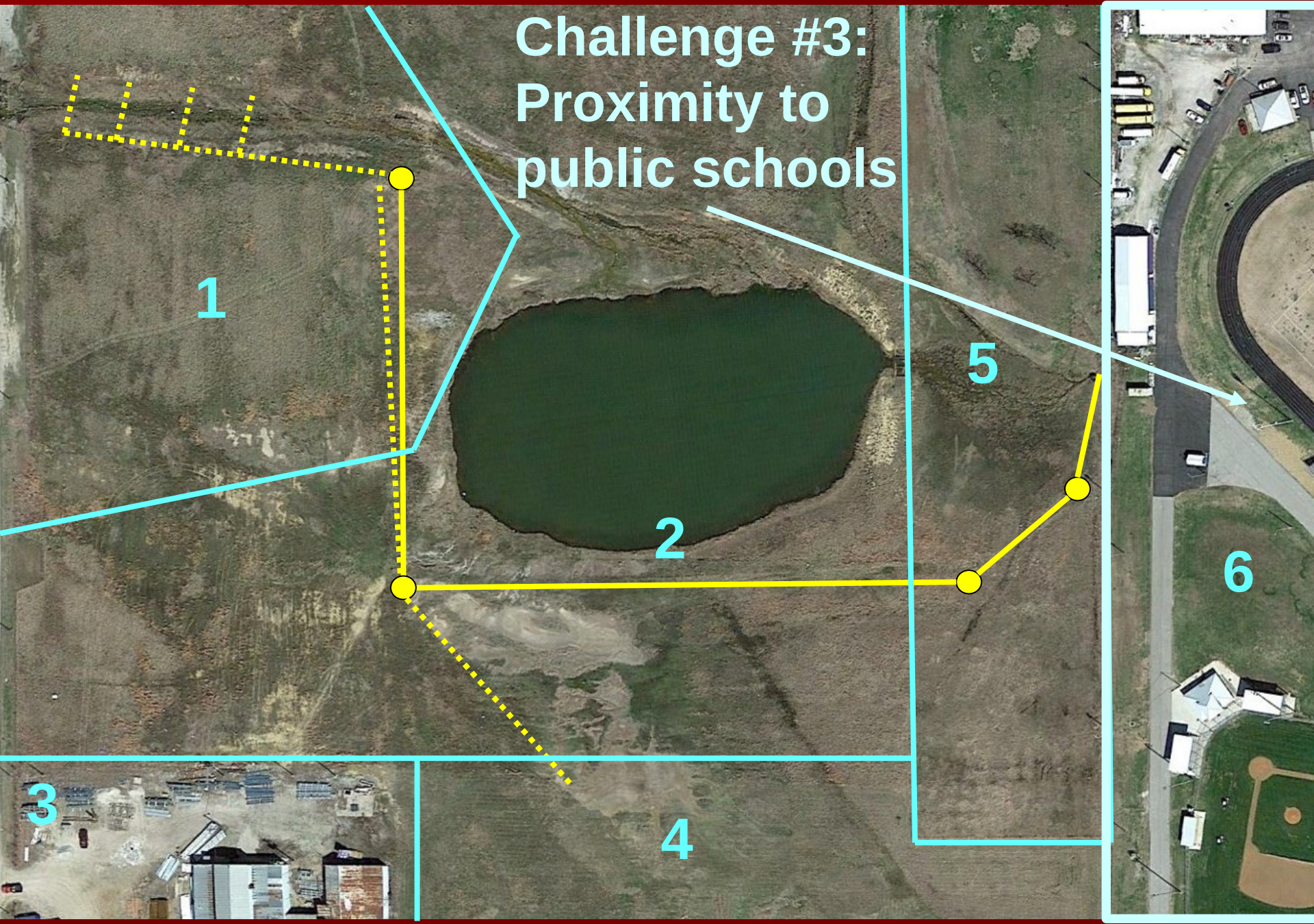


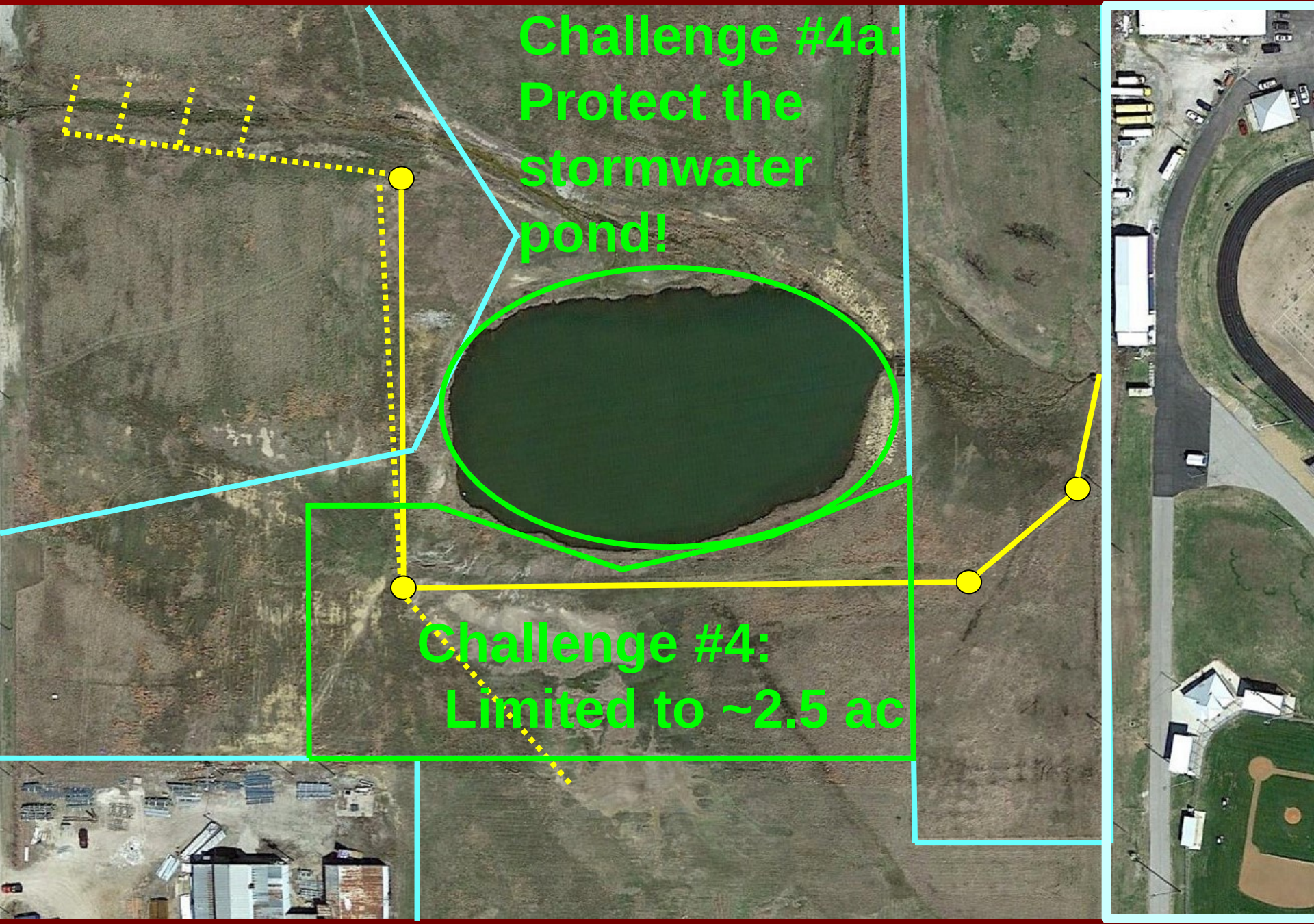
UT headwaters = mine drainage!

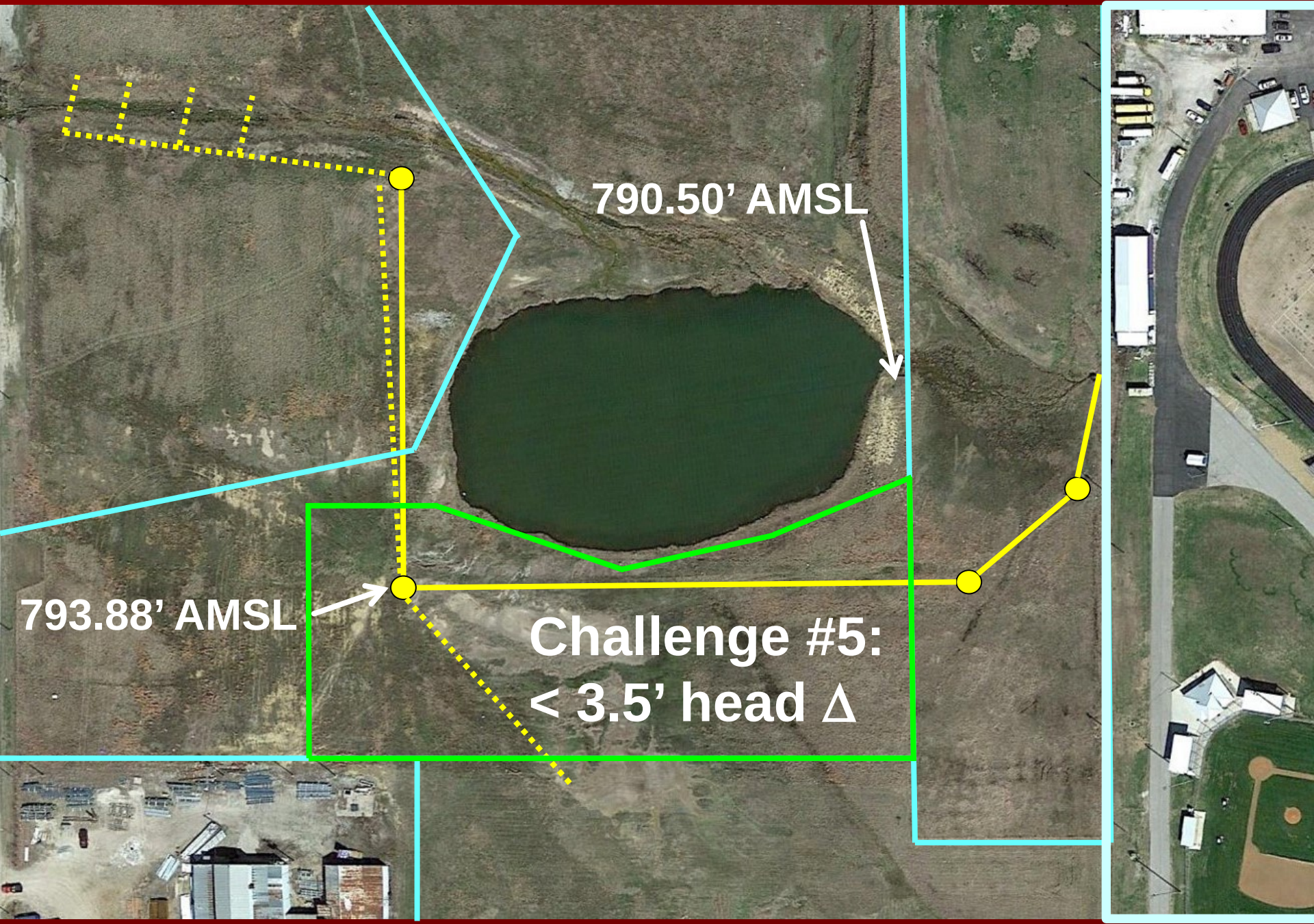
Unnamed tributary

Mayer Ranch PTS


Property boundary
1
2
3
4
5
6
Challenge #2:
Multiple landowners


Challenge #3:
Proximity to
public schools
1
2
3
4
5
6


Challenge #4a:
Protect the
stormwater
pond!
Challenge #4:
Limited to ~2.5 ac

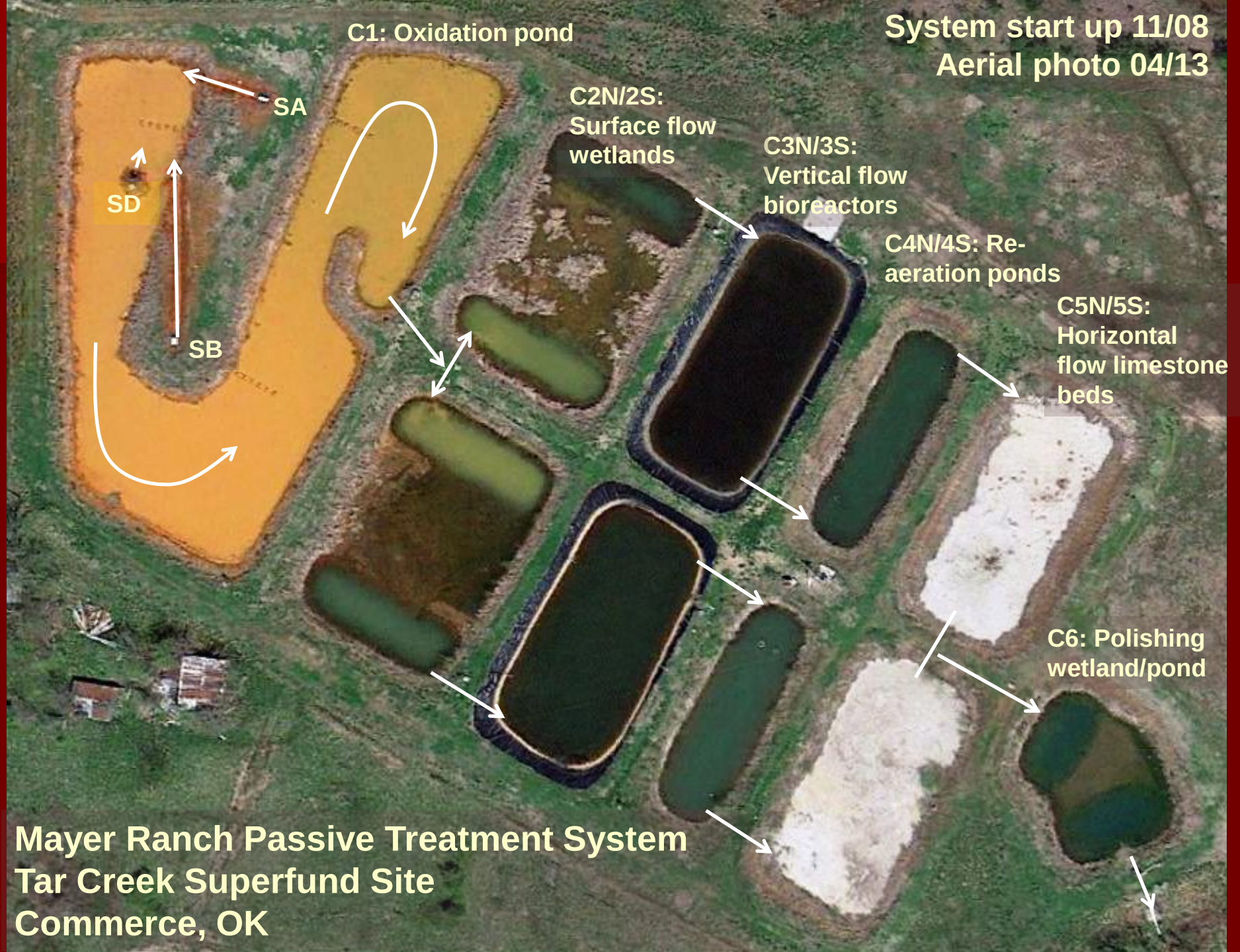

790.50’ AMSL
793.88’ AMSL
Challenge #5:
< 3.5’ head Δ

SEC Site Challenges

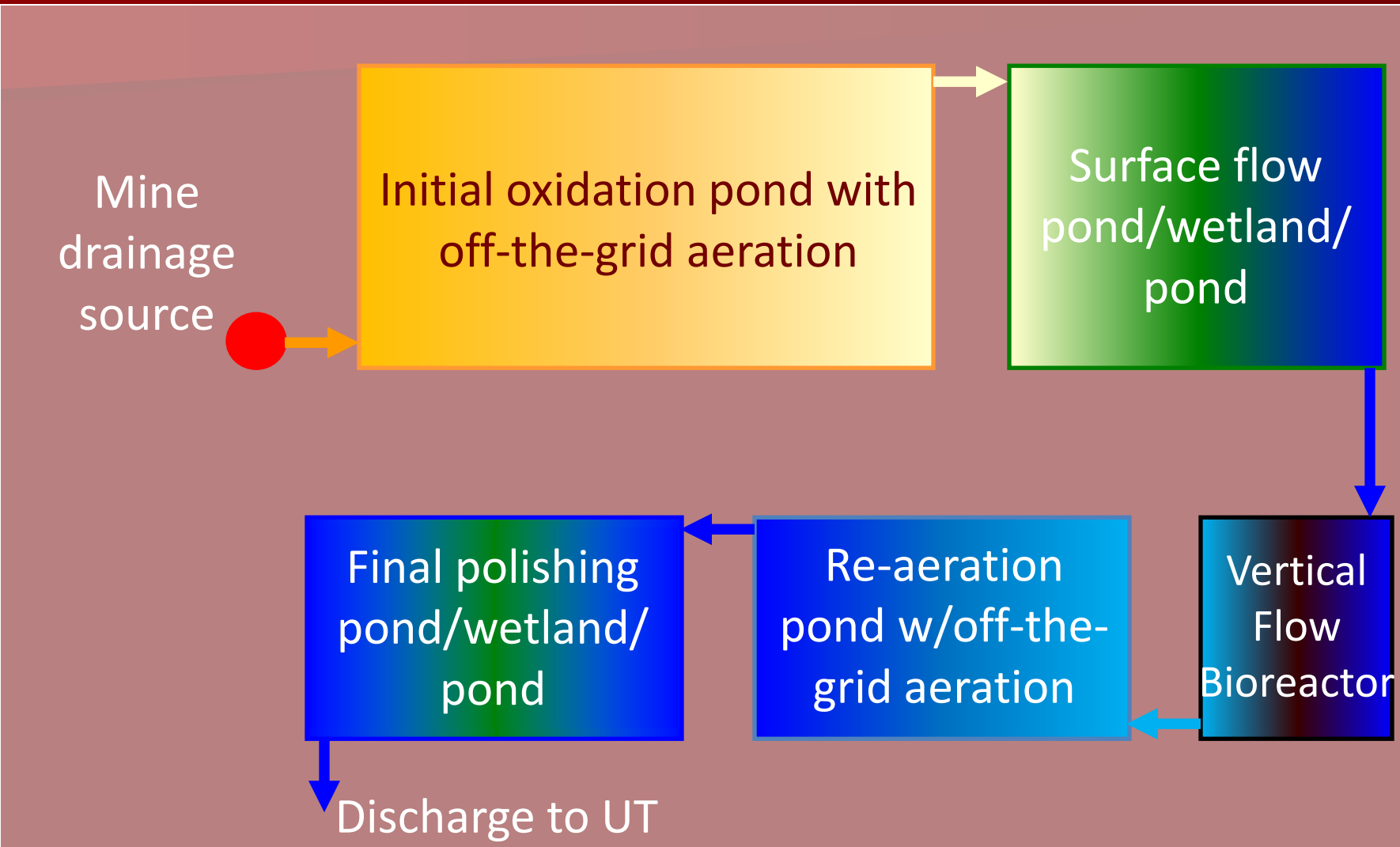
1. Mine water captured subsurface
   a) No as-built designs
2. Multiple landowners
3. Proximity to public schools
4. Limited land area
   a) Protect the stormwater pond
5. Minimal head difference

Preliminary Designs


Commerce
High
School
S. Main
Street
SE
Commerce
Project Site
Mantle
Statue
Unnamed tributary
US69/OK66
Mayer Ranch Passive Treatment System


C1: Oxidation pond
System start up 11/08
Aerial photo 04/13
SA
SD
SB
C2N/2S:
Surface flow
wetlands
C3N/3S:
Vertical flow
bioreactors
C4N/4S: Re-
aeration ponds
C5N/5S:
Horizontal
flow limestone
beds
C6: Polishing
wetland/pond
Mayer Ranch Passive Treatment System
Tar Creek Superfund Site
Commerce, OK

SECPTS Conceptual Design



SECPTS Design Approach

Envi. Sci./ Env. Eng. Senior Capstone class

- Academic year 2015-16
- Two multidisciplinary teams
- Field data collection
- Elevation surveying
- Produced engineering designs
- Final presentations/ reports to City of Commerce City Council

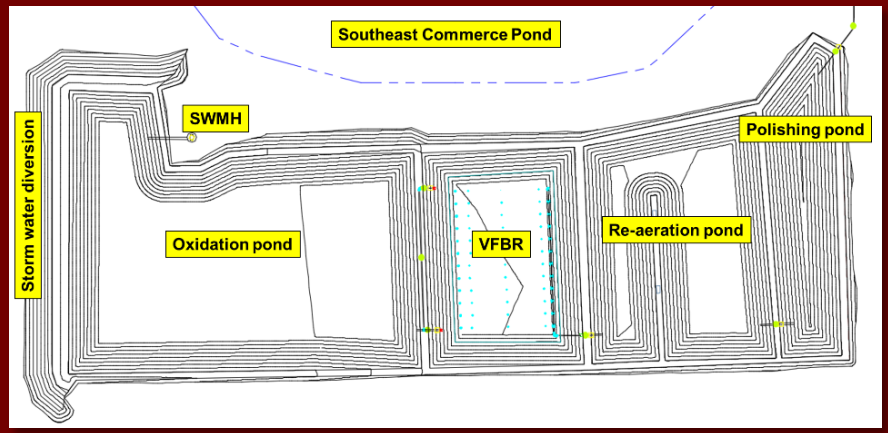
DEQ research agreement with OU CREW

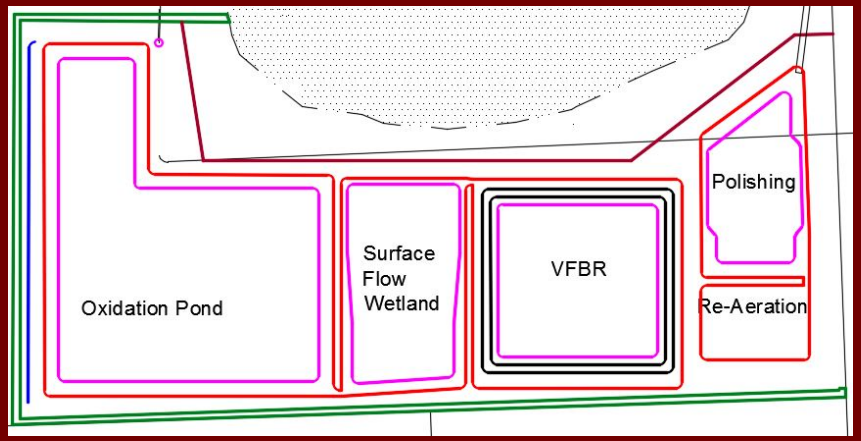
- Awarded 09/2014
- Water quality/ quantity/ elevation data collection
- Design/Build proposals requested 08/2015
- Design/Build awarded 12/ 2015 to **Biomost, Inc.**
- Final engineering designs 09/2016
- Construction completed 02/2017

Capstone Class Designs

OGAXPA ENGINEERING

Leaf LLC

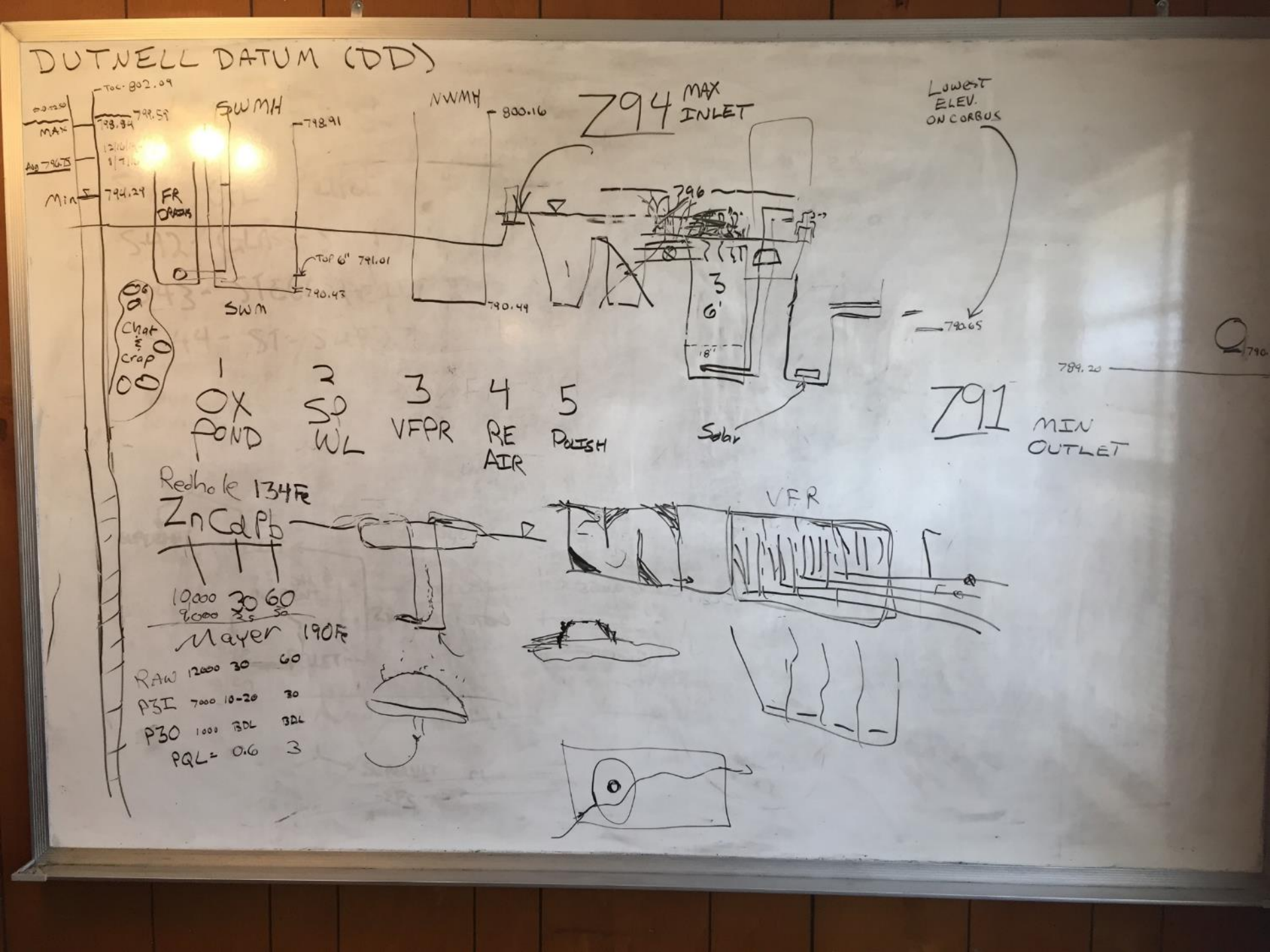




- Four process units
- $700K design/build

- Five process units
- $681K design/build


Design Innovations

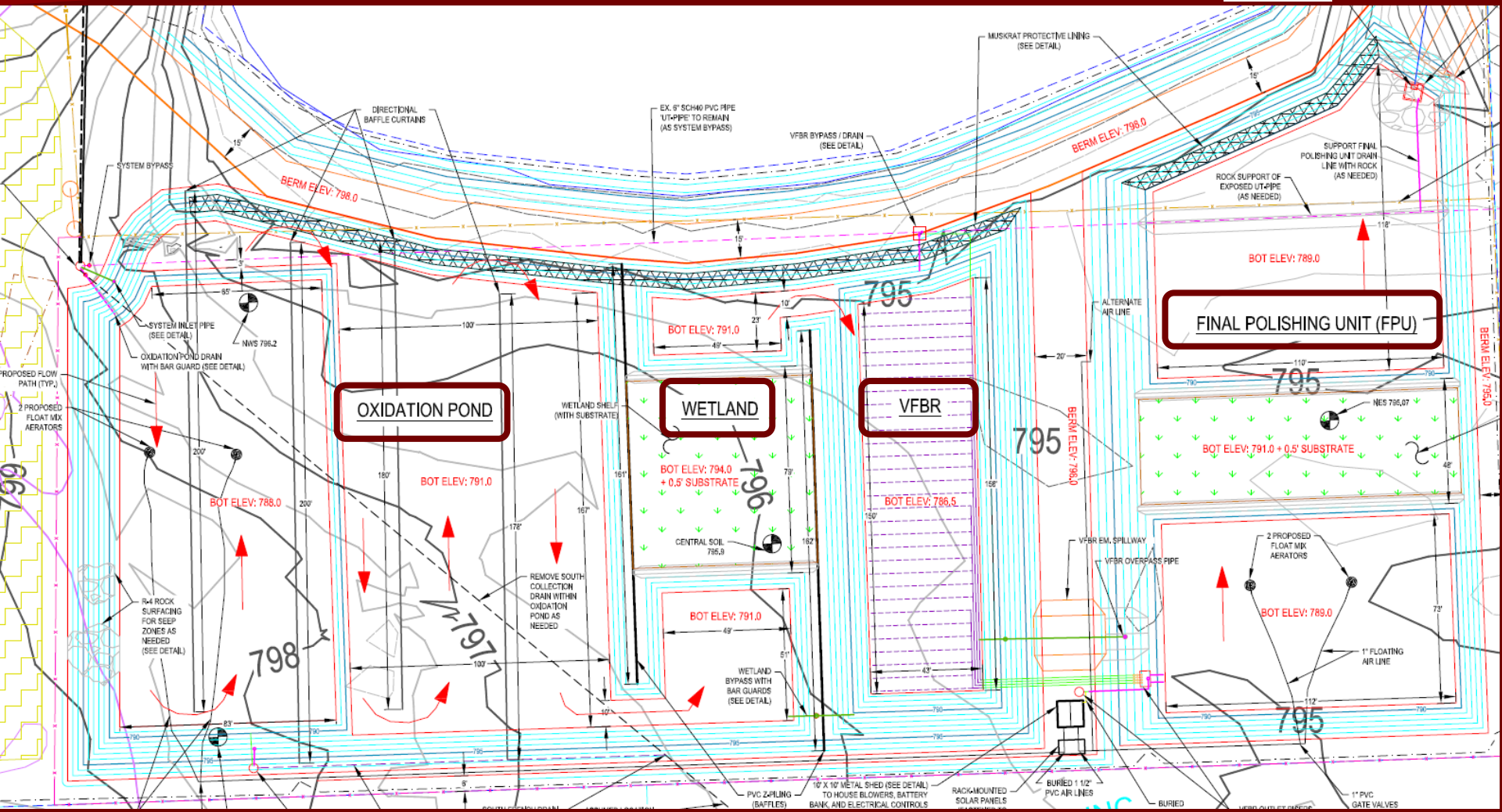

DUTNELL DATUM (DD)
SWMH
NWMH
800.16
794 MAX INLET
LOWEST ELEV. ON CORBUS
796
798.91
798.84
798.58
794.24
FR DRAIN
Top 6" 791.01
790.42
790.44
SWM
Chat & crap
790.65
789.20
1 OX POND
2 SP WL
3 VFPR
4 RE AIR
5 POLISH
Sabr
791 MIN OUTLET
Redhole 134Ft
ZnCdPb
10,000 30 60
9000 30 30
Mayer 190Ft
RAW 12000 30 60
P3I 7000 10-20 30
P30 1000 BDL BDL
PQL= 0.6 3
VFR

SECPTS Engineering Design

BioMost, Inc.
Mining & Reclamation Services

Riverman Engineering

CREW
Center for Restoration of Ecosystems and Watersheds
University of Oklahoma



Meeting the Challenges

Challenge

- Mine water captured subsurface
- Multiple landowners
- Proximity to public schools
- Limited land area
- Minimal head difference

Solution

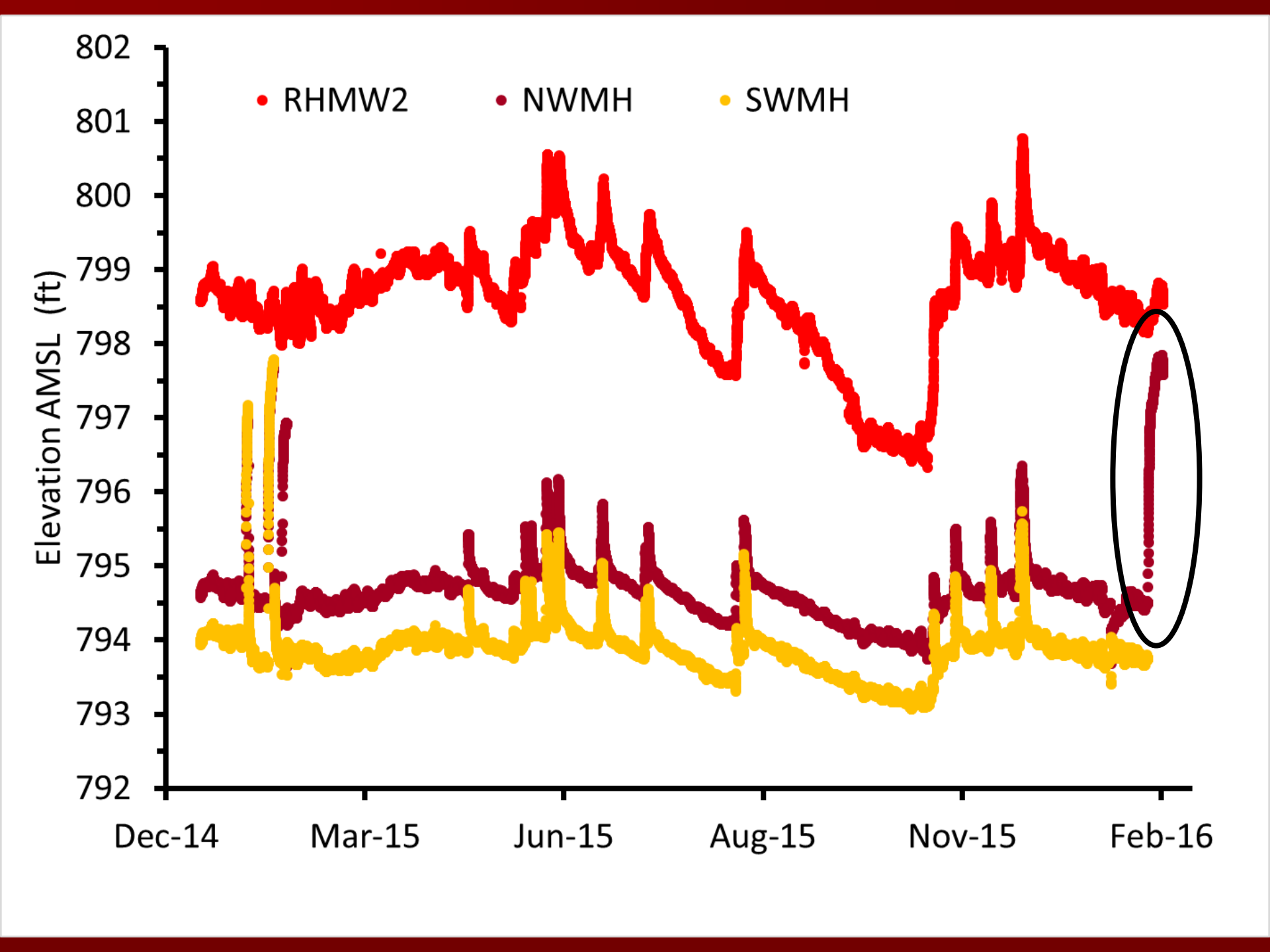
Meeting the Challenges

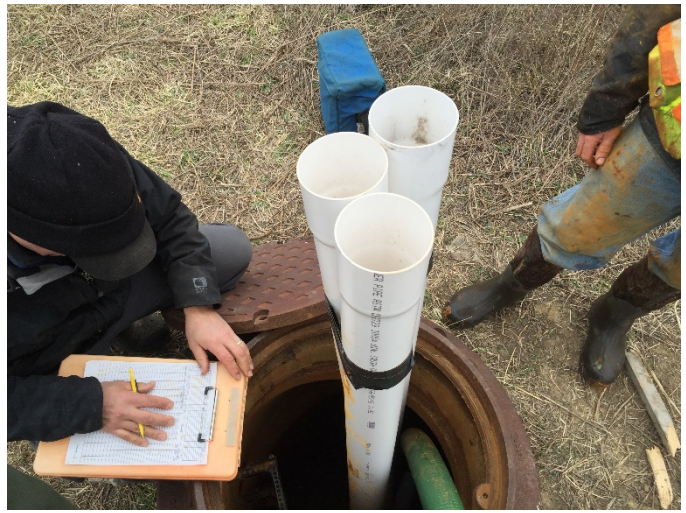
Challenge

- **Mine water captured subsurface**
- Multiple landowners
- Proximity to public schools
- Limited land area
- Minimal head difference

Solution

- **Determine water level variability**
- **Capture / maintain at reasonable elevation**
- **Tie into existing French drain**
- **All process units excavated**
- **Retain all existing infrastructure**


802
801
800
799
798
797
796
795
794
793
792
Elevation AMSL (ft)
RHMW2
NWMH
SWMH
Dec-14
Mar-15
Jun-15
Aug-15
Nov-15
Feb-16



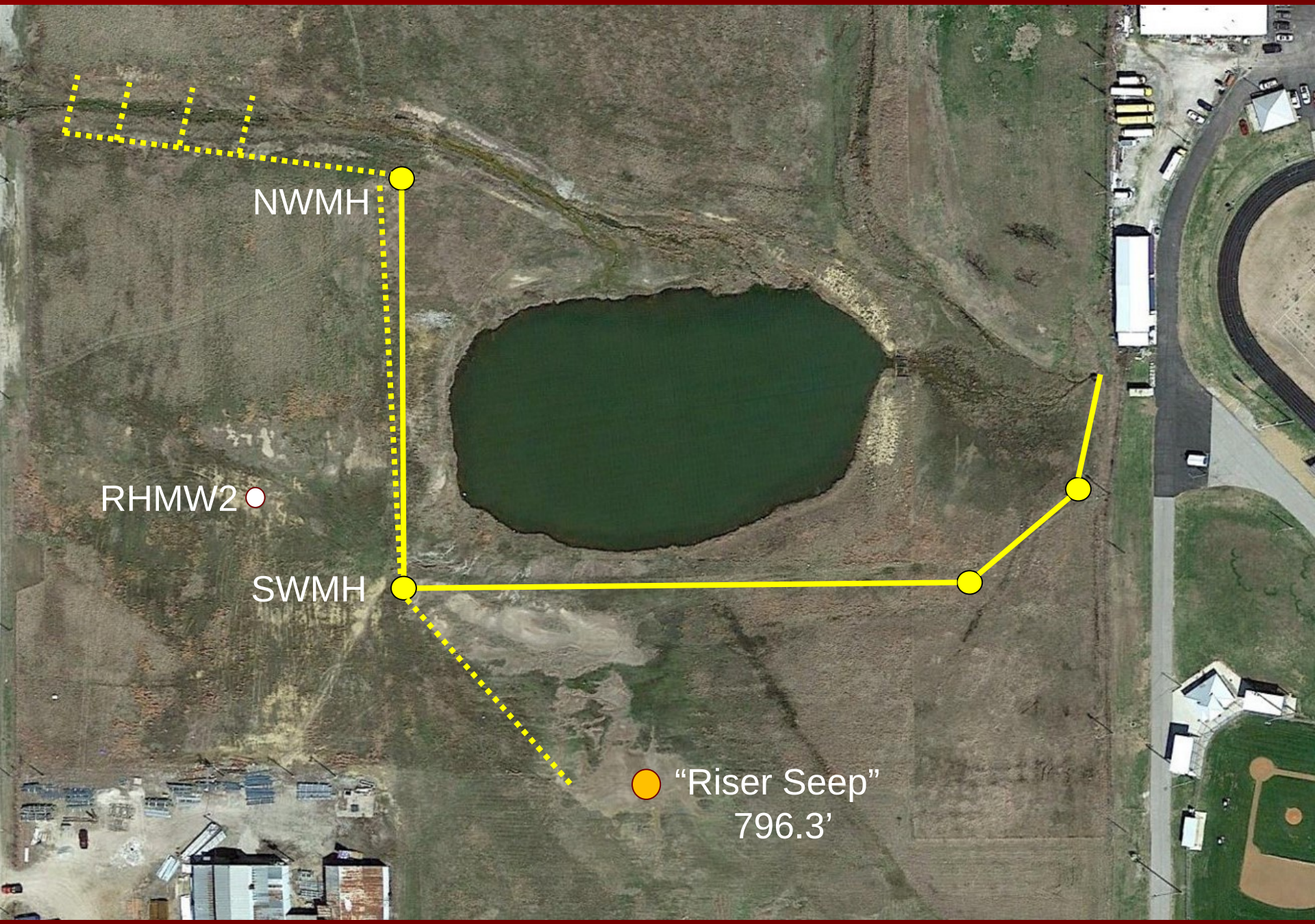
Elevation AMSL (ft)

799
798
797
796
795
794
793
792

RHMW2
NWMH
SWMH
RHMW2 (DTW)
NWMH (DTW)
S-Riser (DTW)

2/22
2/24
2/26
2/28
3/1
3/3

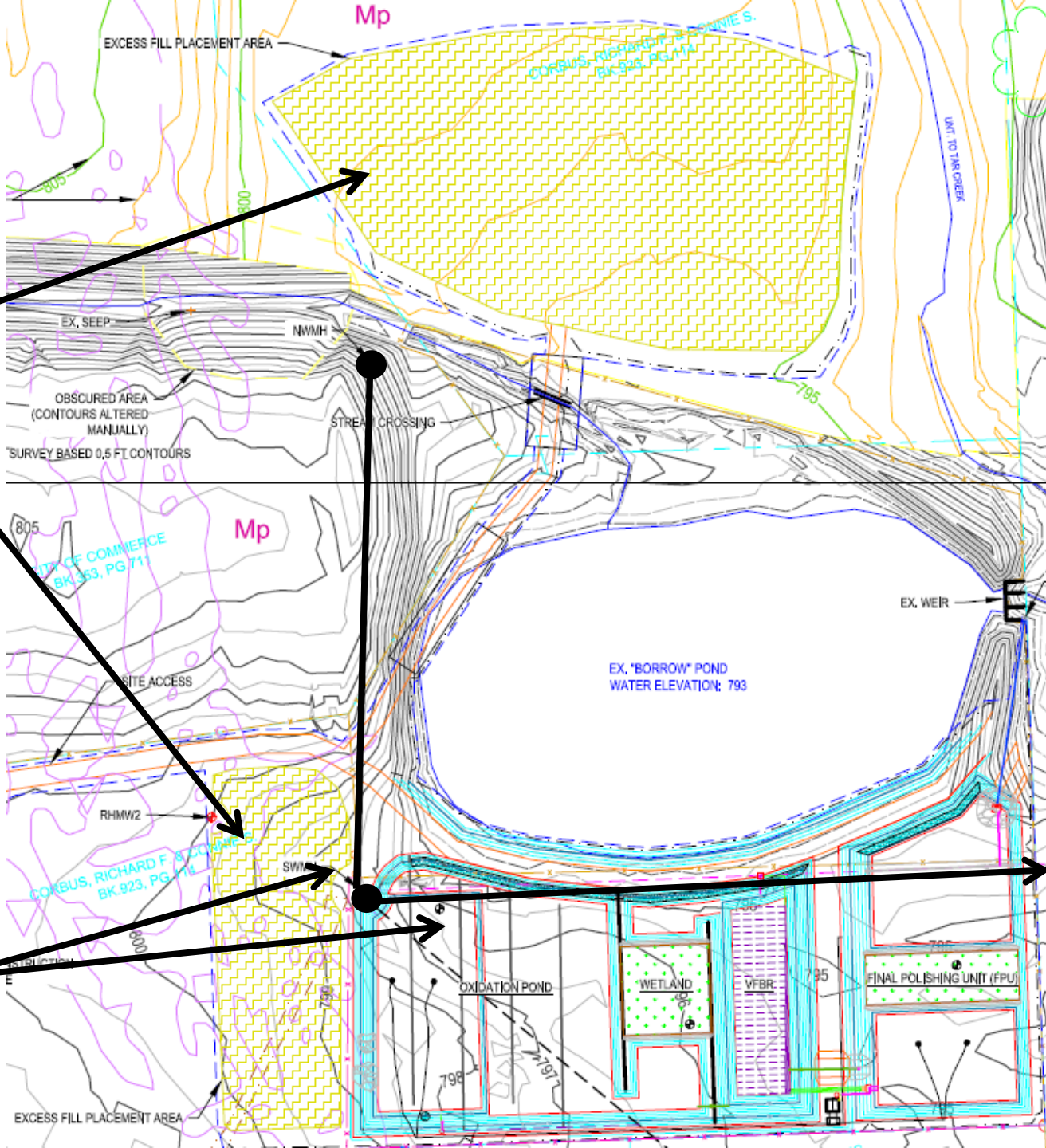
2016


NWMH
RHMW2
SWMH
“Riser Seep”
796.3’

	Design Elevation (ft. AMSL)
N and S inflow invert	796
Oxidation Pond DSWE	795
Wetland DSWE	795
VFBR DSWE	795
FPU DSWE	792
Final outflow invert	790.5

19K yd³ excess fill

Existing infrastructure



Meeting the Challenges

Challenge

- Mine water captured subsurface
- **Multiple landowners**
- Proximity to public schools
- Limited land area
- Minimal head difference

Solution

- **Only work with one!**

Meeting the Challenges

Challenge

- Mine water captured subsurface
- Multiple landowners
- **Proximity to public schools**
- Limited land area
- Minimal head difference

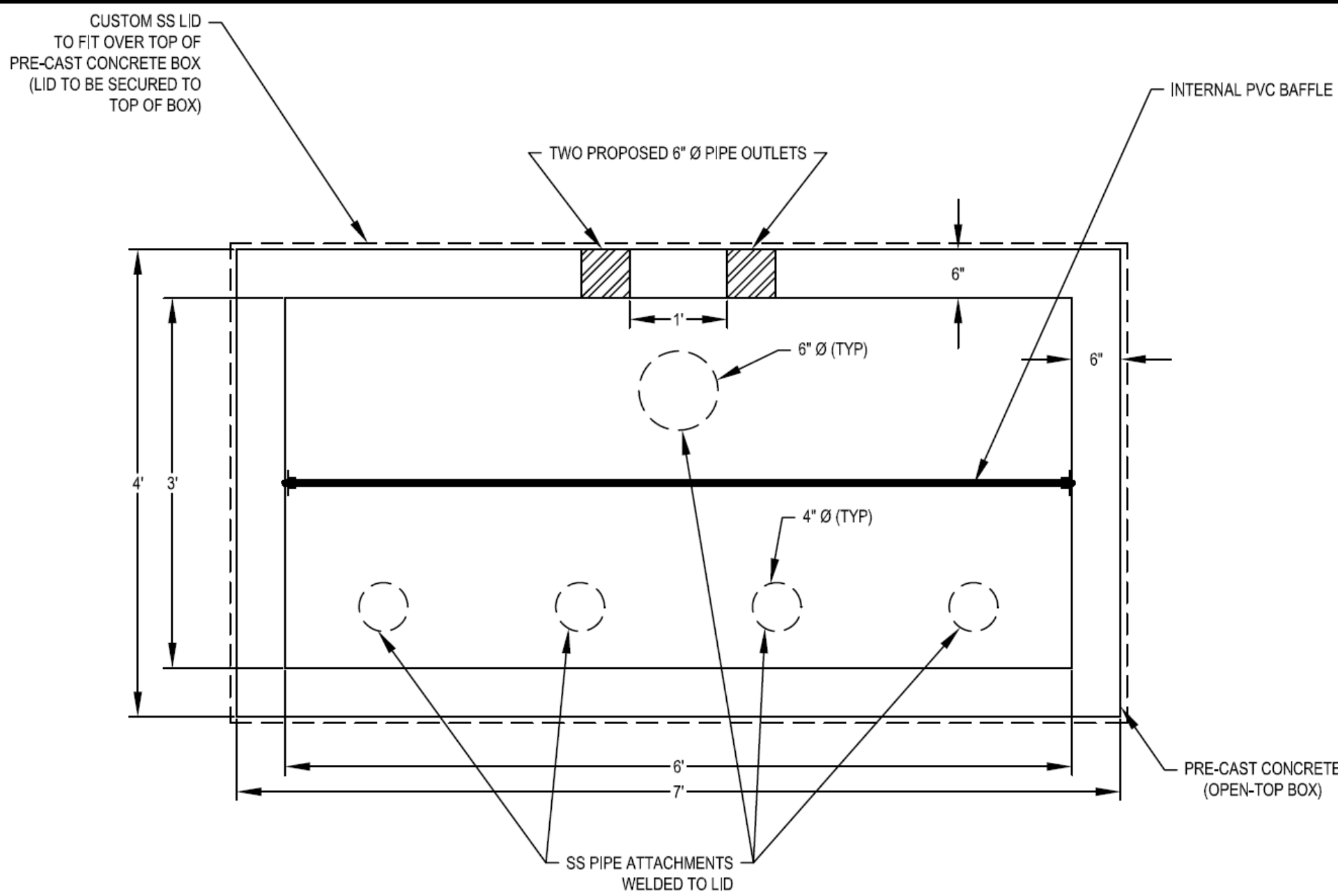
Solution

- **Unique VFBR effluent collection structure**
- **Solar-powered hydrogen sulfide removal system**
- **Custom activated charcoal media system**

FOUR 3" SCH40 PVC OUTLET RISERS (ONE FOR EACH UNDERDRAIN CELL)

FOUR 3" ACTIVATED CARBON FILTERS

Horizontal Scale: 1



APART HORIZONTALLY

PRE-CAST CONCRETE BOX (SEE DETAIL)


SOONERS
OU

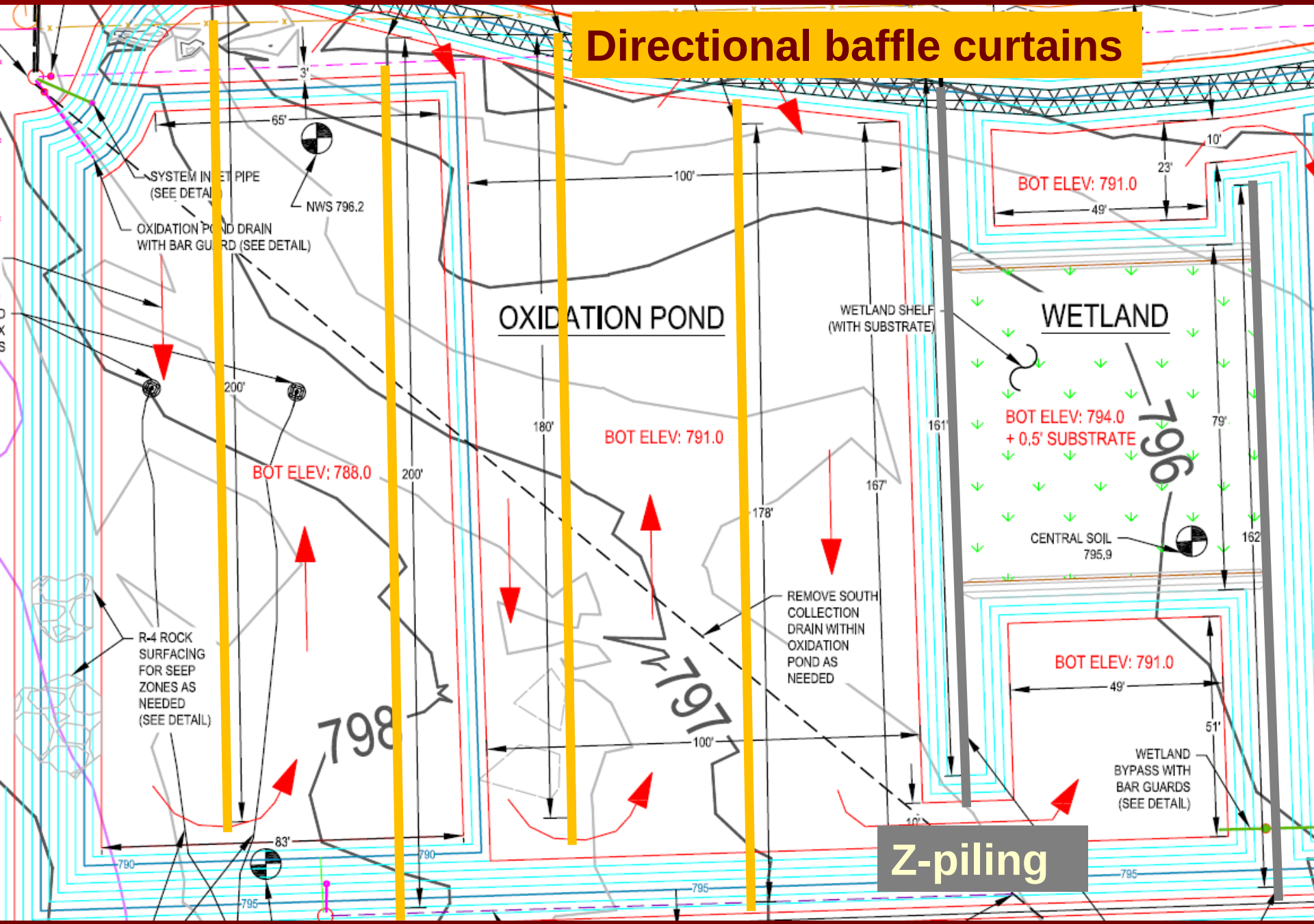
Meeting the Challenges

Challenge

- Mine water captured subsurface
- Multiple landowners
- Proximity to public schools
- **Limited land area**
- Minimal head difference

Solution

- **Use every bit available!**
- **Shared berms**
- **Directional baffle curtains**
- **Z-piling barriers**
- **Single water surface for three process units**


Directional baffle curtains
OXIDATION POND
WETLAND
SYSTEM INLET PIPE (SEE DETAIL)
NWS 796.2
OXIDATION POND DRAIN WITH BAR GUARD (SEE DETAIL)
BOT ELEV: 788.0
BOT ELEV: 791.0
BOT ELEV: 791.0
BOT ELEV: 794.0 + 0.5' SUBSTRATE
WETLAND SHELF (WITH SUBSTRATE)
CENTRAL SOIL 795.9
R-4 ROCK SURFACING FOR SEEP ZONES AS NEEDED (SEE DETAIL)
REMOVE SOUTH COLLECTION DRAIN WITHIN OXIDATION POND AS NEEDED
WETLAND BYPASS WITH BAR GUARDS (SEE DETAIL)
798
797
796
Z-piling

Meeting the Challenges

Challenge

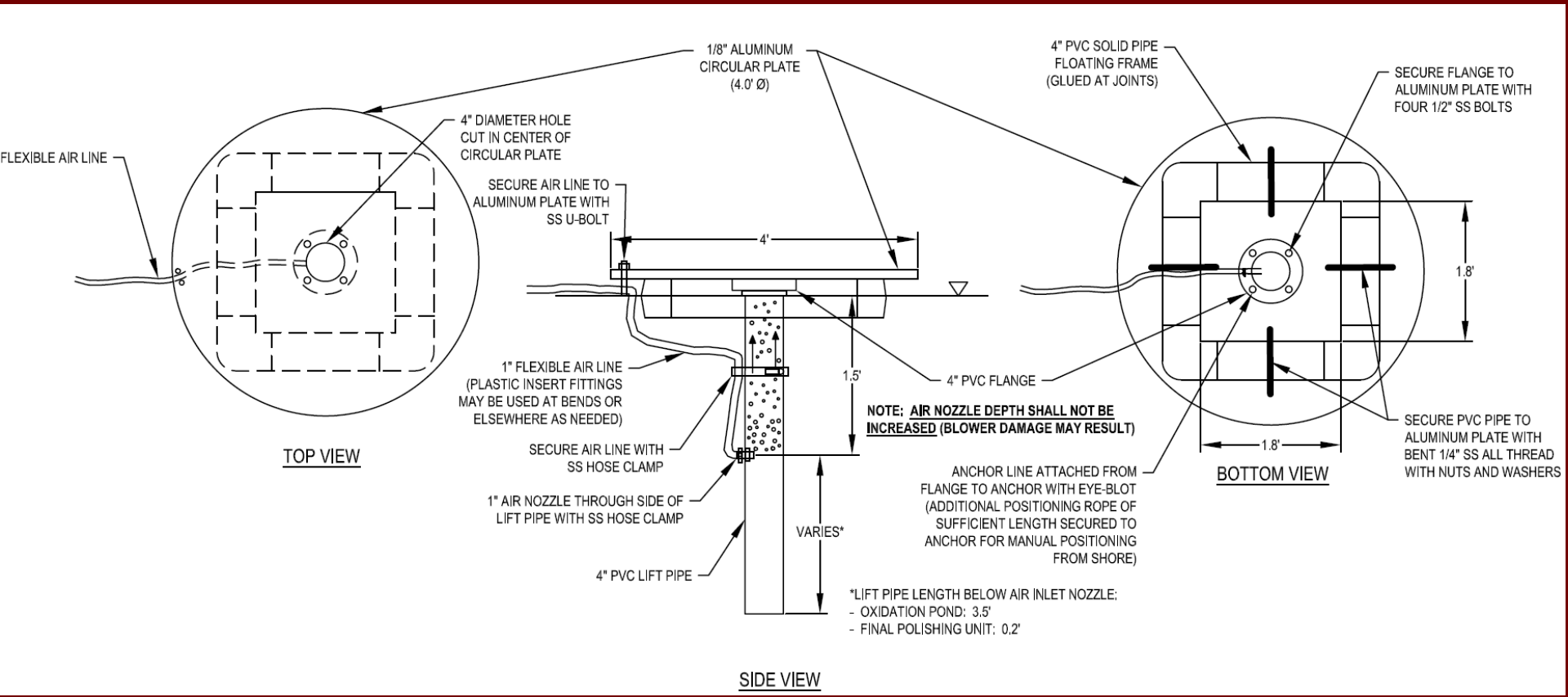
- Mine water captured subsurface
- Multiple landowners
- Proximity to public schools
- Limited land area
- **Minimal head difference**

Solution

- **Single water surface for three process units**
- **Open channel connections**
- **Oversized final effluent pipe**
- **Solar-powered float-mix aerators**

Float-Mix Aerators

- Two in oxidation pond
- Two in final polishing unit



New Challenges!

New Challenges!

- Daylighted two mine shafts during construction
  - Discharge into bottom of oxidation pond
  - Immediate mine pool elevation drop ~2’
  - Measurable inflow = ~25% of outflow

New Challenges!

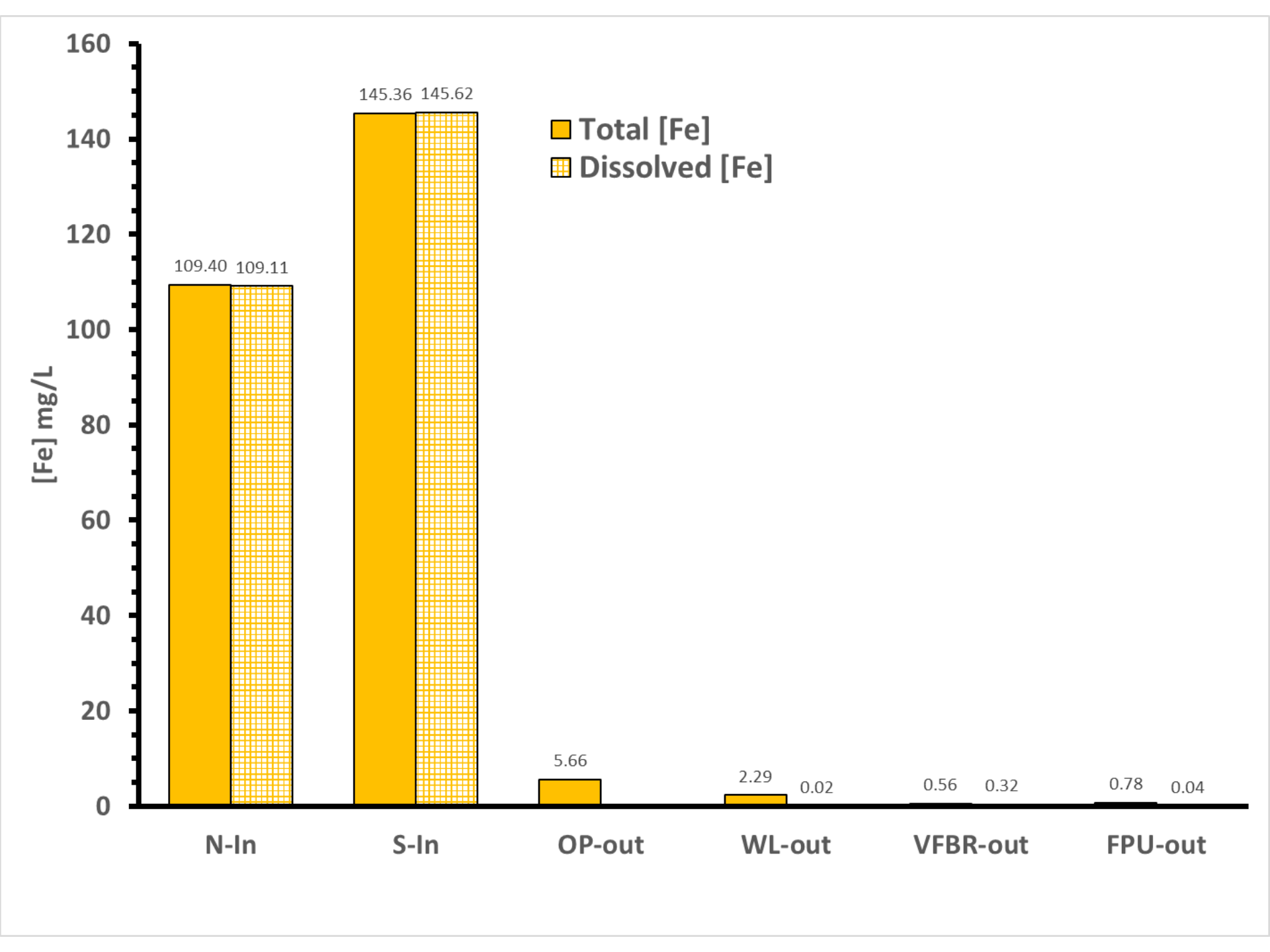
- Excavated soil disposition
  - Original design to stockpile on site
  - [Total metals] > Tar Creek remedial goals

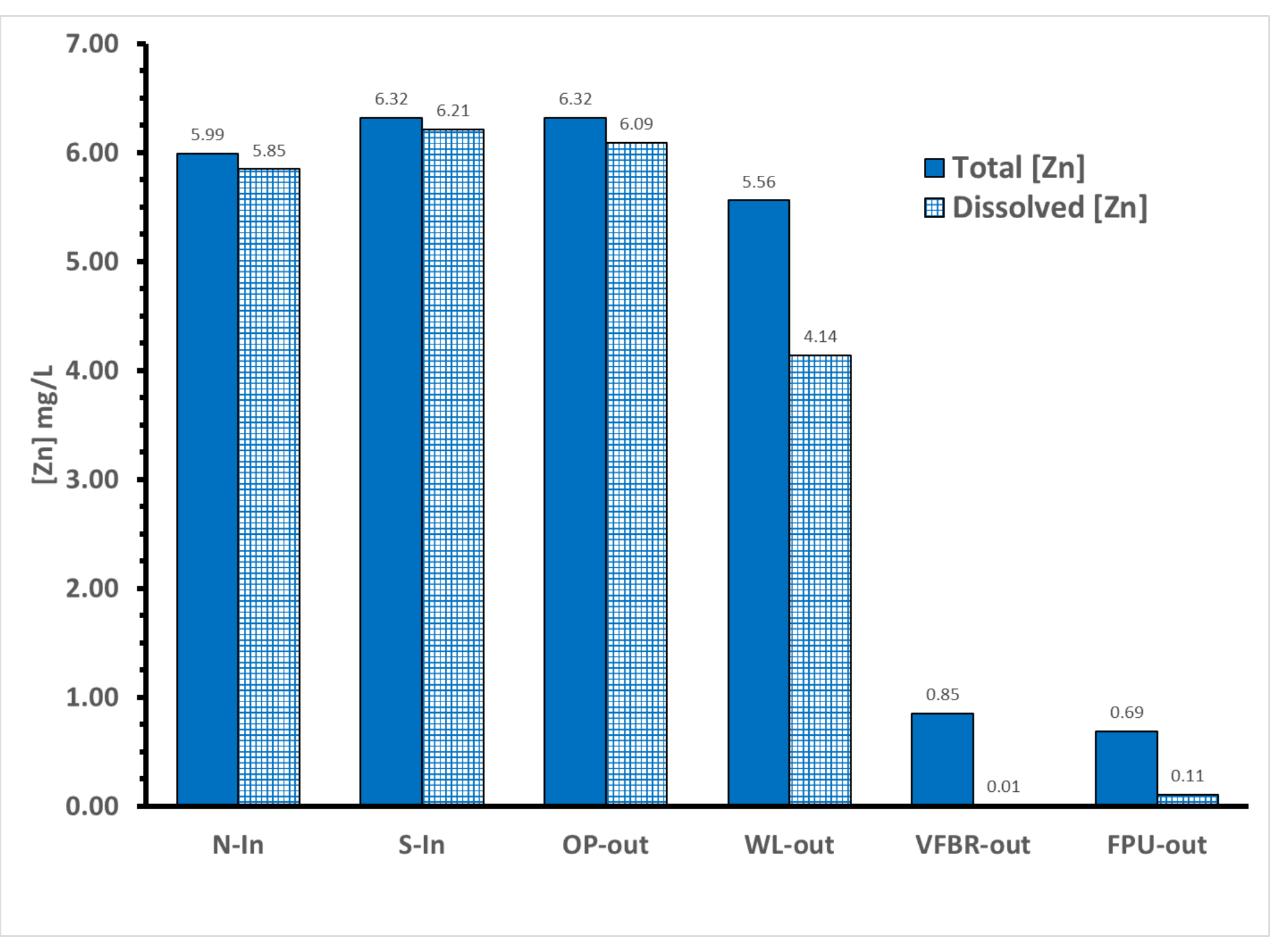
	Remedial Goal (mg/Kg)	Range (mg/kg)	% Exceeding RG
Cd	10	< PQL - 37	13
Pb	500	7 - 1670	50
Zn	1100	8 - 6140	50

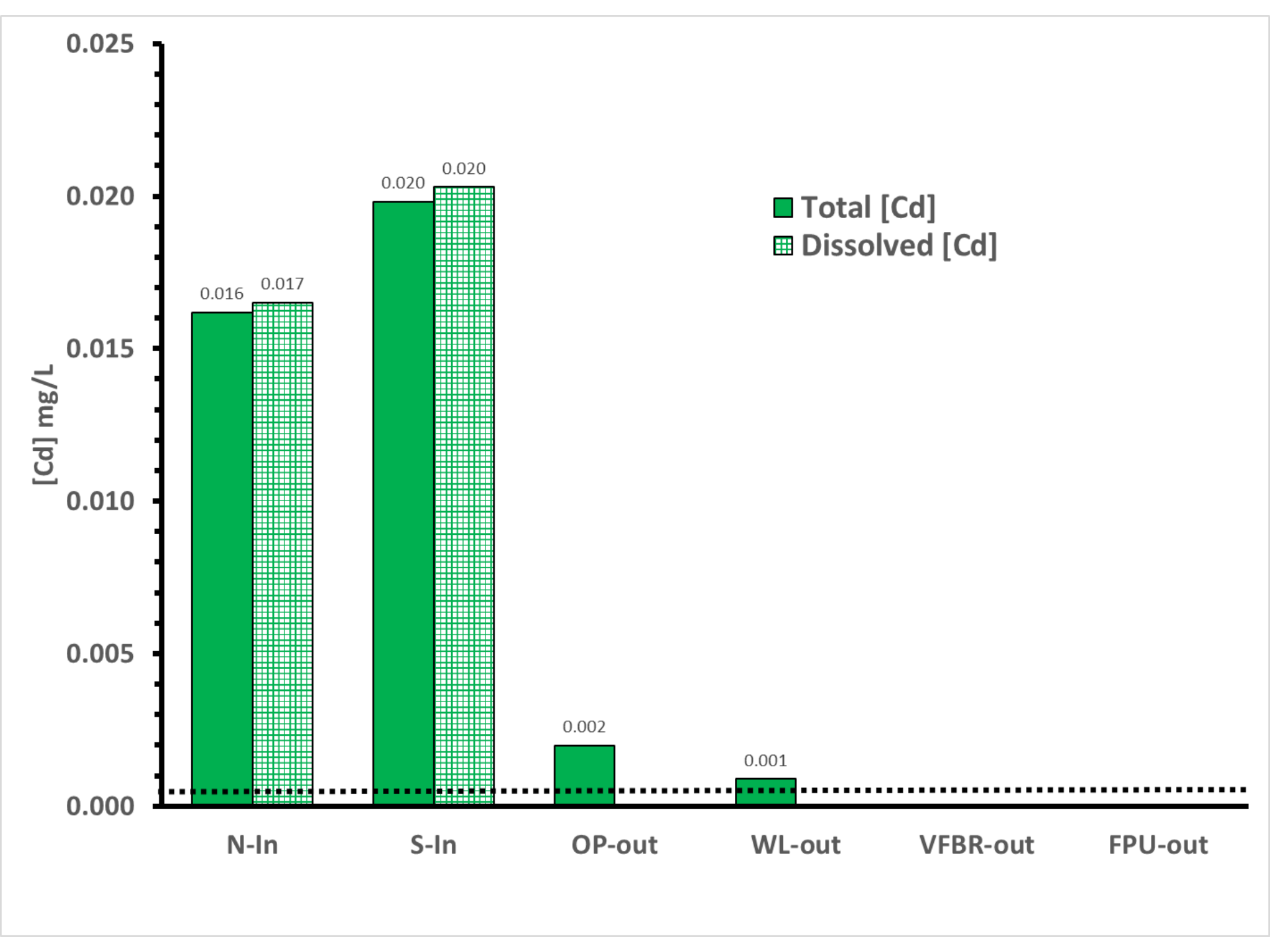
  - Change order for hauling to approved repository on Superfund Site

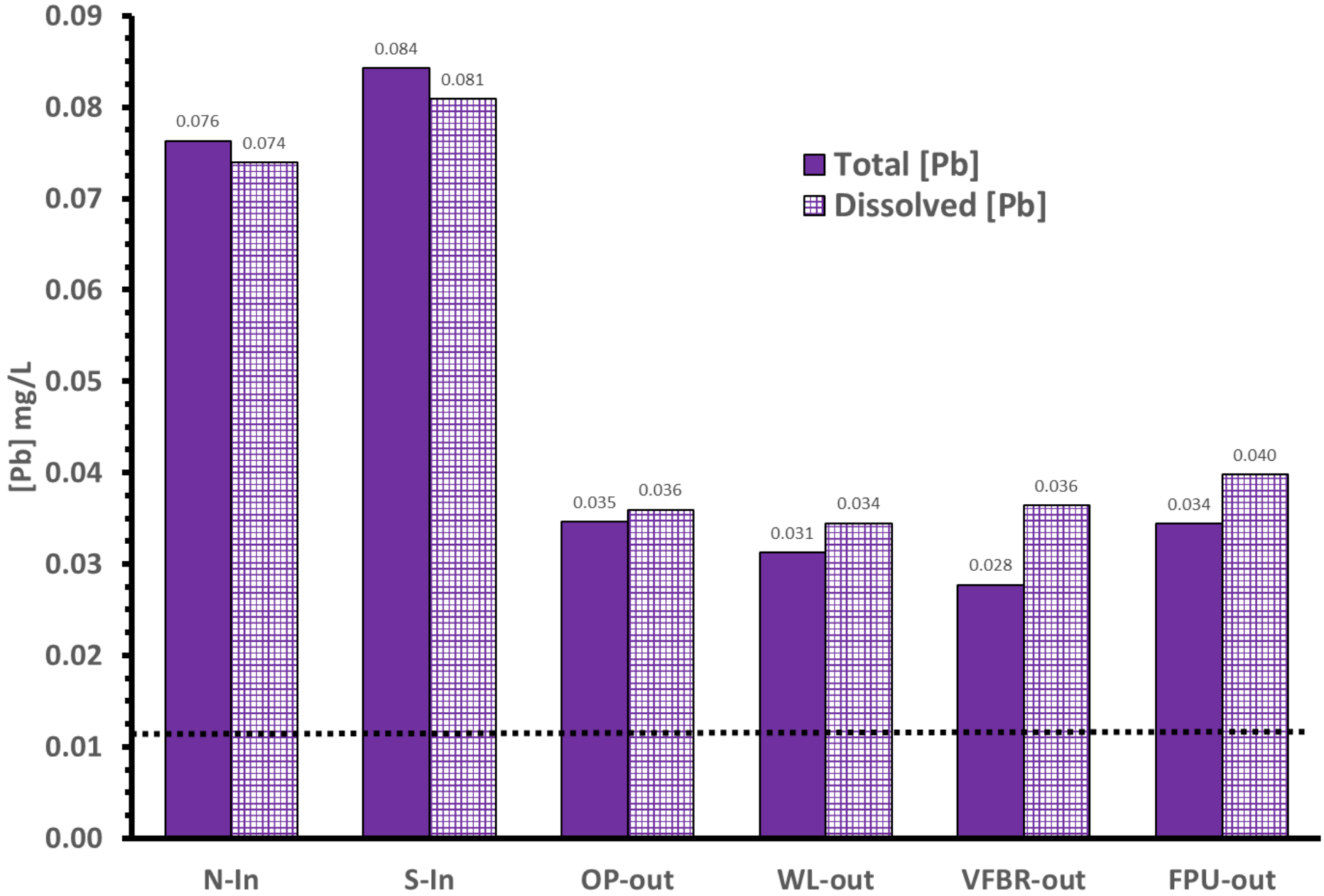
Performance

System online: February 25, 2017
Single sampling event: March 25, 2017


160
140
120
100
80
60
40
20
0
[Fe] mg/L
Total [Fe]
Dissolved [Fe]
109.40
109.11
145.36
145.62
5.66
2.29
0.02
0.56
0.32
0.78
0.04
N-In
S-In
OP-out
WL-out
VFBR-out
FPU-out

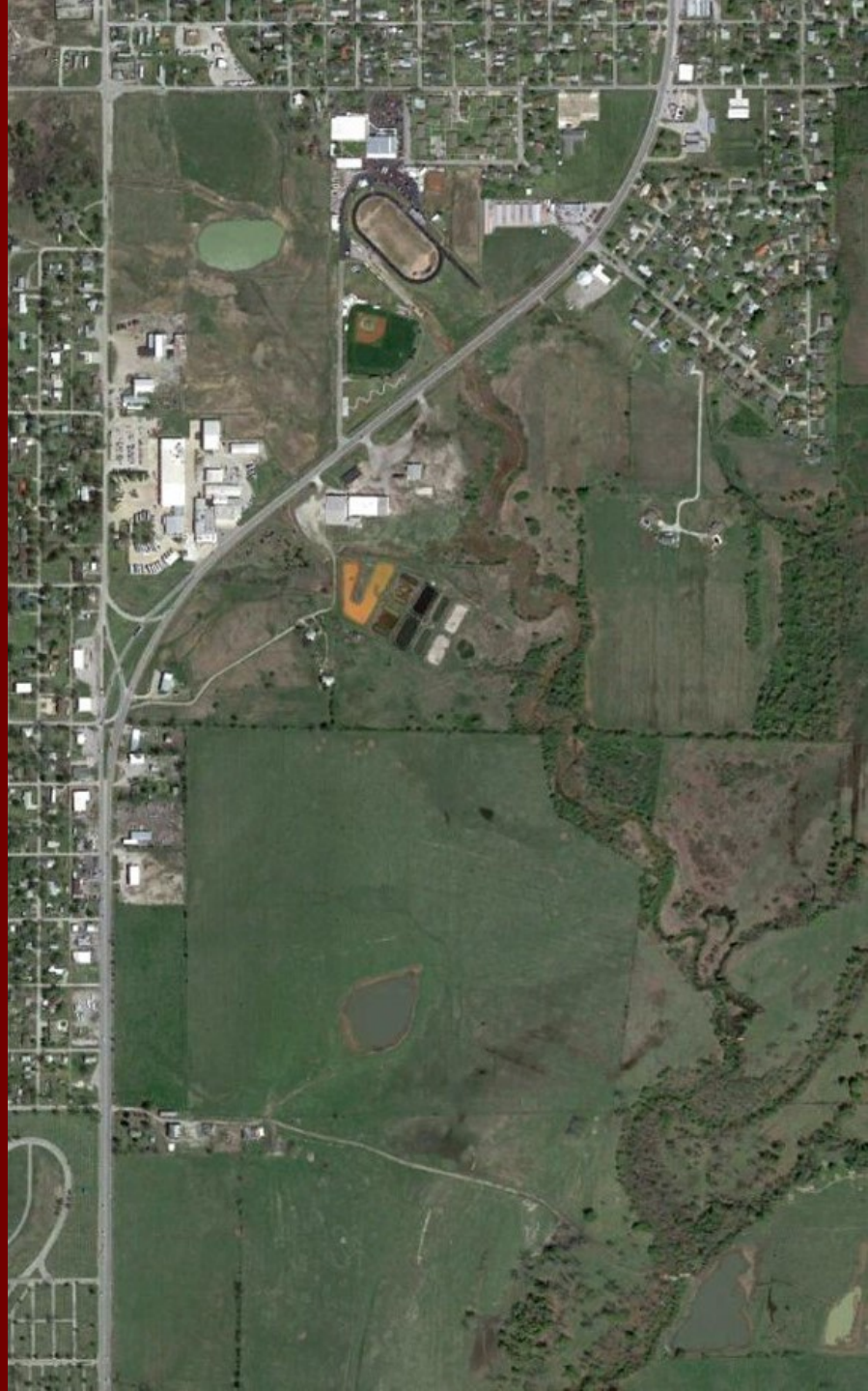

7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
[Zn] mg/L
5.99
5.85
6.32
6.21
6.32
6.09
5.56
4.14
0.85
0.01
0.69
0.11
Total [Zn]
Dissolved [Zn]
N-In
S-In
OP-out
WL-out
VFBR-out
FPU-out


0.025
0.020
0.015
0.010
0.005
0.000
[Cd] mg/L
0.016
0.017
0.020
0.020
0.002
0.001
Total [Cd]
Dissolved [Cd]
N-In
S-In
OP-out
WL-out
VFBR-out
FPU-out


0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
[Pb] mg/L
Total [Pb]
Dissolved [Pb]
0.076
0.074
0.084
0.081
0.035
0.036
0.031
0.034
0.028
0.036
0.034
0.040
N-In
S-In
OP-out
WL-out
VFBR-out
FPU-out

Conclusions

- Challenges addressed
- Innovative design solutions
- Partnerships key to success
- Addressed last mine drainage influence to Unnamed Tributary



Questions?

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