Storage Tank Optimization

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Overview

1. Water Quality
   - Components
   - Tanks
   - PA DEP Distribution System Optimization Goals
   - PA DEP Tank Operations Worksheet
2. Tank Mixing
3. Case Studies
4. Strategies

Water Quality Components

Components System

- Quality of water entering tank
- Reactivity
- Velocity entering tank
- Temperature and density
- Travel time before entry into tank

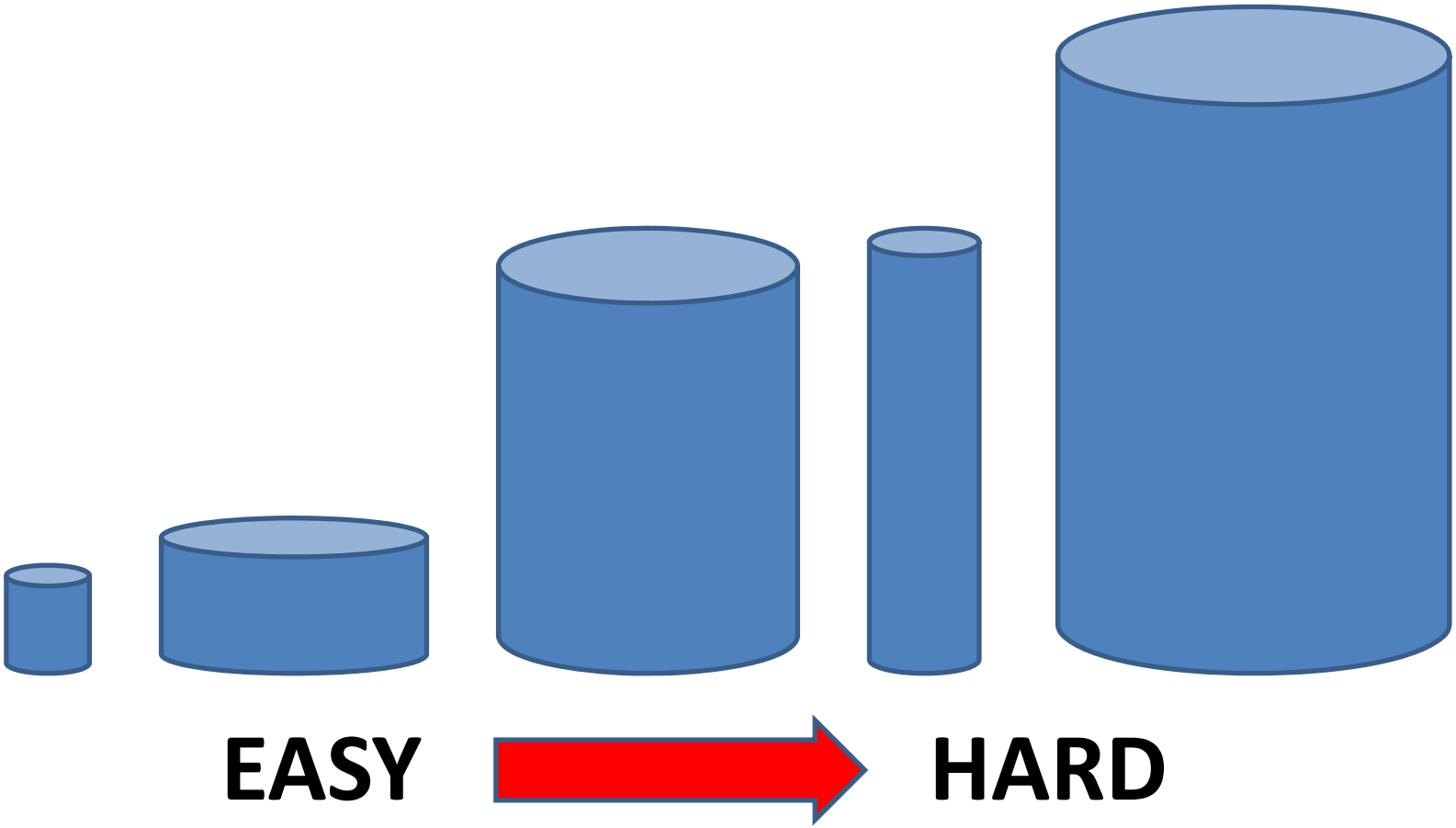
Components Operations

- Always keep the tanks full
- Low usage - seasonal
- Type of disinfectant used

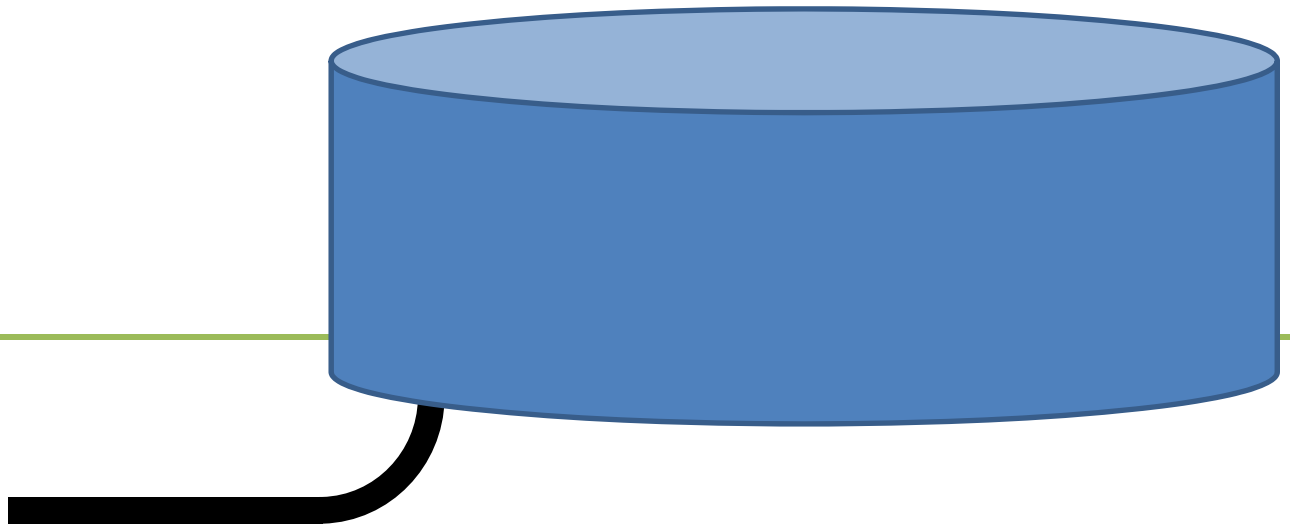
Components Regulatory

- Disinfection Byproducts Rule
- Revised Total Coliform Rule
- Proposed changes from PA DEP
  - 0.20 chlorine residual at entry point
  - 0.2 chlorine residual in system

Tanks Geometry

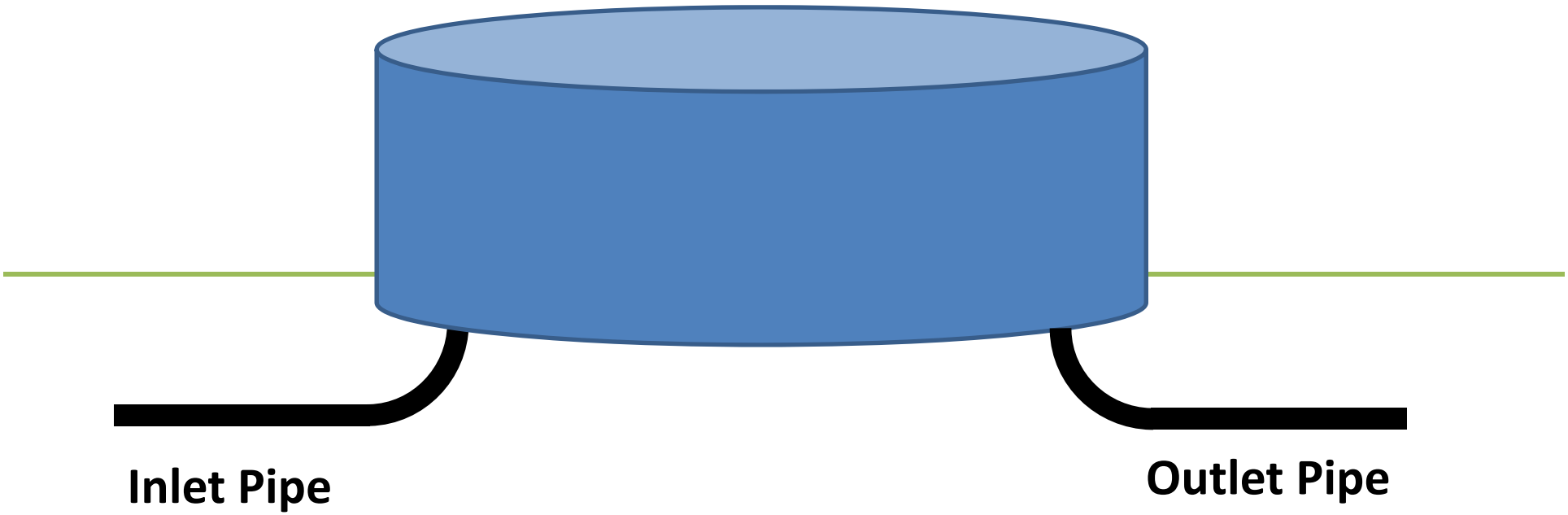


Piping

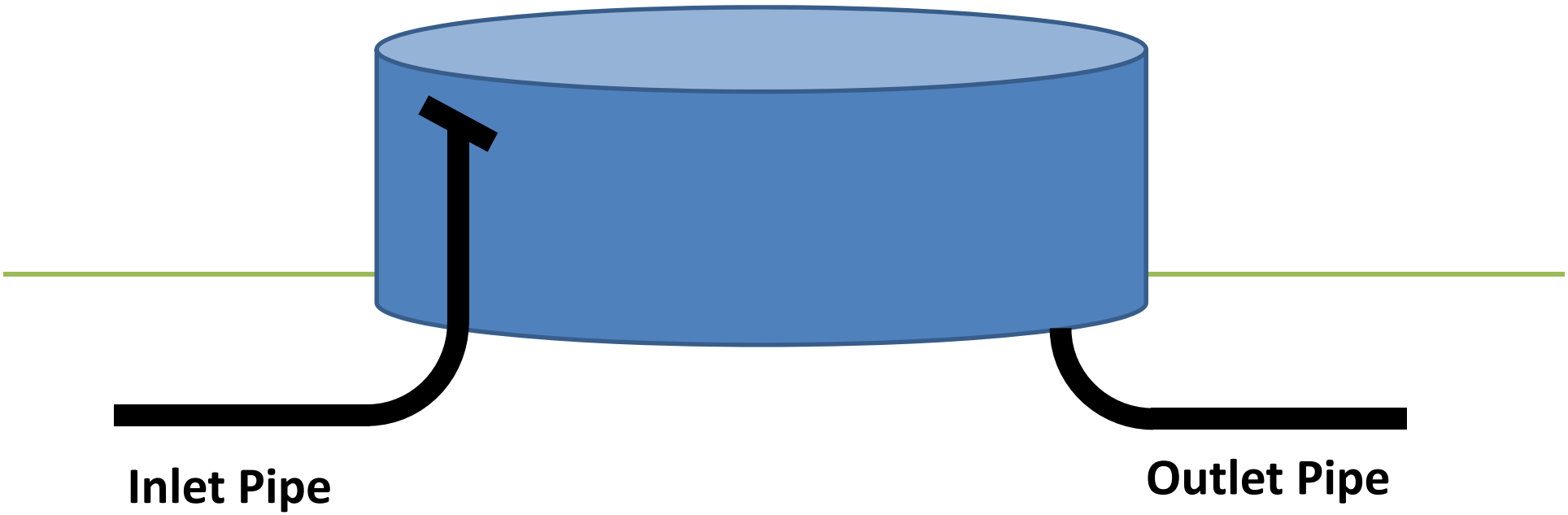


Inlet/Outlet Pipe

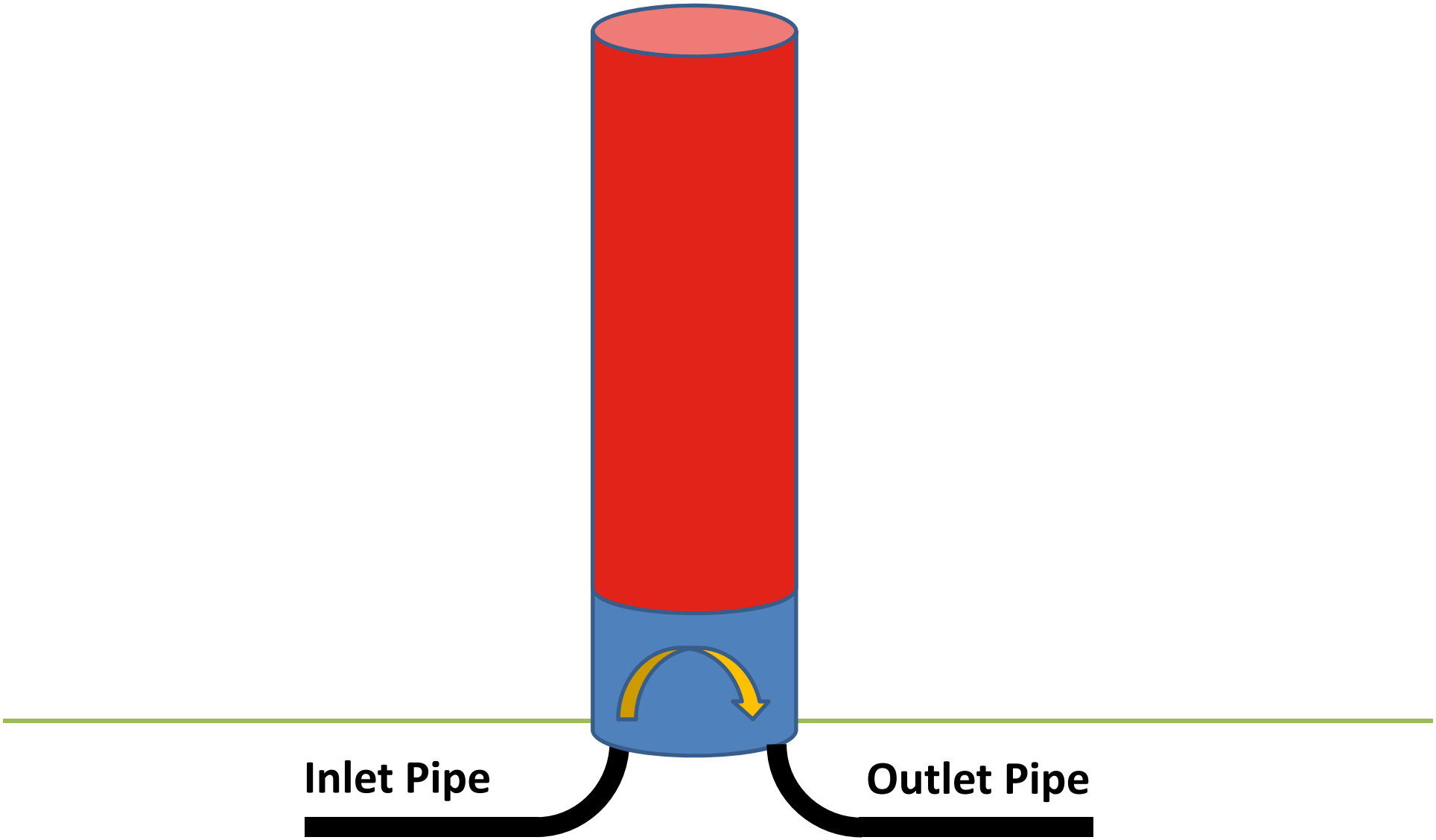
Tank Design: *Back In The Day*



Tank Design: *Options*



Tank Design: *Options*



Tank Design: *Standpipe*

What's the Problem?

Got data?

Monitoring Studies

- **Water Quality** – Chlorine residual readings at various levels inside tank or system.
- Tracer Studies or Computational Fluid Dynamic **(CFD) Modeling** – Info on mixing behavior.
- **Temperature** – Temperatures at various levels inside tank over short and long term.

What's the Problem?

#1: Tank Not Mixed

- Zones of older water
- Thermal stratification
- Chemical stratification
- Sediment buildup

What's the Problem?

#2: High Water Age

- Loss of chlorine residuals
- Microbial growth & biofilm formation
- Formation of disinfectant byproducts
- Nitrification in chloraminated systems
- Taste & odor complaints

What's the Problem?

#3: Freezing

- Coating abrasion
- Structural damage
  - Leaks - bolted
  - Ladders
  - Overflows
- Complete freezing, loss of storage

PA DEP Distribution System Optimization Goals

Tank Operations Guidelines:

1. Maintain turnover time less than or equal to 5 days at all times, or establish and maintain an optimal water turnover rate at each tank.
   - Keep system pressure in mind when manipulating tank operations
2. Maintain good mixing performance ratio (PR ≥1.0) at all times.

PA DEP Distribution System Optimization Goals

Drinking Water Storage Tank Assessment

- Calculates tank turnover and mixing performance ratio (PR)
- Calculations based on theory
- Provide a starting point to enhance tank operations

Tank Summary

Instructions:

1. Enter tank characteristics into section I below. Section II and III will be populated automatically when data is entered into the t
shown in red. Data must be entered into section I for the spreadsheet to function.

2. After completing section I, go to the tank worksheets entitled "Tank #1", "Tank #2", etc. Enter the operational data in Step 1 o
to Step 2 and 3, if appropriate.

3. If the tank calculations in Step 1 determine that turnover time and/or mixing is poor, Step 2 and 3 of the tank worksheet will de
calculations analyze current operations and develop operational solutions to decrease water age and increase mixing in the tank

I. Tank Characteristics (See Glossary worksheet for illustrations of Tank Characteristics)

**Data must be entered into this section for the spreadsheet to function.

**Do not enter tank dimensions if the tank is NOT cylindrical, rectangular, or hydropillar.

**Hydropillar tanks can be approximated as cylindrical tanks depending on their operating range

			Tank #1	Tank #2	Tank #3	T
A.	Name of Tank	Example				
B.	Volume (MG)	0.5				
If the SCADA/ telemetery reports tank level in feet answer question C, then answer questions E, F, and G. If the SCADA/ telemetry does not report the tank level in feet, answer "n" in question C and then answer questions D1, D2, E3, F, and G.						
C.	Is the tank Cylindrical (C), Rectangular (R), Hydropillar[1] (H), or None of these (n)?	c				
D1.	Does the SCADA/ telemetry report tank level in volume (y/n)?	n				
D2.	If SCADA/ telemetry is reported in volume, are the tank mixing equations applicable - see note 4 (y/n)?					
E1.	(if cylindrical/hydropillar/) Tank diameter or (if rectangular) Longest Sidewall length, D (ft)	50				

D2.	If SCADA/ telemetry is reported in volume, are the tank mixing equations applicable - see note 4 (y/n)?			
E1.	(if cylindrical/hydropillar/) Tank diameter or (if rectangular) Longest Sidewall length, D (ft)	50		
E2.	(If rectangular) Shortest Sidewall length, L (ft)			
E3.	(all tanks) Inlet Diameter, d (ft)	1.00		
F.	(all tanks) Maximum Operating Water Depth, H (ft)	24		
G.	(all tanks) Is the tank operated fill-draw (fd) or flow-through[2] (ft)?	fd		
	H/D ratio	0.48	#DIV/0!	#DIV/0!

The remaining data is automatically calculated based on the data entered above:

Are the turnover time calculations applicable?[3]	yes	no	no
Are the mixing equations applicable?[4]	yes	no	no

II. Tank Calculations (from Tank Data Input worksheets)

**If data is missing the reason could be that the tank mixing equations may not be applicable or the that reports volume rather than level.

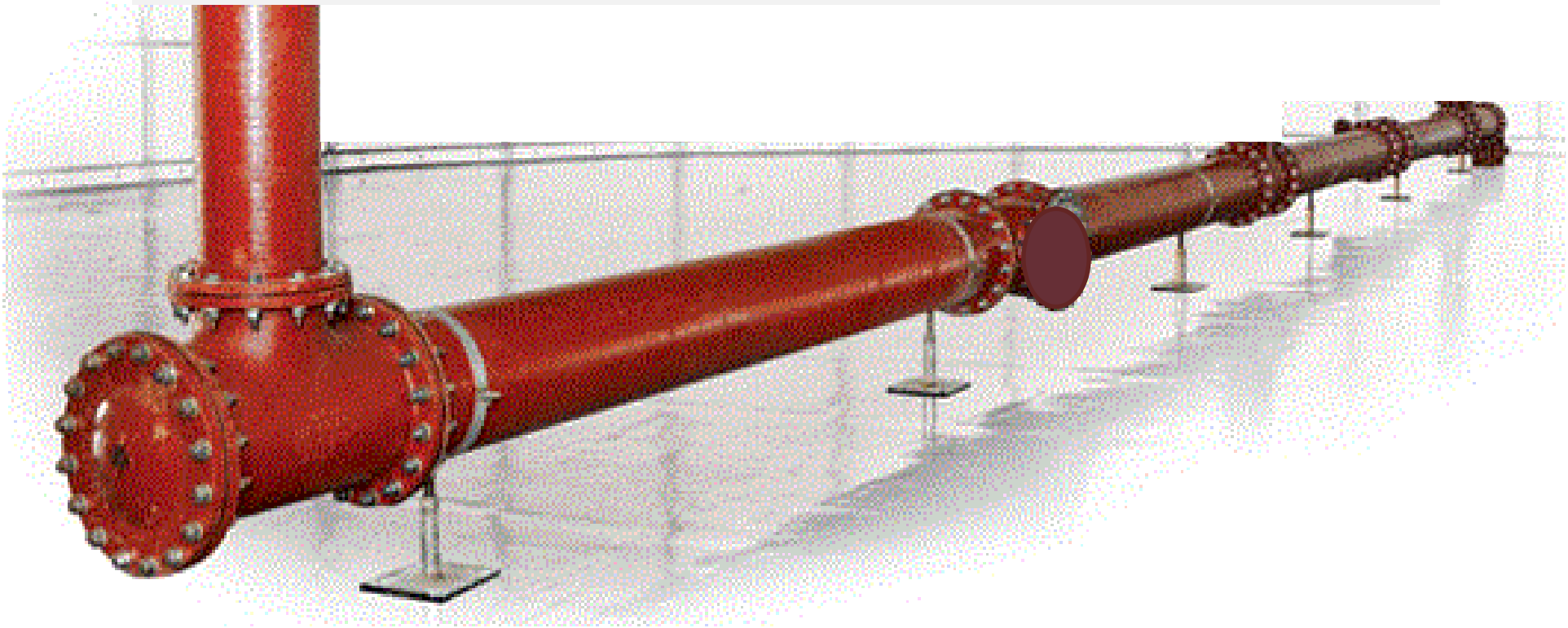
Turnover Time (days)	4.6		
Mixing Performance Ratio (Measured/ Desired)	0.41		

Notes:

1. Hydropillar tanks can be approximated as cylindrical tanks depending on their operating range. See glossary
2. In flow-through operation water is simultaneously coming into the tank and leaving the tank. In fill-draw opera from the tank at any one time (this is typical of most tanks).
3. If the tank operates flow-through the turnover time calculations are not applicable.
4. The mixing calculations are applicable if the tank shape is cylindrical, rectangular, elliptical, or a hydropillar AND are not applicable if the tank operates flow-through OR the tank is irregularly shaped.

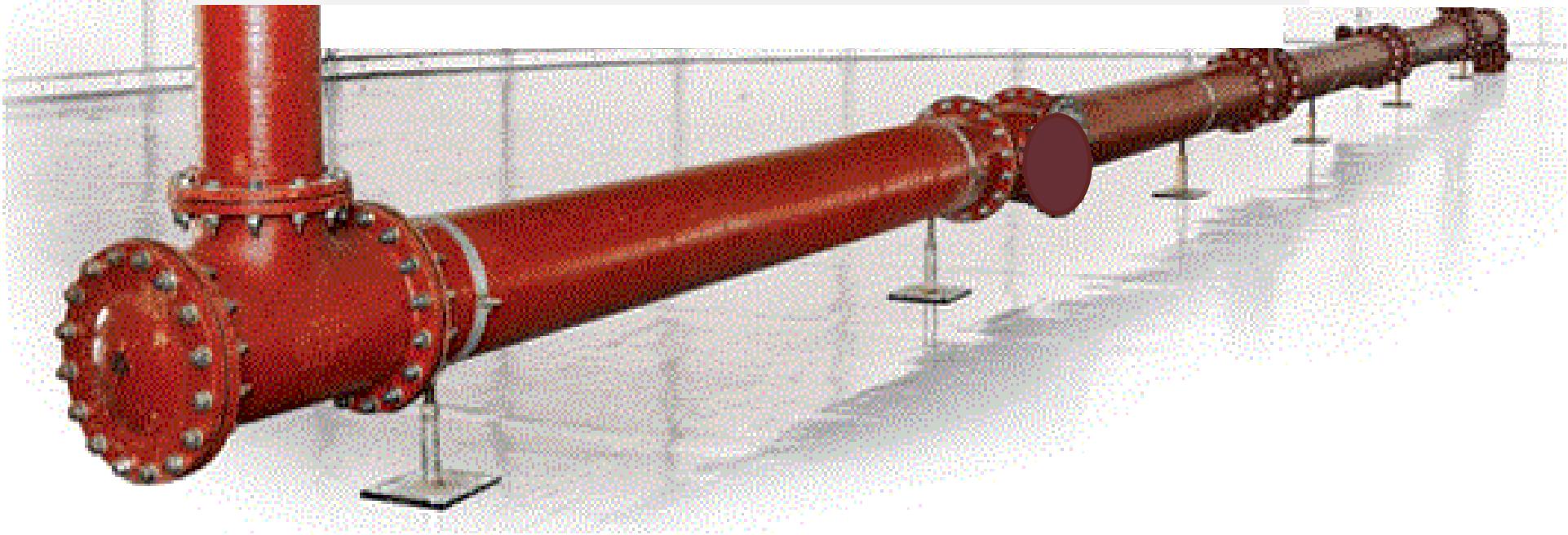
2. Tank Mixing

- Tank mixing is in its infancy.
- Majority of tanks do not have mixers.



What can mixers do?

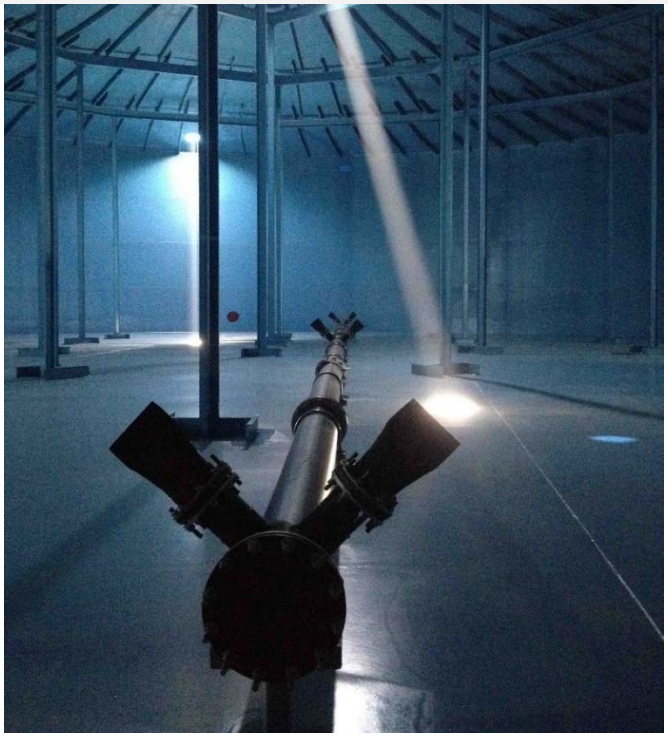
- ☑ Move water in the tank
- ☑ Inject chemicals
- ☒ Reduce water age



Mixers Types

Passive

Increase water velocity upon entering tank to mix.



Active

Provide energy to move water in the tank.

Photos courtesy of Tideflex Technology and PAX Water Technology

Mixers Differences

Passive	**Active**
✗ Moving parts	✓ Moving parts
✗ Power	✓ Power
✗ Maintenance	✓ Maintenance
✓ Drain tank to install	✗ Drain tank to install
✗ Always mixing	✓ Always mixing
✓ Accurate data critical to design	✗ Accurate data critical to design
✗ Move to another tank	✓ Move to another tank
✓ Small pressure loss	✗ Small pressure loss
✓ Chemical injection	✓ Chemical injection

Mixers Passive

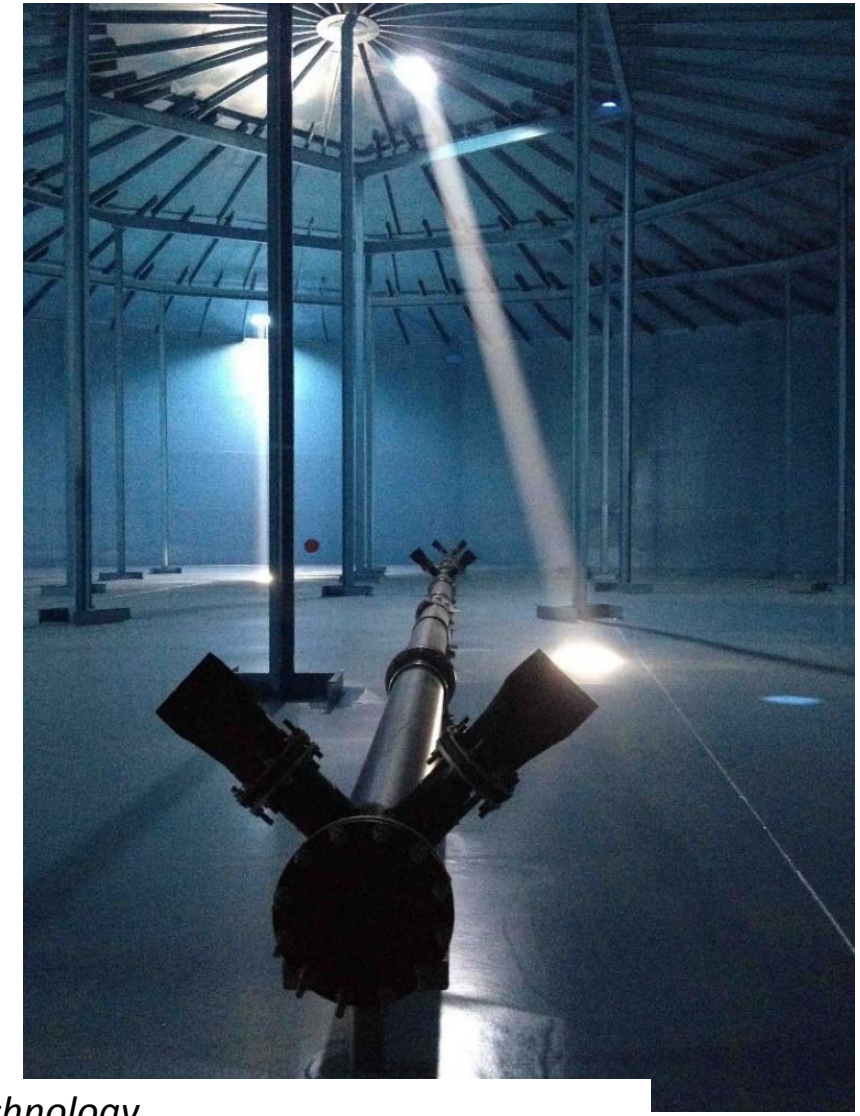


Photo courtesy of Tideflex Technology

Passive Tideflex

Passive Homemade

Passive CB&I - FreshMix

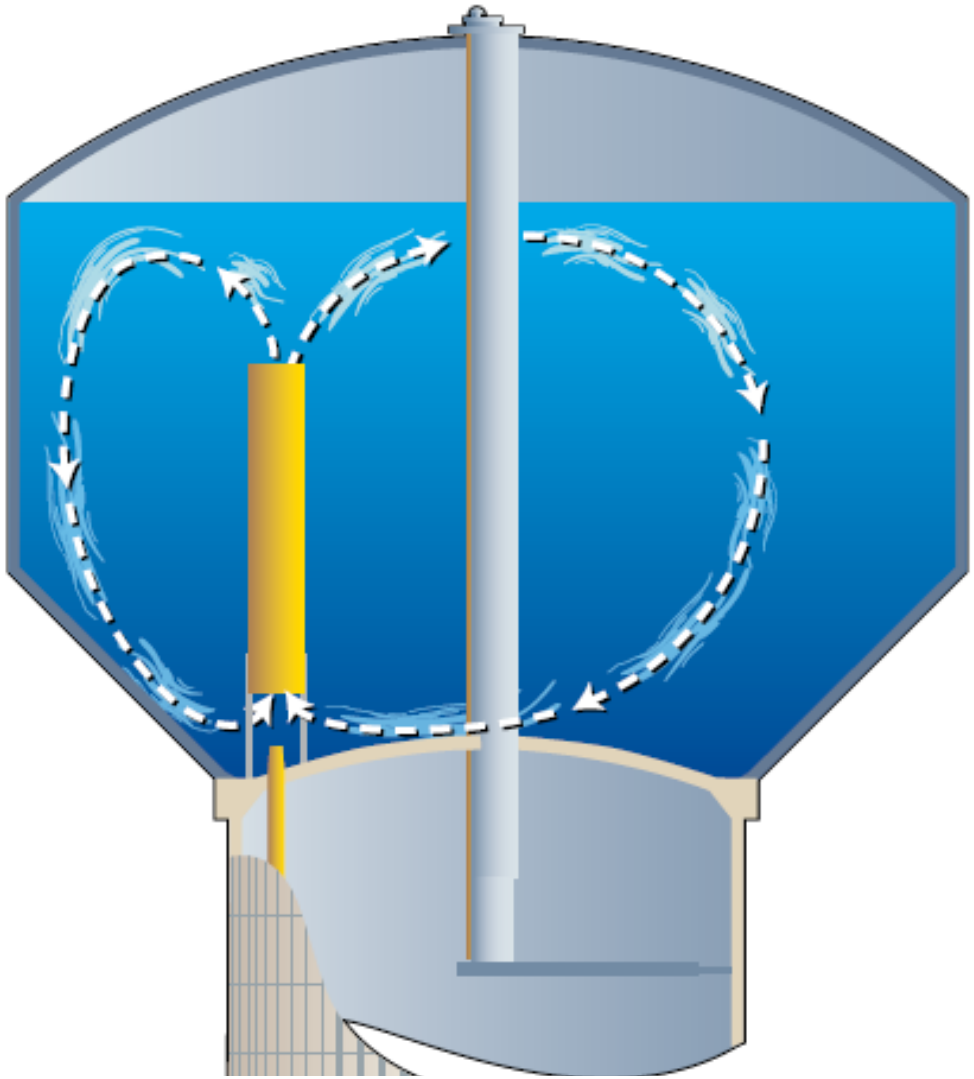


Photo courtesy of CB&I

Passive Landmark Tanks
Hydrodynamic Mixing System (HMS)

Photo courtesy of Landmark Corporation

Passive "Tank Mixer" from York Water

Passive "Tank Mixer" from York Water

Passive "Tank Mixer" from York Water

Mixers Active

Photo courtesy of PAX Water Technology

Active PAX

Photo courtesy of PAX Water Technologies

Active SolarBee

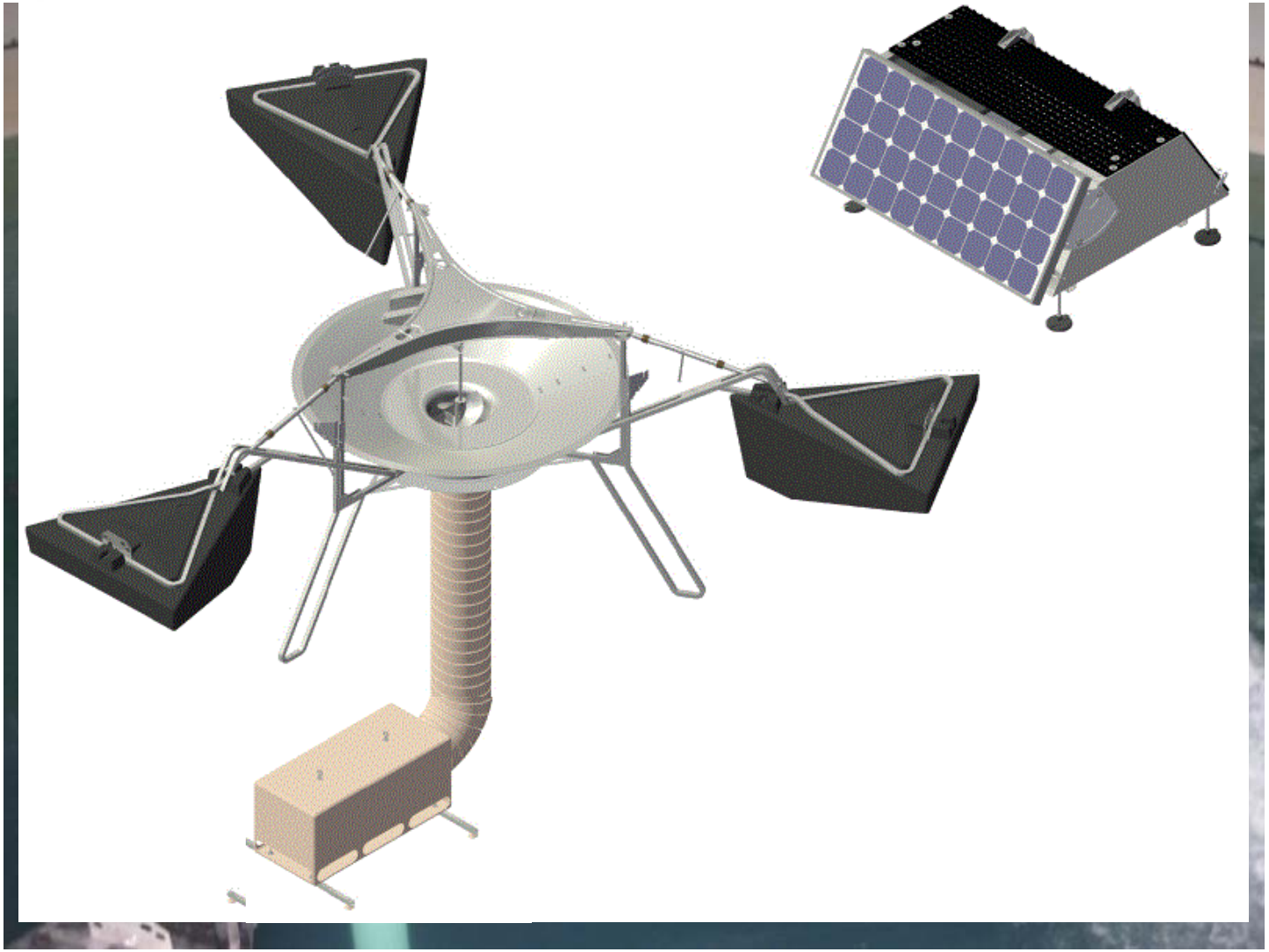


Photo courtesy of Medora Corporation

Photo courtesy of Medora Corporation

Active SolarBee

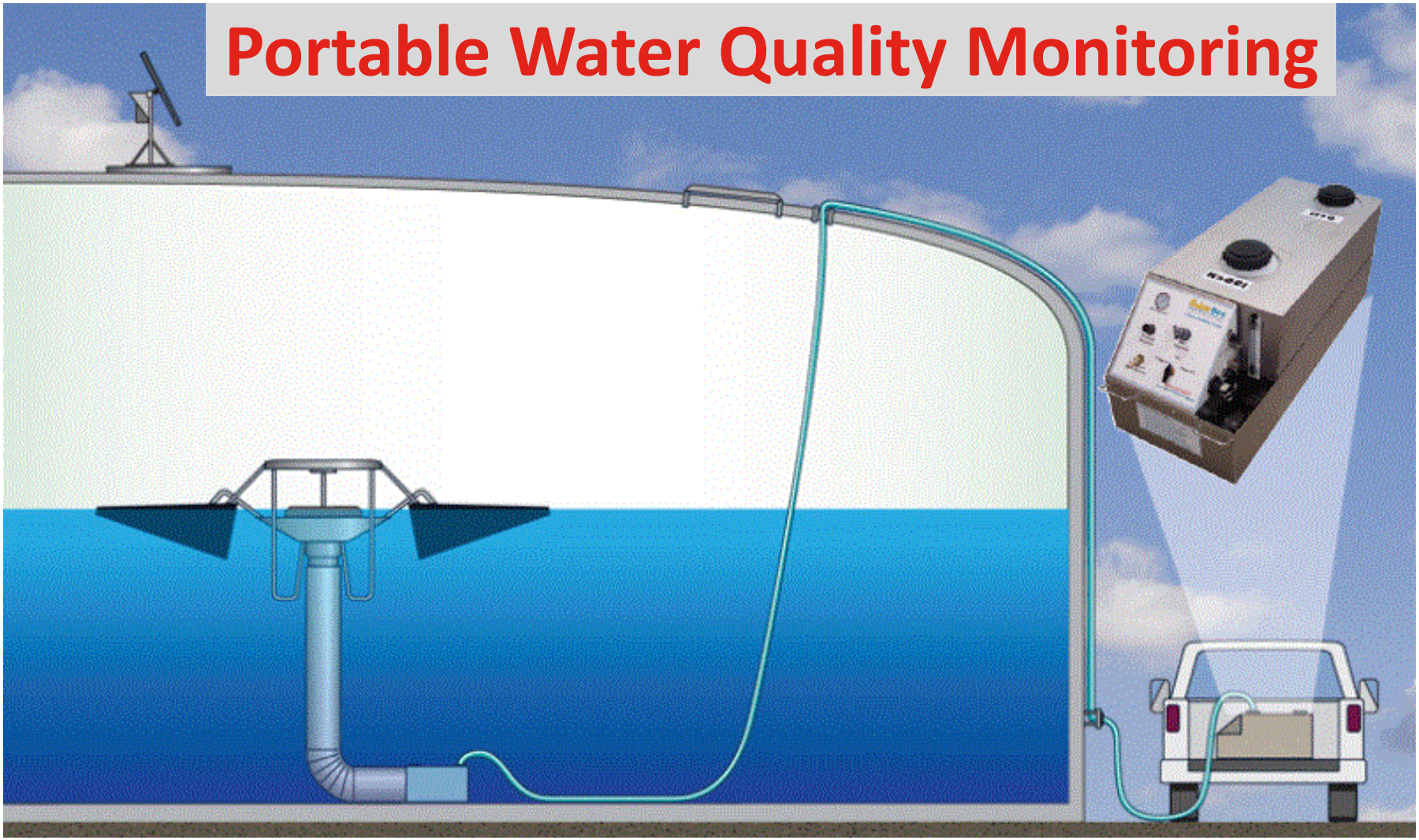


Photo courtesy of Medora Corporation

Active GridBee

Photo courtesy of Medora Corporation

Active Tank Shark

Photo courtesy of UGSI Solutions, Inc.

Active Pulsair

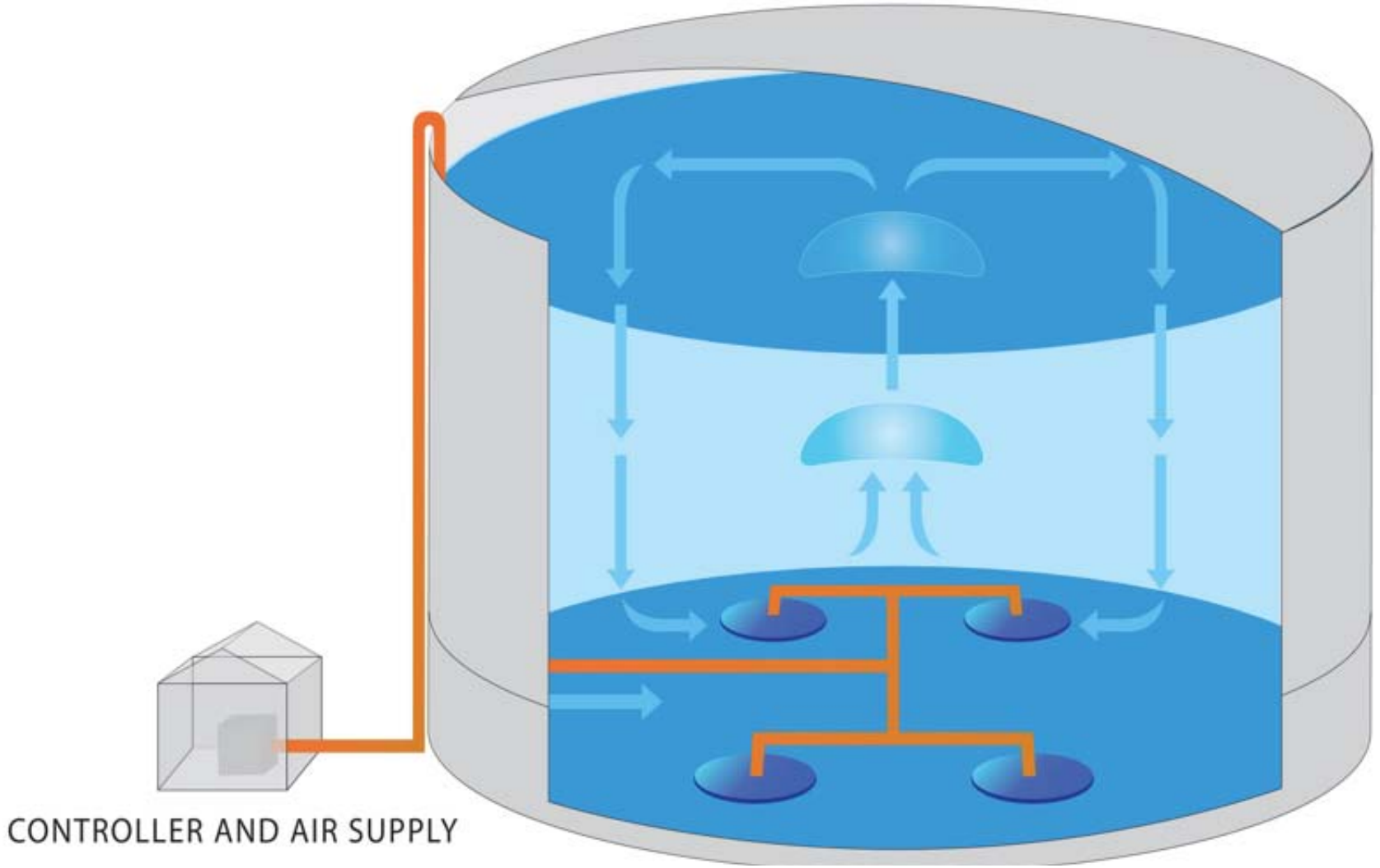
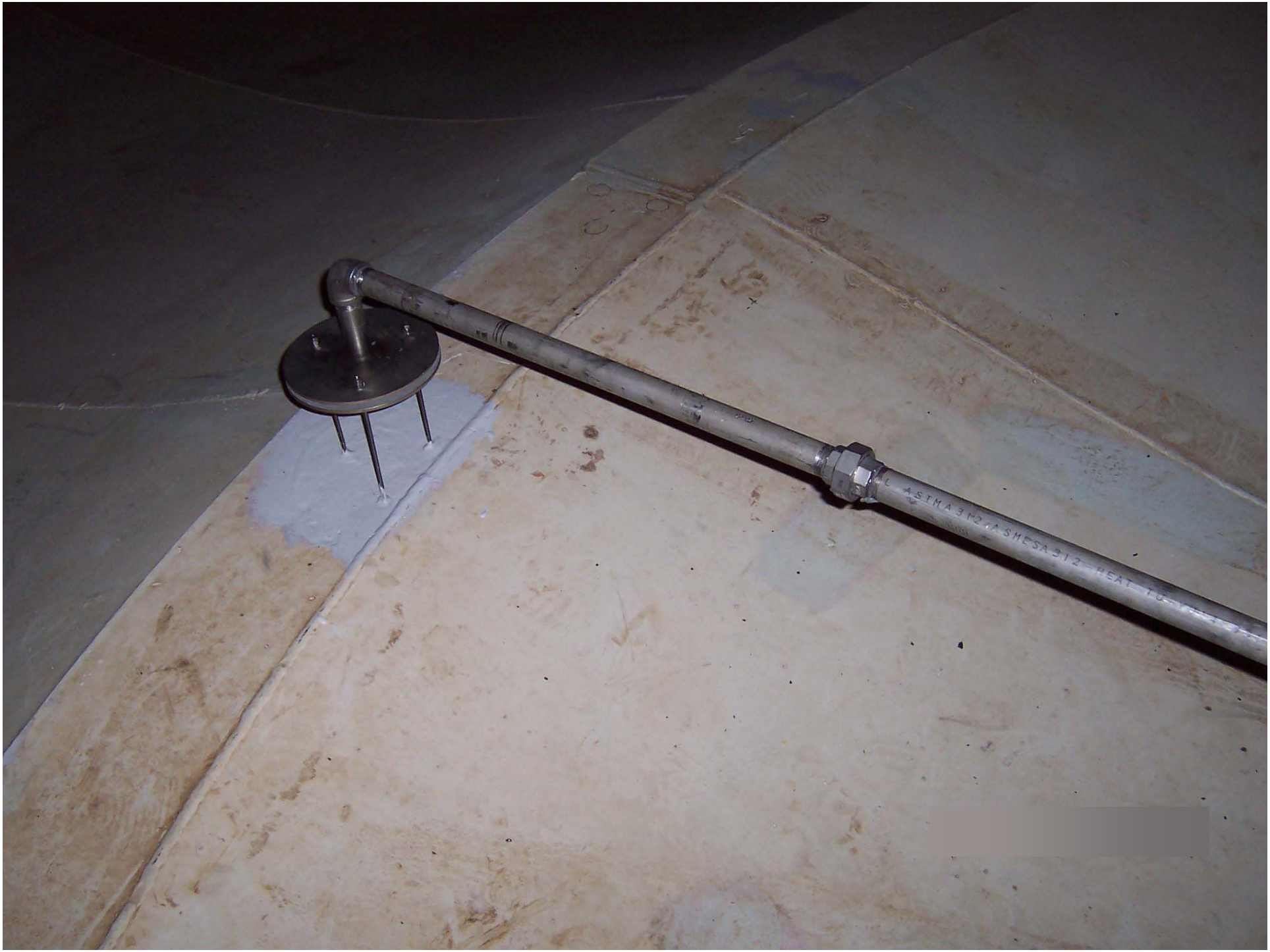


Photo courtesy of Pulsed Hydraulics, Inc.


ASTM A 312 / ASME SA-312 HEAT

Mixers FAQ

1. Do I need to drain and clean out my tank first?
   No, but it's recommended.
2. Does the PA DEP require mixing in all tanks?
   No, but it should be considered.
3. Will the SolarBee work on a shady site?
   Not always.
4. Who installs mixers?
   Owners, Tank Painters, Tank Builders, Suppliers.
5. Which type should I buy?

Accurate Data

POTABLE WATER QUESTIONNAIRE

Please enter as much information as possible in the boxes below, then email this form to INFO@MEDORACO.COM, or fax to 701-225-0002.

SolarBee | GridBee
Medora Corporation

A. TANK LOCATION AND OWNER INFORMATION

RESERVOIR OR TANK OWNER, and CITY and STATE	North Penn Water Authority, Lansdale, PA
RESERVOIR OR TANK NAME	Hilltown #1 and #2 Tanks
TANK STREET ADDRESS	Clearview Rd x E. Cherry Ln., Souderton, PA
CLIMATE NOTE (HOT, DESERT, EXTREME COLD, OTHER)	extreme cold occasionally

CONTACT NAME	Christine Gunsaullus
ORGANIZATION	Entech Engineering
MAILING ADDRESS	PO Box 32, Reading, PA 19603
EMAIL AND FAX	cgunsaullus@entechena.com
PHONE (OFFICE & CELL)	610-373-6667 / 484-354-9201

ARE YOU WORKING WITH A MEDORA CORP. REGIONAL MANAGER OR LOCAL REPRESENTATIVE ? no

B. CITY WATER SYSTEM OVERVIEW

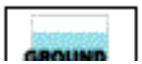
TYPE OF DISINFECTANT BEING USED IN THIS WATER? (CHLORINE, OR CHLORAMINE, OR OTHER)	Chlorine
IS THE SOURCE WATER FROM SURFACE (RIVER AND IMPOUNDMENTS,) OR WELLS	River
EXISTING TANK, OR NEW TANK BEING CONSTRUCTED	Existing
THIS TANK'S MAIN FUNCTION, SUCH AS GENERAL STORAGE, CT TANK, CLEARWELL, OTHER	General Storage
EXISTING AND/OR EXPECTED WATER QUALITY PROBLEMS IN THIS TANK	Want to maintain chlorine levels; no TTHM problems
PROJECT OBJECTIVES: GENERAL MIXING, THM REMOVAL, CHLORINE BOOSTING, ICE PROTECTION	General mixing, ice protection
MOST STATES REQUIRE A PERMIT FOR MIXING OR THM REMOVAL IN A TANK, DOES YOURS	yes

C. TANK DESCRIPTION AND DIMENSIONS (PLEASE FILL OUT THE PERTINENT SECTION BELOW)

PUT "X" IN ONE:

Spheroid		RATED VOLUME, GALLONS		RISER DIAMETER , INCHES		ROOF SHAPE	
Hydropillar		TANK DIAMETER, FEET		WET RISER OR DRY RISER?		CONSTRUCTED OF	
Cylindrical		TANK HEIGHT, FEET		RISER HEIGHT, FEET			
Other		DISTANCE, TANK BOTTOM TO GROUN				'ERIOR OBSTRUCTIONS	
		HATCH: UNOBSTRUCTED L X W, INCHES		LOCATION OF HATCH(S)			

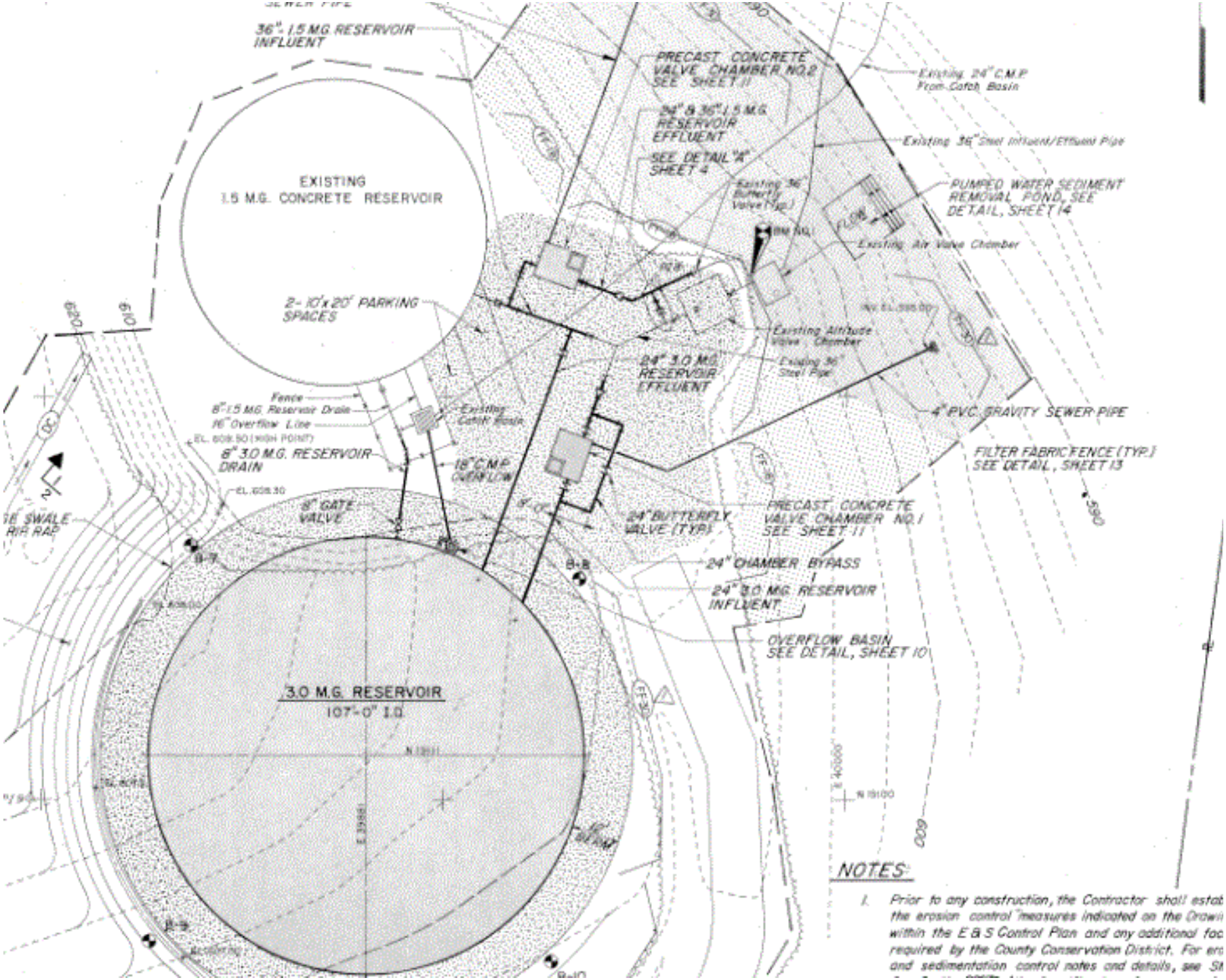
OR



PUT "X" IN ONE:

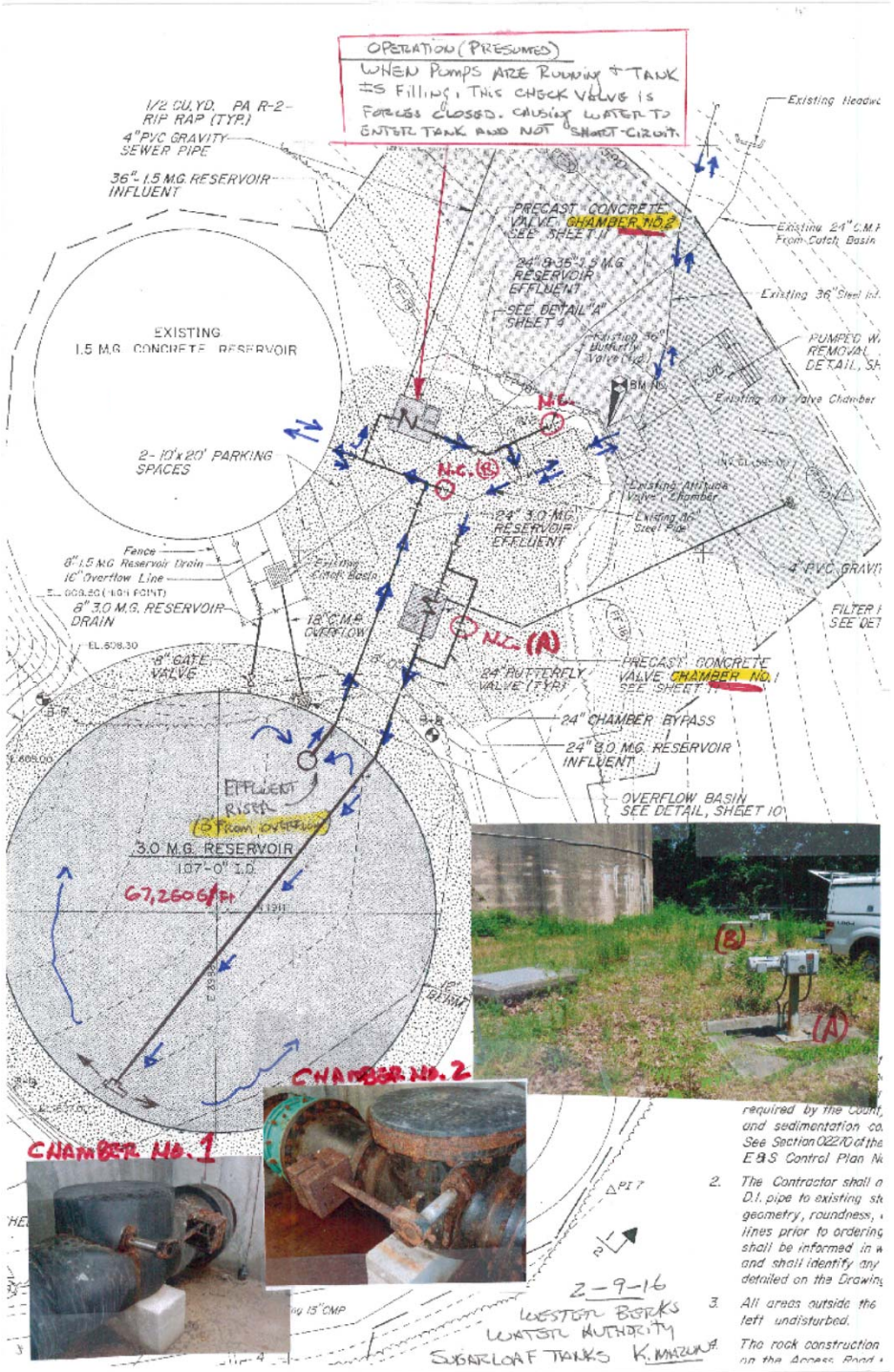
All Above Ground	X	RATED VOLUME, GALLONS	1,500,000	ROOF SHAPE (FLAT, DOMED, OTHER)	domed w/ knuckle

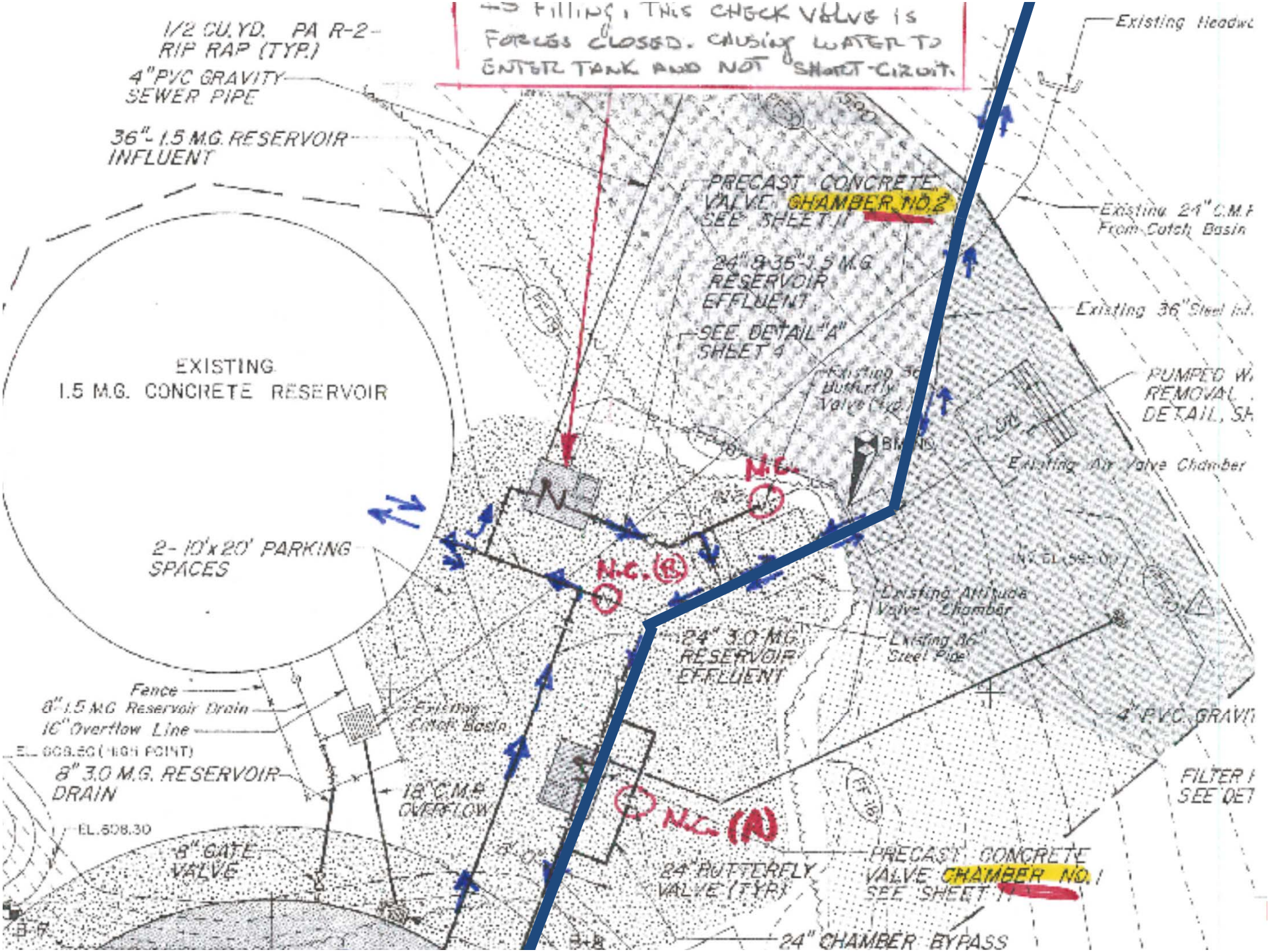

1.5 MG
3.0 MG


36" - 1.5 M.G. RESERVOIR INFLUENT
PRECAST CONCRETE VALVE CHAMBER NO.2 SEE SHEET 11
Existing 24" C.M.P From Catch Basin
24" & 36" 1.5 M.G. RESERVOIR EFFLUENT
SEE DETAIL "A" SHEET 4
Existing 36" Steel Influent/Effluent Pipe
EXISTING 1.5 M.G. CONCRETE RESERVOIR
Existing 36" Butterfly Valve (Typ.)
PUMPED WATER SEDIMENT REMOVAL POND, SEE DETAIL, SHEET 14
Existing Air Valve Chamber
2- 10'x 20' PARKING SPACES
Existing Altitude Valve Chamber
24" 3.0 M.G. RESERVOIR EFFLUENT
Existing 36" Steel Pipe
4" P.V.C. GRAVITY SEWER PIPE
Fence
8" 1.5 M.G. Reservoir Drain
16" Overflow Line
EL. 608.50 (HIGH POINT)
8" 3.0 M.G. RESERVOIR DRAIN
Existing Catch Basin
18" C.M.P. OVERFLOW
FILTER FABRIC FENCE (TYP.) SEE DETAIL, SHEET 13
EL. 608.30
8" GATE VALVE
24" BUTTERFLY VALVE (TYP.)
PRECAST CONCRETE VALVE CHAMBER NO.1 SEE SHEET 11
24" CHAMBER BYPASS
24" 3.0 M.G. RESERVOIR INFLUENT
OVERFLOW BASIN SEE DETAIL, SHEET 10
3.0 M.G. RESERVOIR
107'-0" I.D.
B-7
B-8
B-9
B-10
E 40000
N 19100
NOTES
1. Prior to any construction, the Contractor shall estab
the erosion control measures indicated on the Drawi
within the E & S Control Plan and any additional fac
required by the County Conservation District. For ero
and sedimentation control notes and details, see Sh

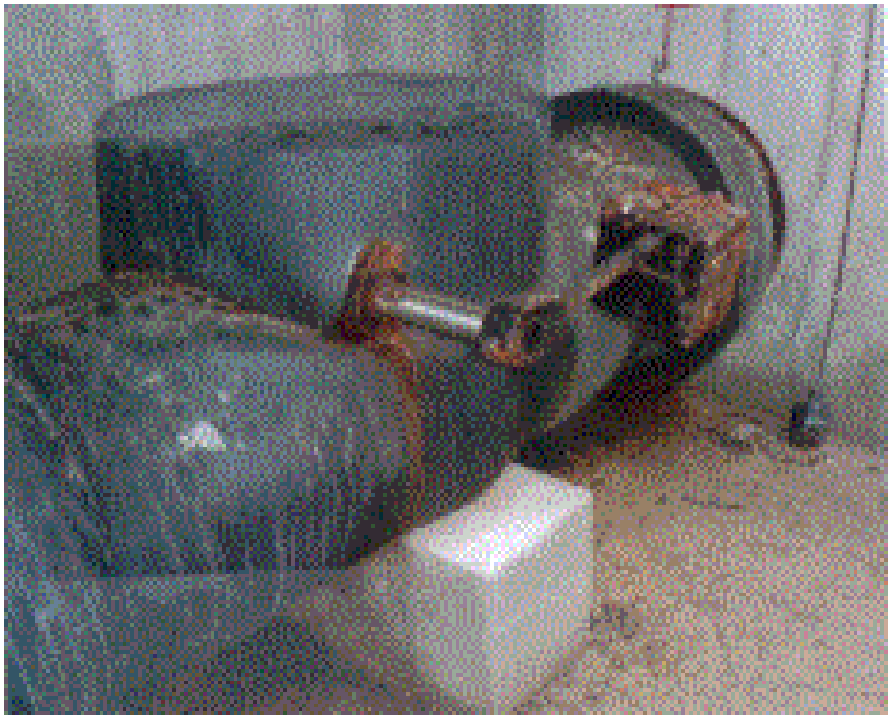
Data

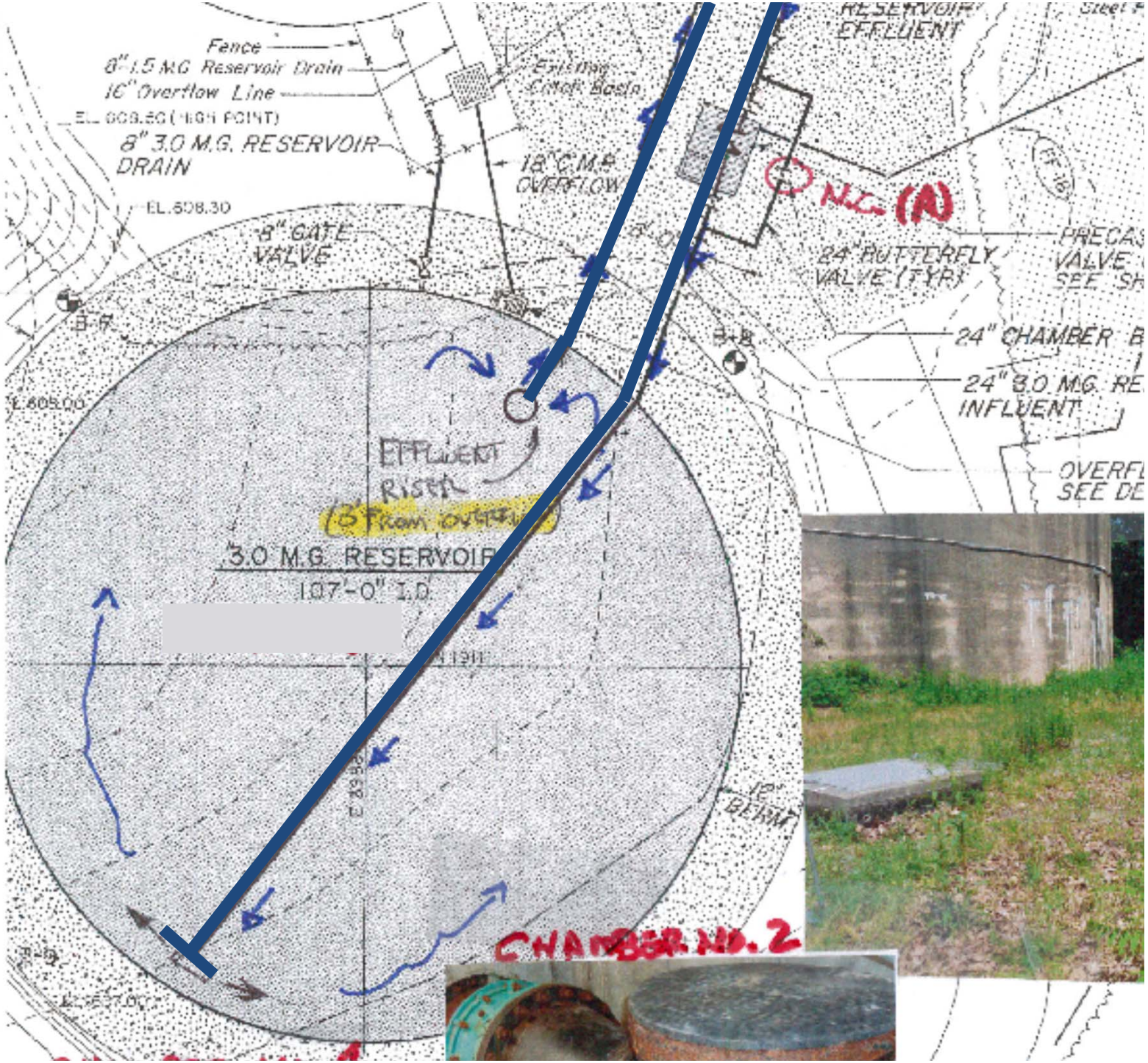
1. Cursory tank evaluations
2. System understanding


OPERATION (PRESUMED)
WHEN PUMPS ARE RUNNING & TANK IS FILLING, THIS CHECK VALVE IS FORCED CLOSED. CAUSING WATER TO ENTER TANK AND NOT SHORT-CIRCUIT.
1/2 CU.YD. PA R-2 RIP RAP (TYP.)
4" PVC GRAVITY SEWER PIPE
36" - 1.5 M.G. RESERVOIR INFLUENT
EXISTING 1.5 M.G. CONCRETE RESERVOIR
2 - 10'x20' PARKING SPACES
PRECAST CONCRETE VALVE CHAMBER NO.2 SEE SHEET 11
24" 9.35-1.5 M.G. RESERVOIR EFFLUENT
SEE DETAIL "A" SHEET 4
Existing 36" Butterfly Valve (N.C.)
Existing Air Valve Chamber
Existing Altitude Valve Chamber
Existing Air Steel Pipe
24" 3.0 M.G. RESERVOIR EFFLUENT
Fence
8" 1.5 M.G. Reservoir Drain
16" Overflow Line
8" 3.0 M.G. RESERVOIR DRAIN
EL. 608.30
18" C.M.P. OVERFLOW
8" GATE VALVE
N.C. (A)
24" BUTTERFLY VALVE (TYP.)
PRECAST CONCRETE VALVE CHAMBER NO.1 SEE SHEET
24" CHAMBER BYPASS
24" 3.0 M.G. RESERVOIR INFLUENT
OVERFLOW BASIN SEE DETAIL, SHEET 10
EFFLUENT RISER
(B From Overflow)
3.0 M.G. RESERVOIR
107'-0" I.D.
67,260 G/Ft
CHAMBER NO. 2
CHAMBER NO. 1
(B)
(A)
2-9-16
WESTON BURKS
WATER AUTHORITY
SUGARLOAF TANKS
K. MARLOW



filling, this check valve is forced closed, causing water to enter tank and not short-circuit.




Fence
8" 1.5 M.G. Reservoir Drain
16" Overflow Line
EL. 608.50 (HIGH POINT)
8" 3.0 M.G. RESERVOIR DRAIN
EL. 606.30
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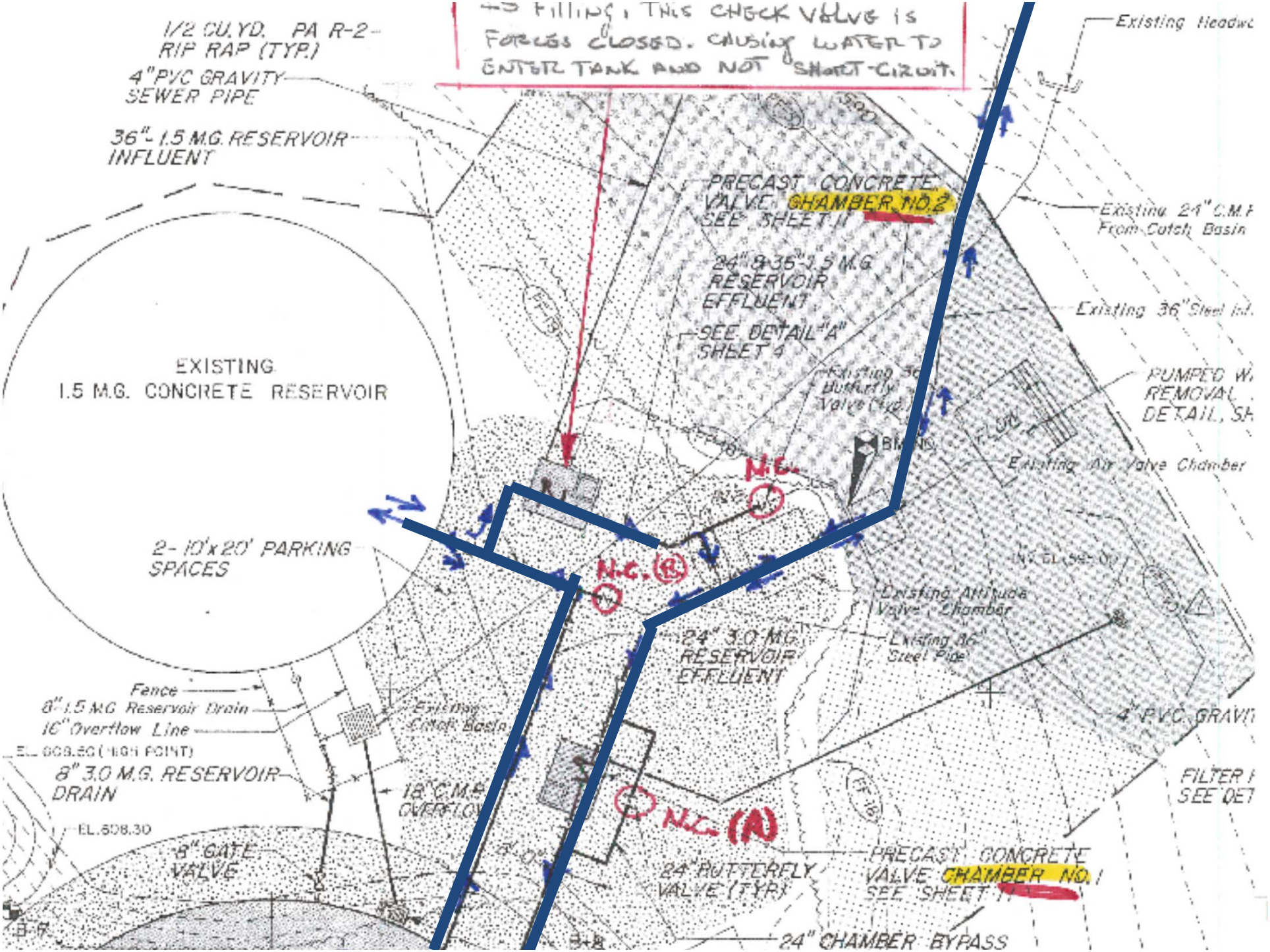
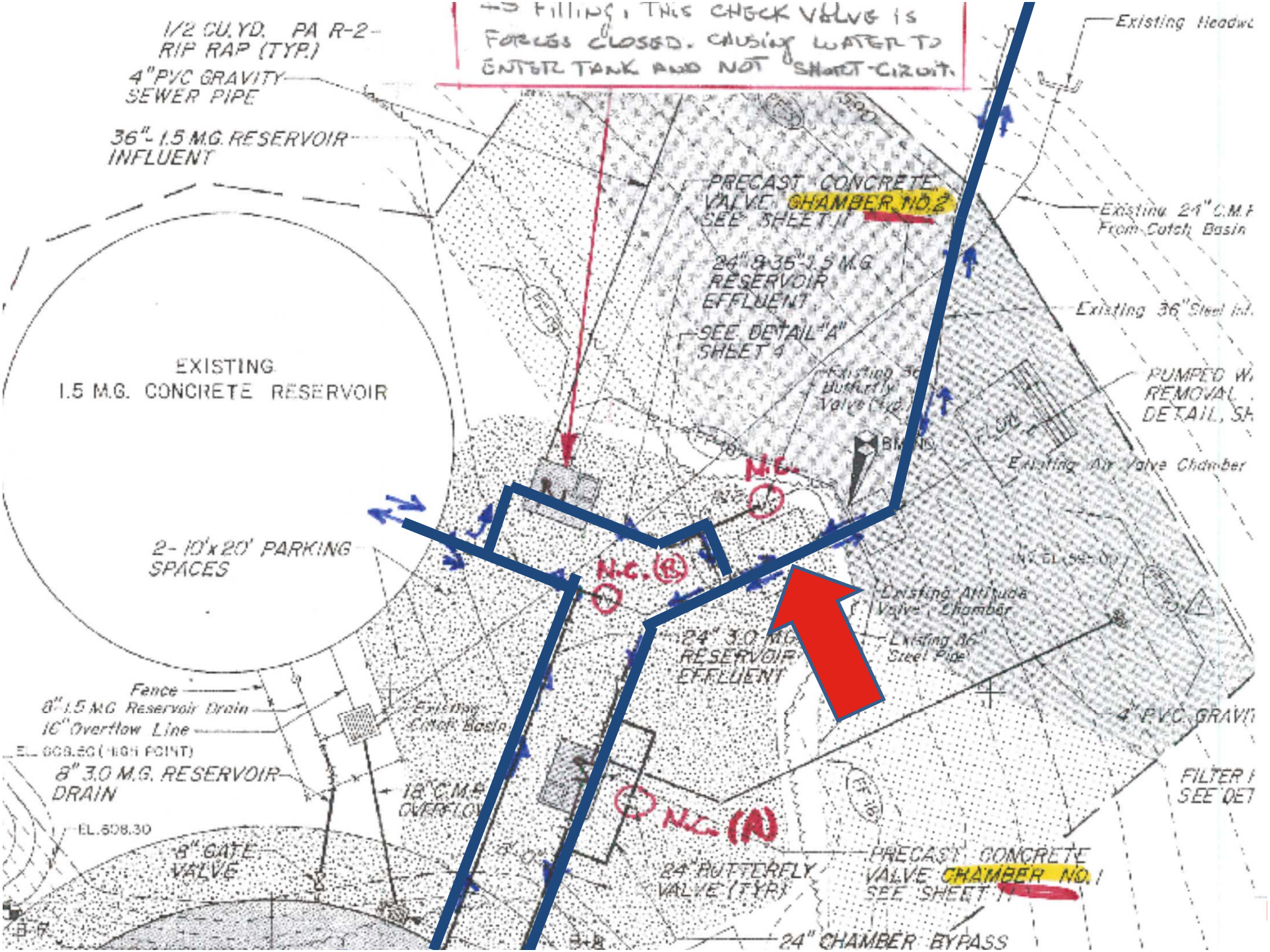
Existing Catch Basin
RESERVOIR EFFLUENT
N.C. (A)
24" BUTTERFLY VALVE (TYP.)
24" CHAMBER
24" 3.0 M.G. RE
INFLUENT
OVERFL
SEE DE
EFFLUENT RISER
(6" From overflow)
3.0 M.G. RESERVOIR
107'-0" I.D.
CHAMBER NO. 2



...s filling, this check valve is forced closed, causing water to enter tank and not short-circuit.

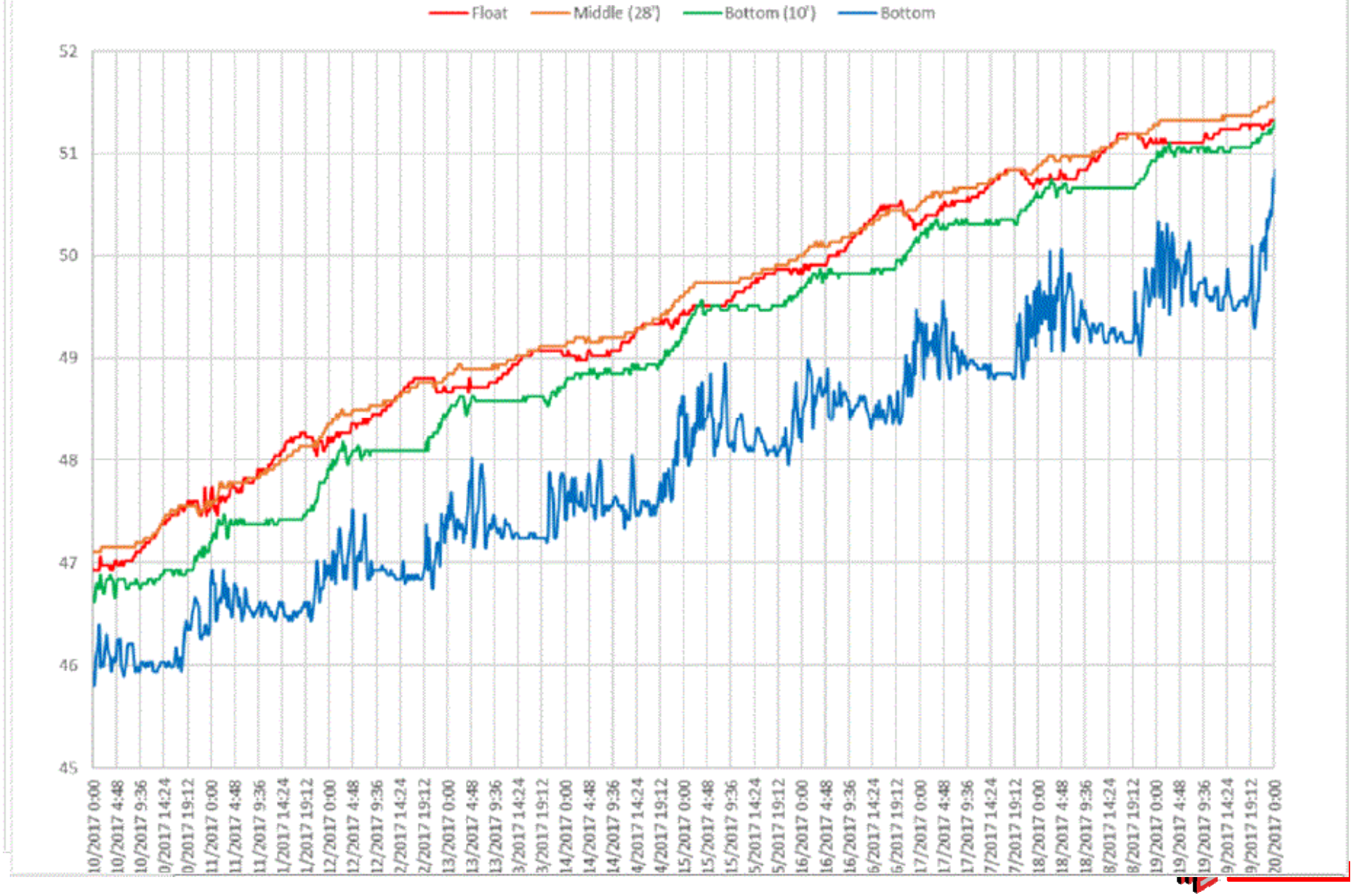


... filling, this check valve is forced closed, causing water to enter tank and not short-circuit.

Data

1. Cursory tank evaluations
2. System understanding
3. Water samples – June 22, 2017
4. Review SCADA data - past 18 months
   - Hourly tank levels
   - Hourly Chlorine Residual at site
   - Chlorine Residual throughout system
   - Hourly pumping rate from plant
   - Hourly air temperatures at plant
5. Temperature probes installed by PAX
   - February thru June 2017

3.0 MG


Float
Middle (28')
Bottom (10')
Bottom
52
51
50
49
48
47
46
45
10/2017 0:00
10/2017 4:48
10/2017 9:36
0/2017 14:24
0/2017 19:12
11/2017 0:00
11/2017 4:48
11/2017 9:36
1/2017 14:24
1/2017 19:12
12/2017 0:00
12/2017 4:48
12/2017 9:36
2/2017 14:24
2/2017 19:12
13/2017 0:00
13/2017 4:48
13/2017 9:36
3/2017 14:24
3/2017 19:12
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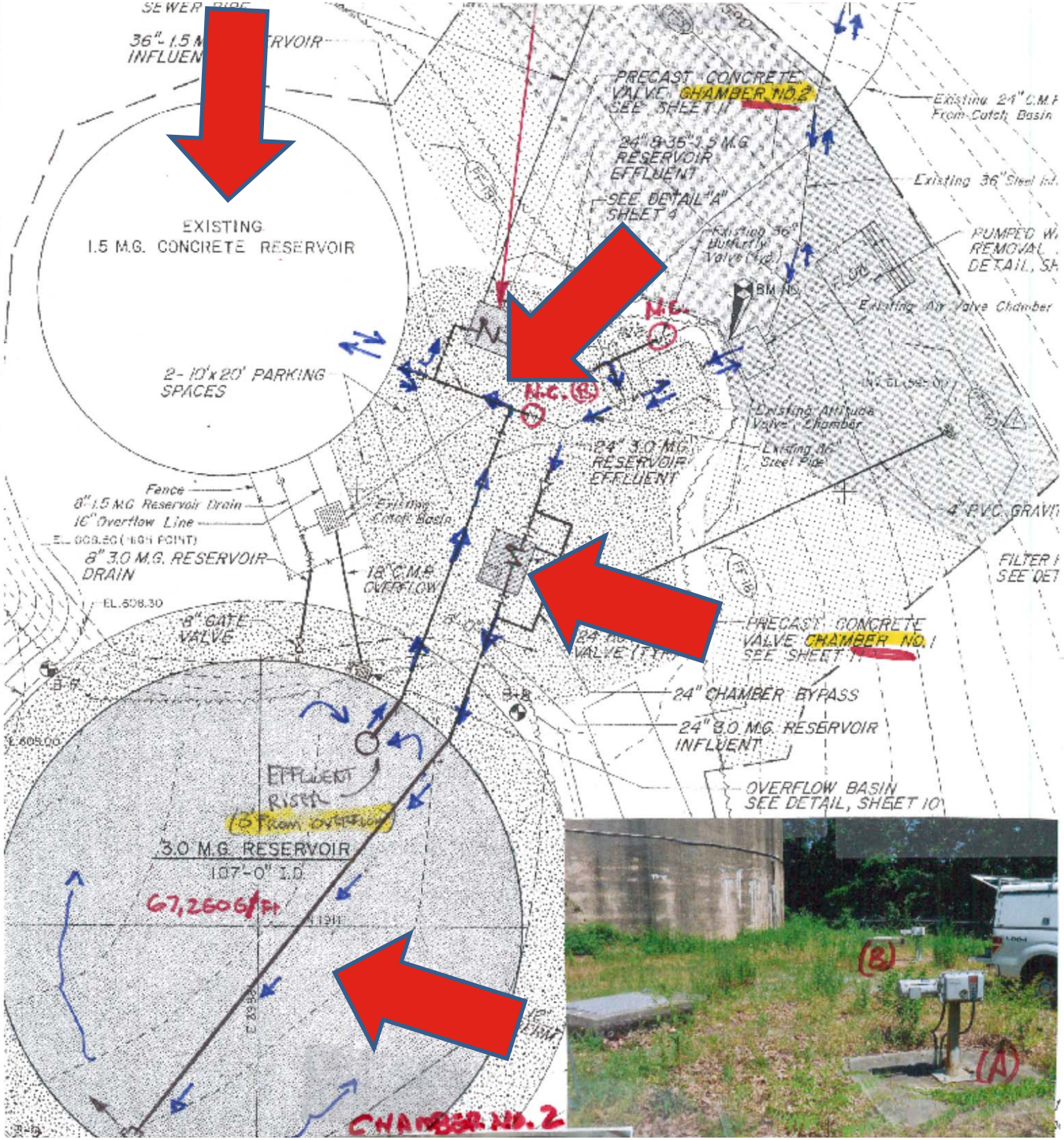
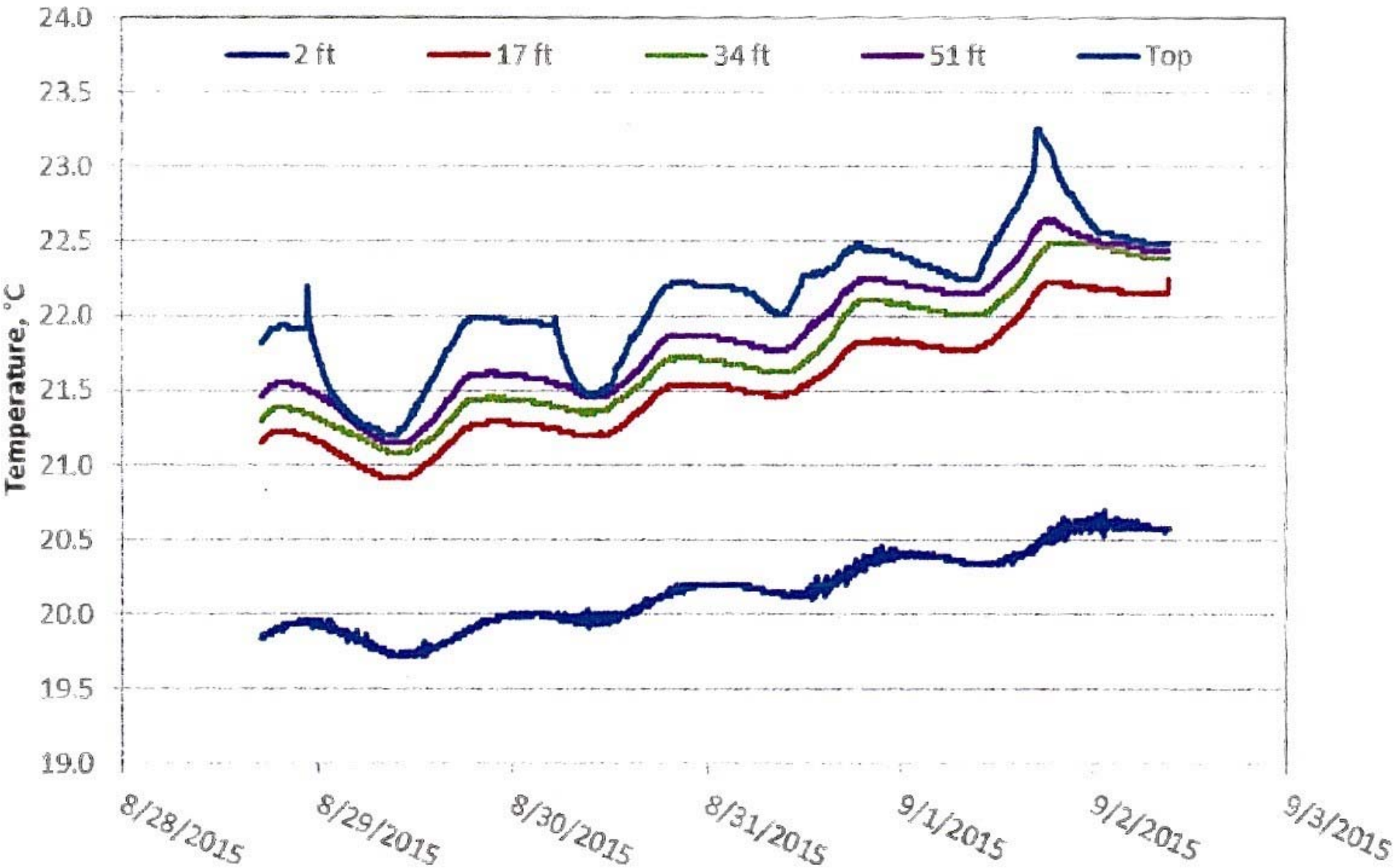
15/2017 0:00
15/2017 4:48
15/2017 9:36
5/2017 14:24
5/2017 19:12
16/2017 0:00
16/2017 4:48
16/2017 9:36
6/2017 14:24
6/2017 19:12
17/2017 0:00
17/2017 4:48
17/2017 9:36
7/2017 14:24
7/2017 19:12
18/2017 0:00
18/2017 4:48
18/2017 9:36
8/2017 14:24
8/2017 19:12
19/2017 0:00
19/2017 4:48
19/2017 9:36
9/2017 14:24
9/2017 19:12
20/2017 0:00

Data

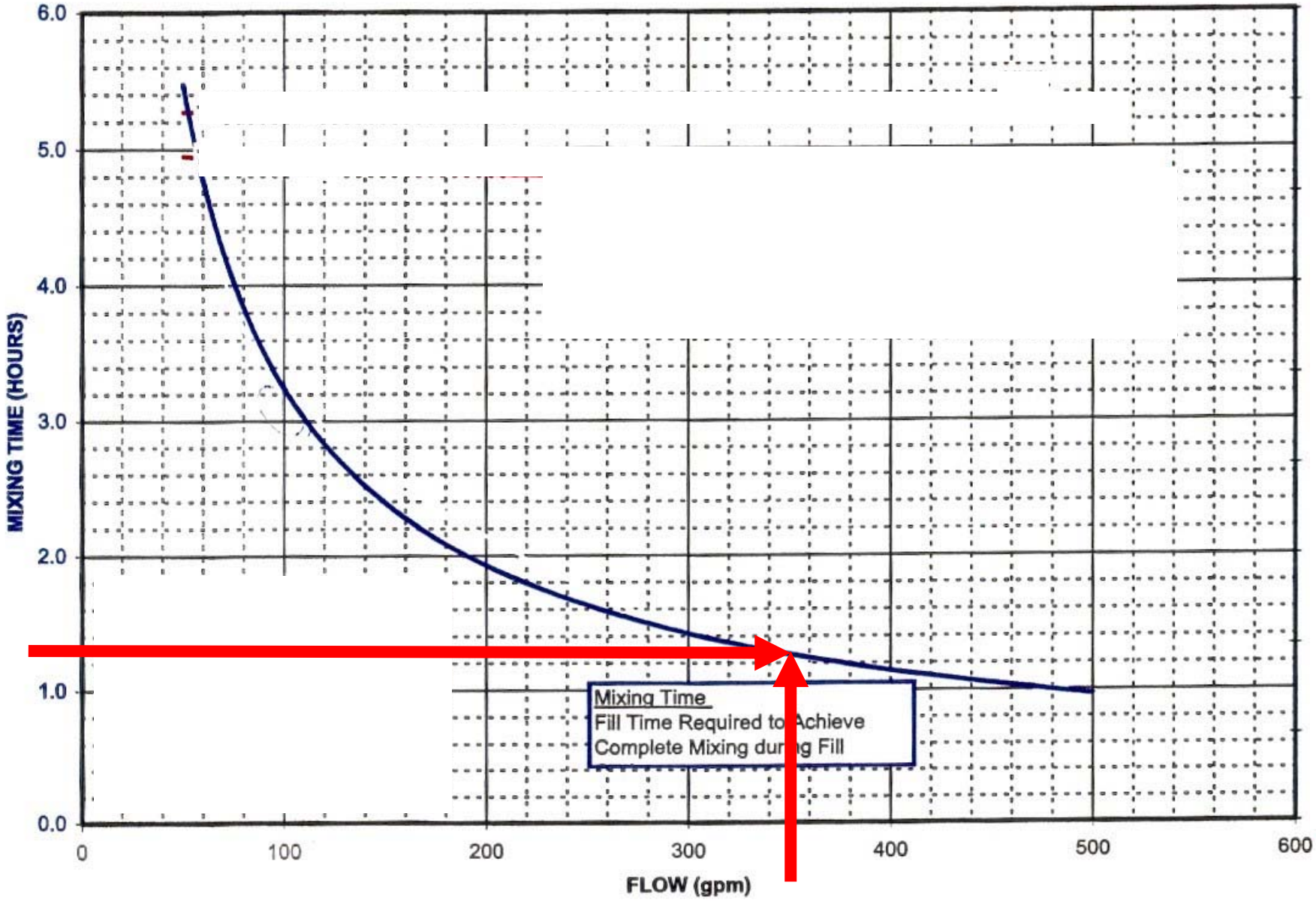
1. Cursory tank evaluations
2. System understanding
3. Water samples – June 20, 2017
4. Review SCADA data - past 18 months
   - Hourly tank levels
   - Hourly Chlorine Residual at site
   - Chlorine Residual throughout system
   - Hourly pumping rate from plant
   - Hourly air temperatures at plant
5. Temperature probes installed by PAX
6. Mixer inspection


EXISTING
1.5 M.G. CONCRETE RESERVOIR
2- 10'x20' PARKING SPACES
PRECAST CONCRETE VALVE CHAMBER NO.2
SEE SHEET 11
24" & 36" 1.5 M.G. RESERVOIR EFFLUENT
SEE DETAIL "A" SHEET 4
Existing 24" C.M.P. From Catch Basin
Existing 36" Steel Inf.
Existing 36" Butterfly Valve (typ.)
BM No.
Existing Air Valve Chamber
N.C.
N.C.
Existing Altitude Valve Chamber
24" 3.0 M.G. RESERVOIR EFFLUENT
Existing 16" Steel Pipe
Fence
8" 1.5 M.G. Reservoir Drain
16" Overflow Line
8" 3.0 M.G. RESERVOIR DRAIN
Existing Catch Basin
18" C.M.P. OVERFLOW
EL. 608.30
8" GATE VALVE
PRECAST CONCRETE VALVE CHAMBER NO.1
SEE SHEET 11
24" CHAMBER BYPASS
24" 3.0 M.G. RESERVOIR INFLUENT
OVERFLOW BASIN
SEE DETAIL, SHEET 10
EFFLUENT RISER
(B From overflow)
3.0 M.G. RESERVOIR
107'-0" I.D.
67,260 Gal
CHAMBER NO. 2
(B)
(A)


24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
19.0
Temperature, °C
2 ft
17 ft
34 ft
51 ft
Top
8/28/2015
8/29/2015
8/30/2015
8/31/2015
9/1/2015
9/2/2015
9/3/2015

Mixing Time and Minimum Required Drawdown

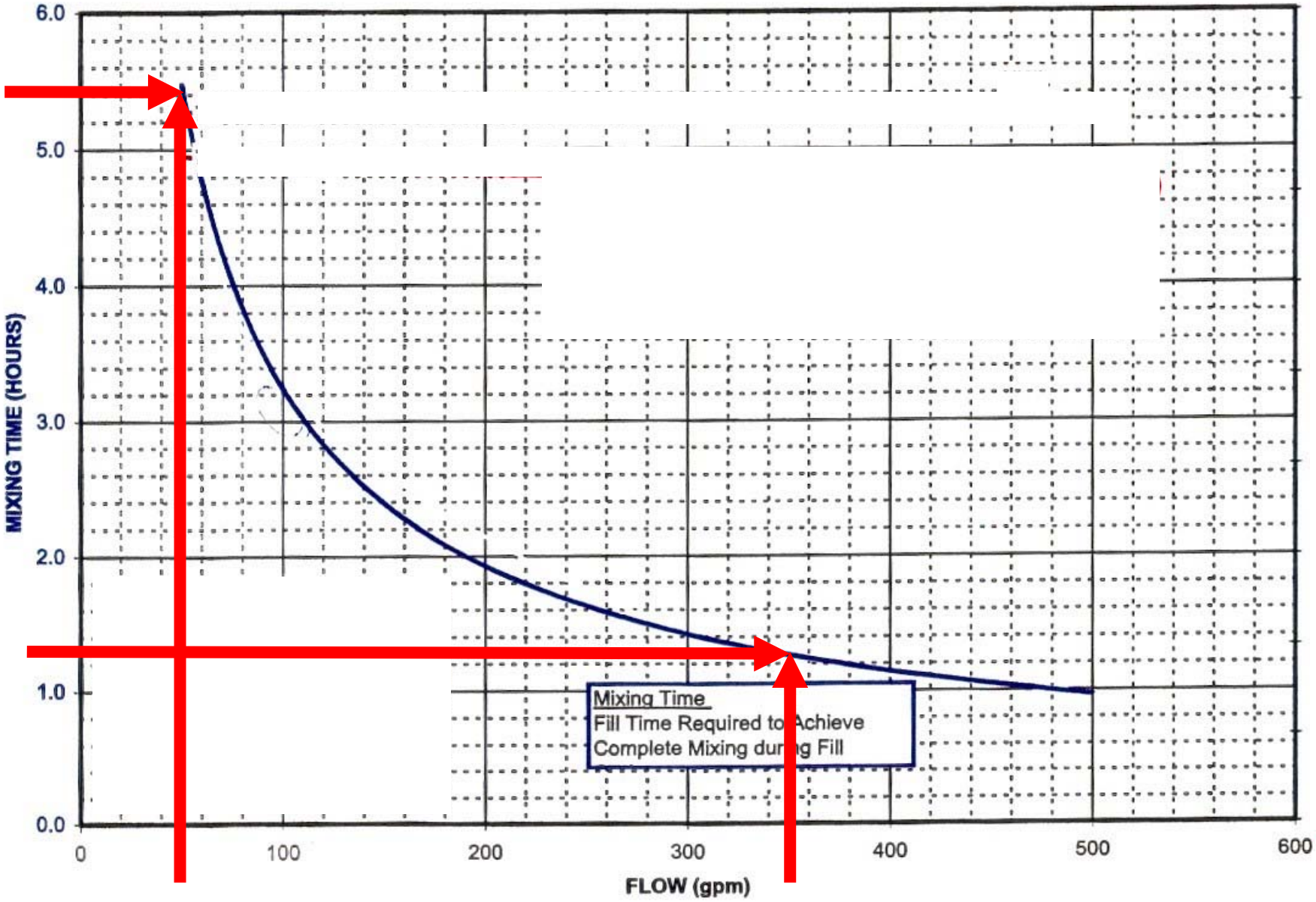
0.25MG Standpipe




Pump: 350 gpm
750,000 Gal.
250,000 Gal.

Mixing Time and Minimum Required Drawdown

0.25MG Standpipe




1.0
MG
1.0
MG
10.0
MG
1.5
MG

PSI provides equipment.
Owner does installation.

Rowlett, TX

4. Strategies

- Inside Tanks
  - Piping
  - Mixers
  - Chemical Injection
  - Water Levels
- Outside Tanks
  - Chlorine Booster Station
- Distribution System
  - Sensors & Controls
  - Demo Tanks

Lessons Learned

- Water systems are complex.
- Solution for one tank or part of the system may not work for others.
- Understand system operations.
- Data. Accurate data.
- Technology is evolving, prices dropping.
- Fix one problem...
- Water systems are complex.

Questions?

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