MINE DRAINAGE AERATION USING A TROMPE

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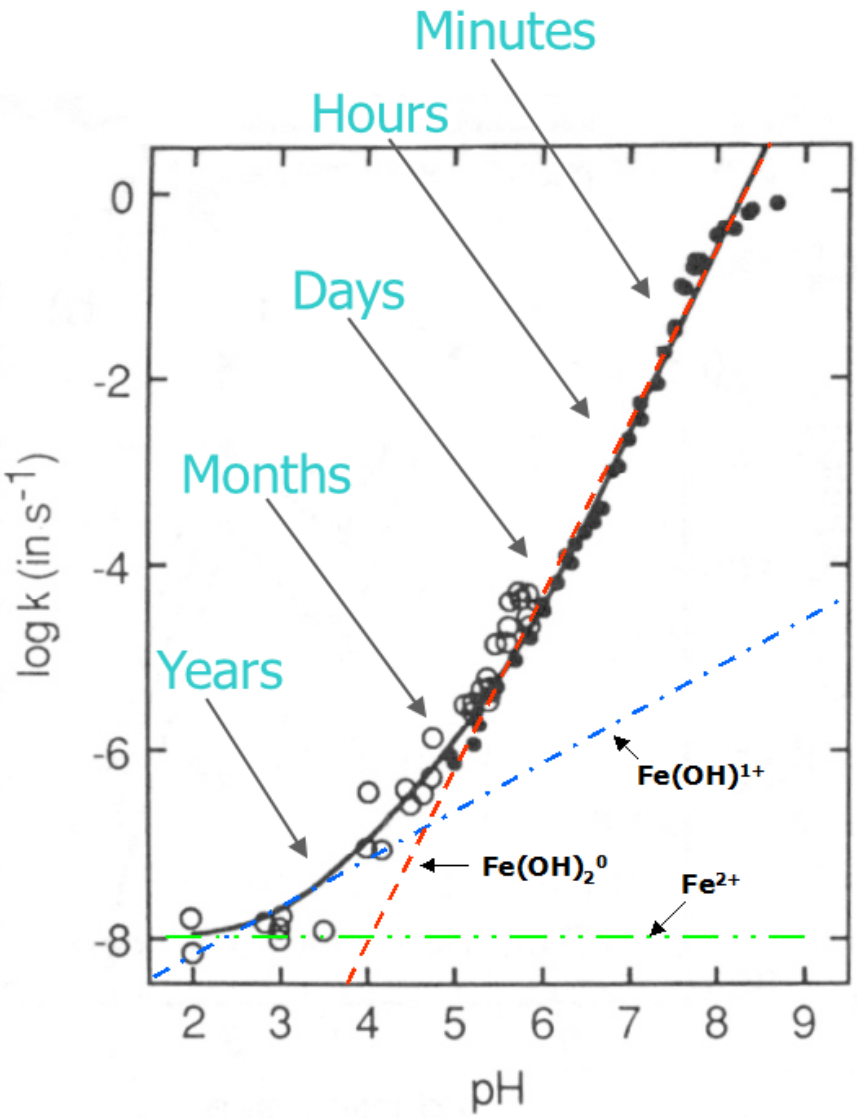
Aeration

- Most mine drainage treatment facilities require aeration for iron oxidation.
- $Fe^{2+} + ¼\ O_2 + H^+ \rightarrow Fe^{3+} + ½\ H_2O$
- The time required for this reaction to occur is dependent on oxygen transfer to the water and the pH of the water.



Effect of pH

- The higher the pH the faster iron is oxidized.
- As iron is oxidized the pH is lowered lengthening the time required for oxidation.
- This increase in detention time requires a proportional increase in pond size.

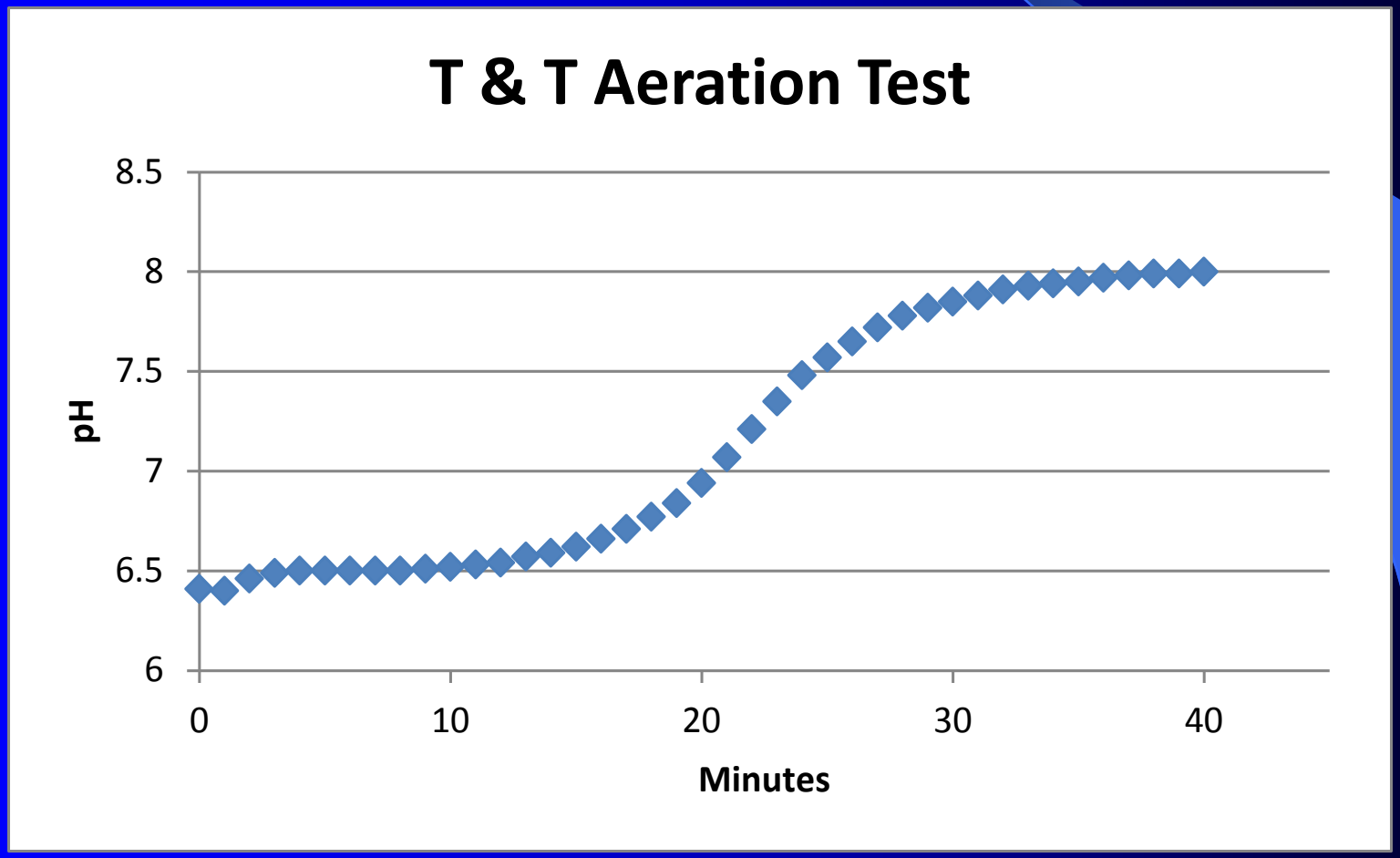
After Dietz 2008

Effect of Carbon Dioxide

- Mine drainage from underground mines frequently contains excess carbon dioxide.
- The effect of this excess carbon dioxide is to lower the pH of the raw water.
- Aeration of mine water will remove the excess carbon dioxide and could increase pH (Kirby et al., 2009).

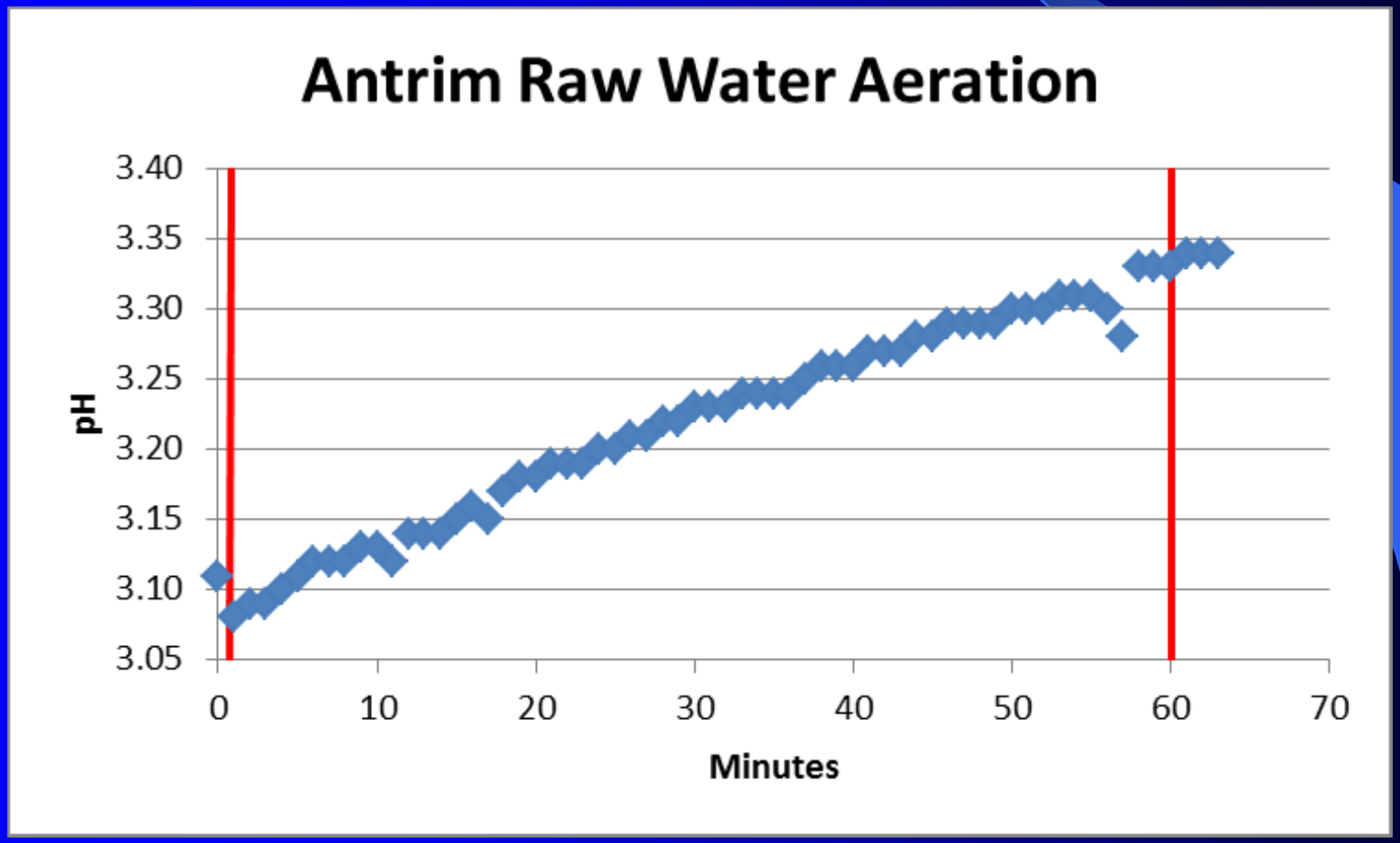
Aeration Removes CO_2 and Increases pH

$H^+ + HCO_3^- \leftrightarrow H_2O + CO_2\,(g)$



Aeration Removes CO_2 and Increases pH Continued

$$H^+ + HCO_3^- \leftrightarrow H_2O + CO_2\,(g)$$



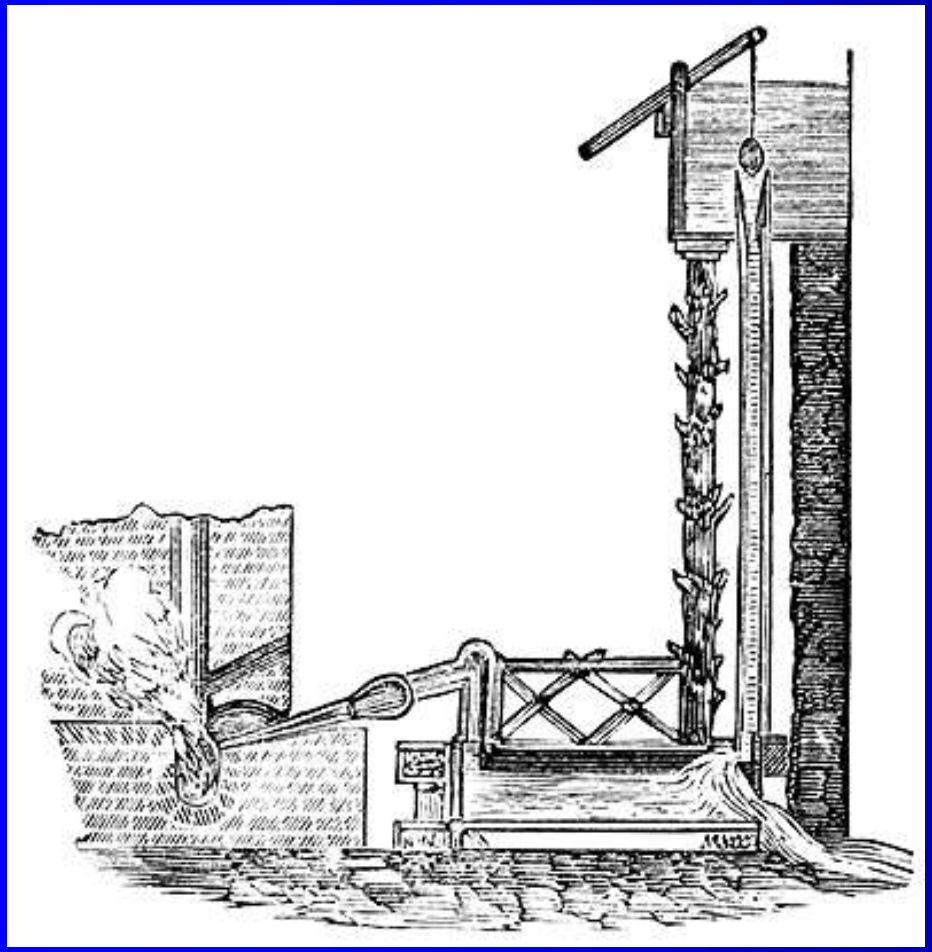
What is a TROMPE?

- It is a device that uses falling water to compress air.
- It has No moving parts.
- It does Not use electricity.
- It is Completely passive.

Principals of Operation

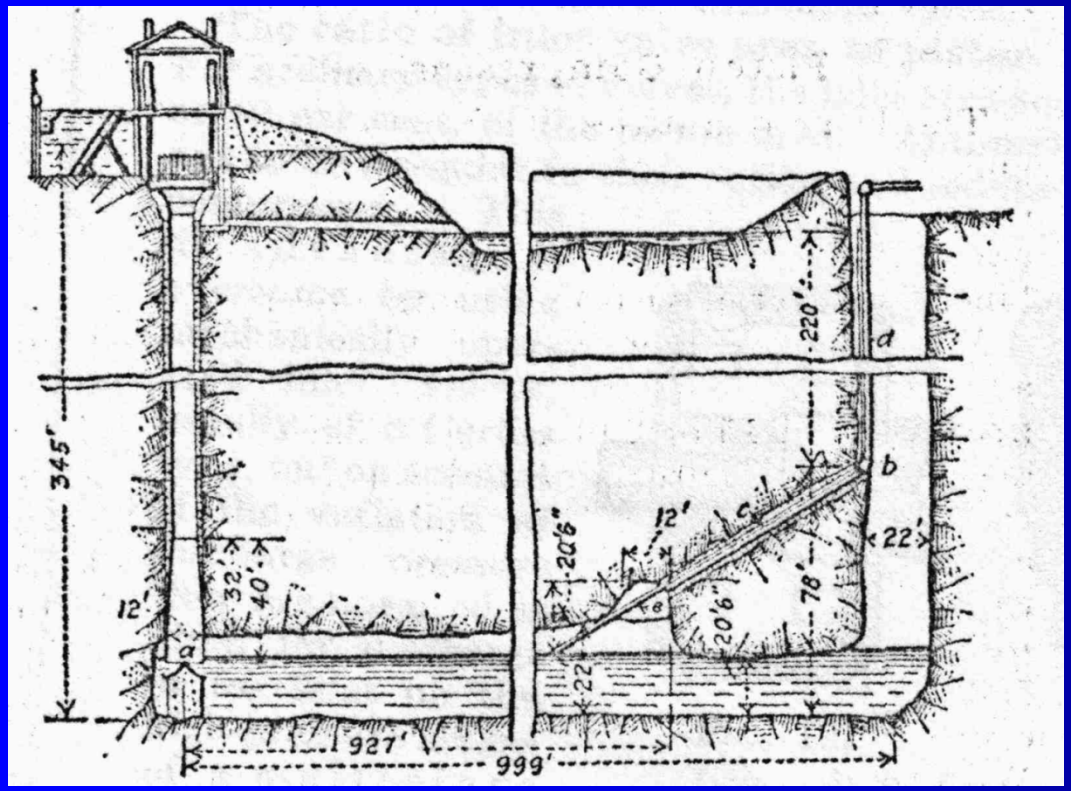
- Falling water in a pipe entrains air.
- The high velocity water carries the air down the pipe to an air separation chamber.
- Compressed air is separated from the water by gravity.
- The air is collected for use.
- The water is discharged.

Trompe History



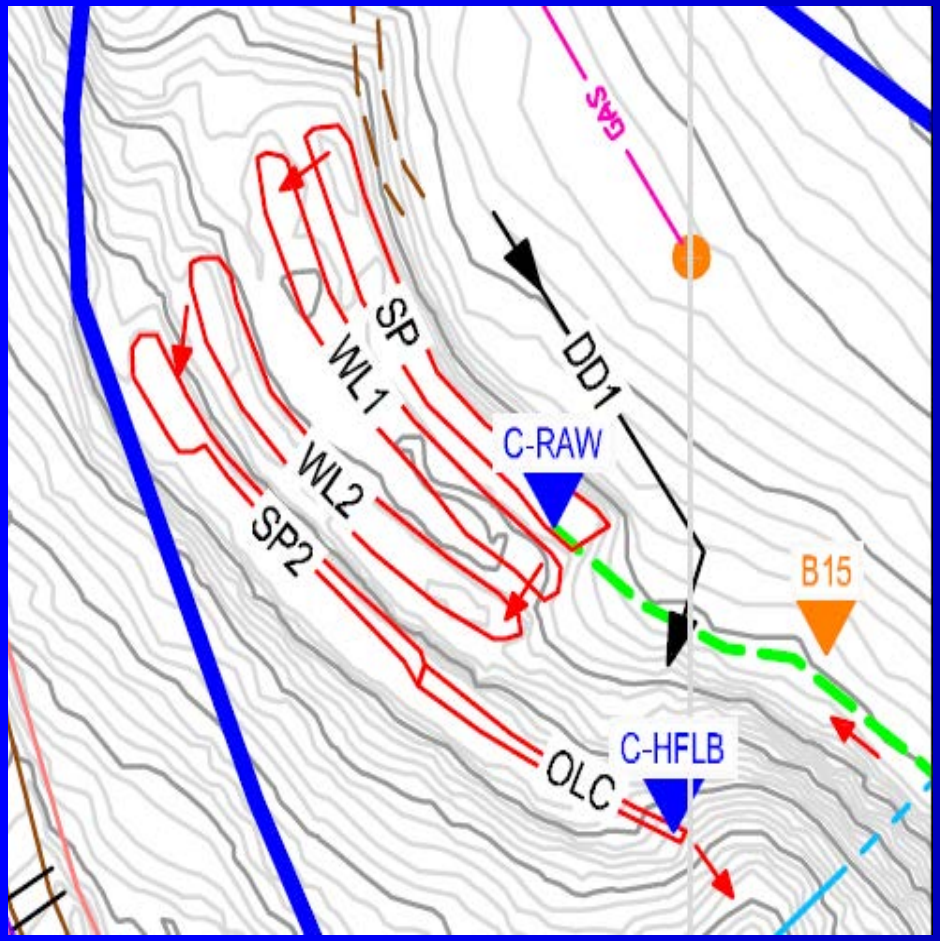
- Discovered in 17th century Italy.
- Defining component of the Catalan Forge
- Developed 1 to 16 oz pressure

Trompe History Continued

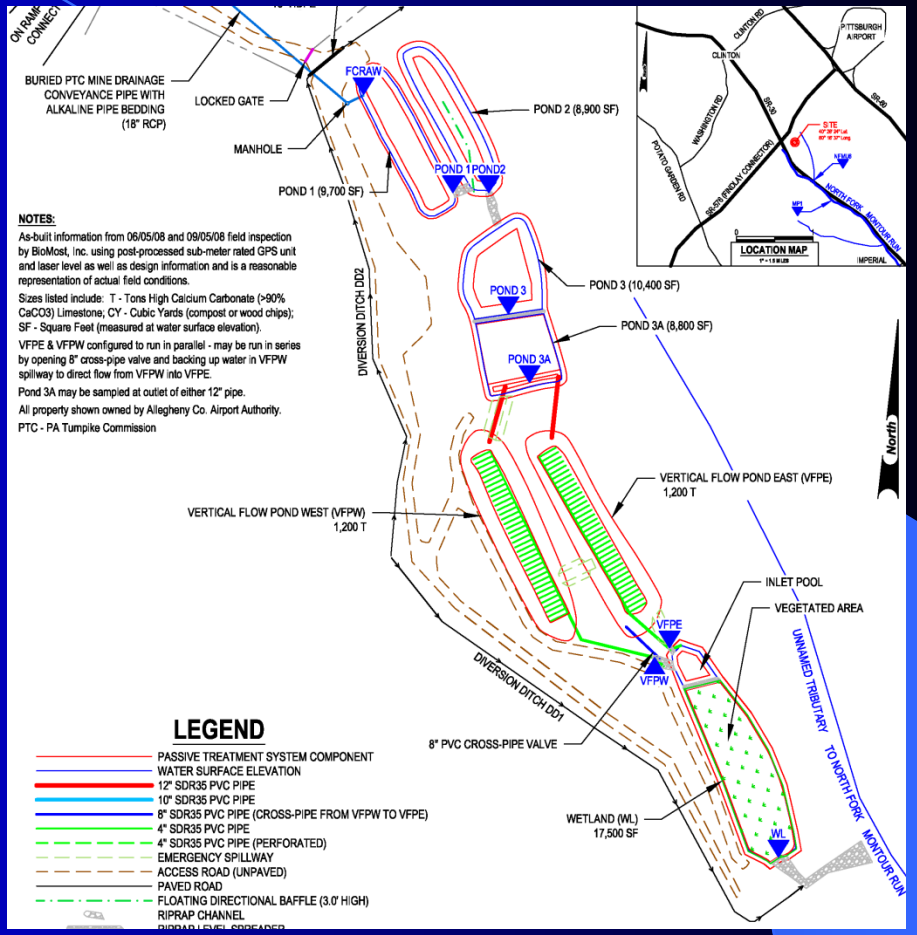


- Rediscovered by Charles Taylor, Canada
- Ragged Chutes Compressor delivered 128 psi to the area mines
- Was in continuous operation for over 70 years with only two maintenance shutdowns.

Curley Site



North Fork Site



Curley Raw Water with Aeration

Curley Raw Water

Alkalinity 425 to 450 mg/l

Flow 31 to 100 gpm

Site	Date	EC	Al total	Ca total	Mg total	Fe total	Fe dissolved	Mn total
CURLEY RAW	1/18/2011	3399	0.018	486.2	276.9	21.59	22.04	10.13
CURLEY RAW	1/26/2011	3584	0.02	508.5	296.1	23.7	22.66	10.85
CURLEY RAW	2/26/2011	3815	0.02	500.4	286.0	25.47	25.89	11.57

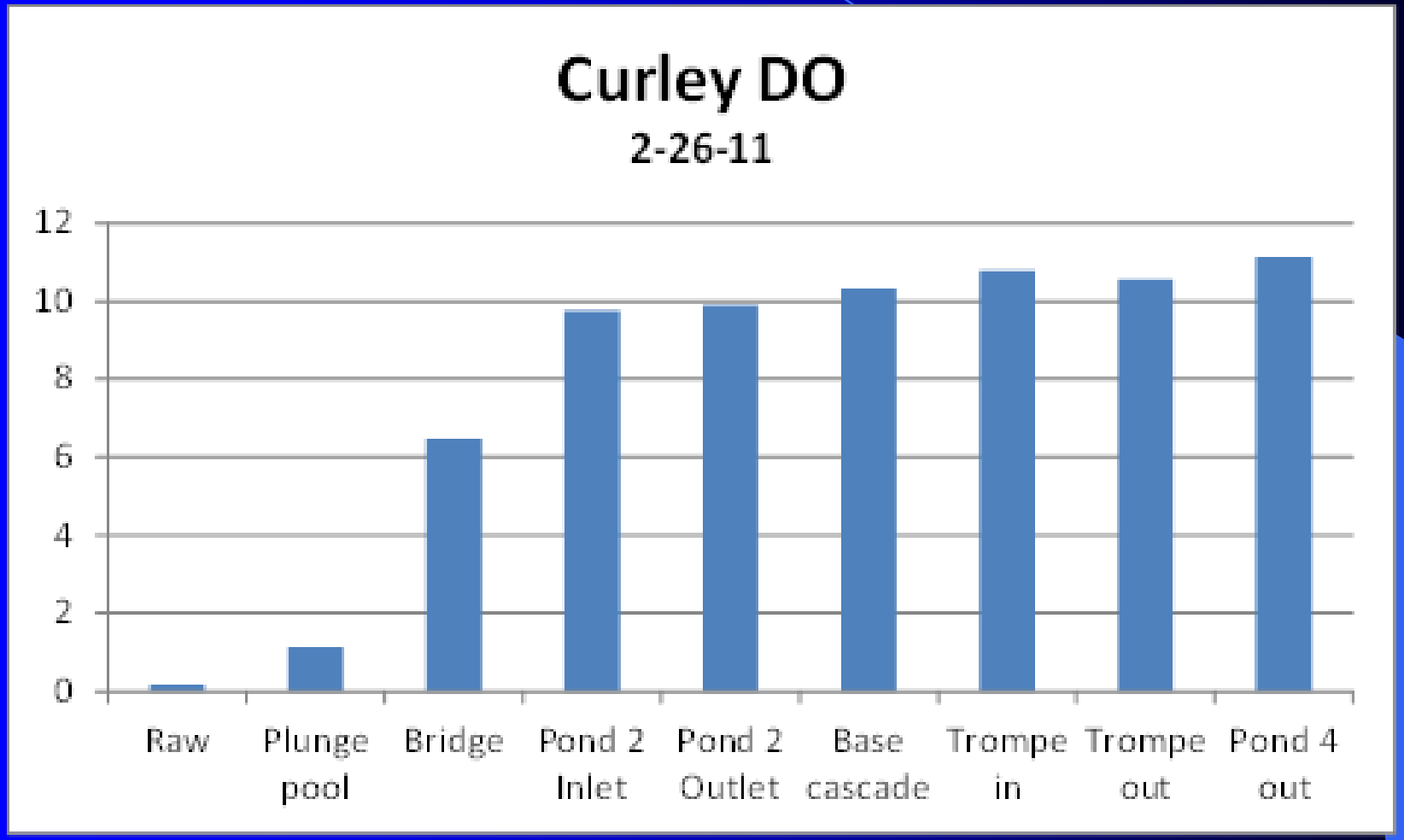
Feed Pipe & Overflow

TROMPE in Operation

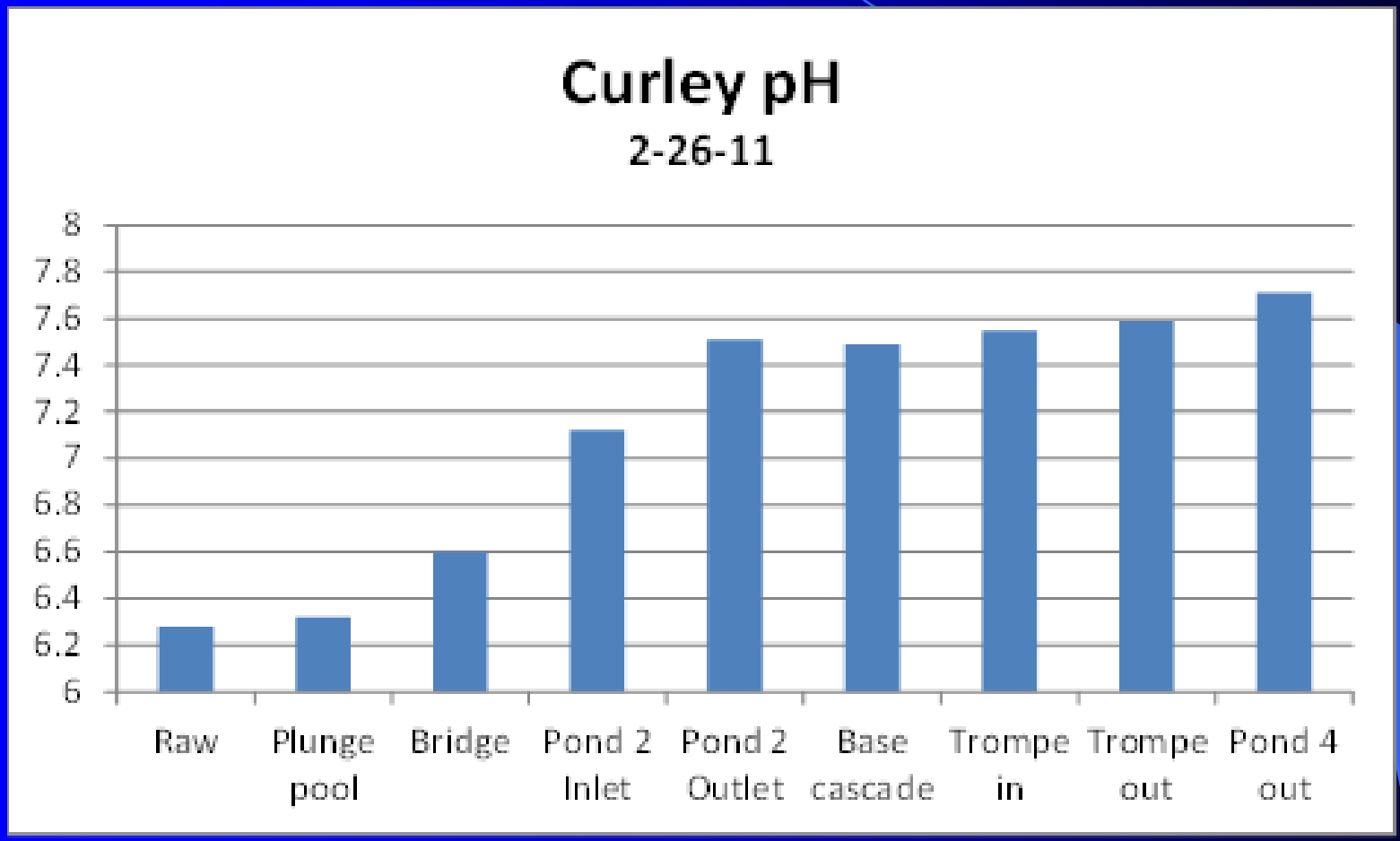
Fine Bubble Aeration Discs

Curley Aeration with Bridge

Air In

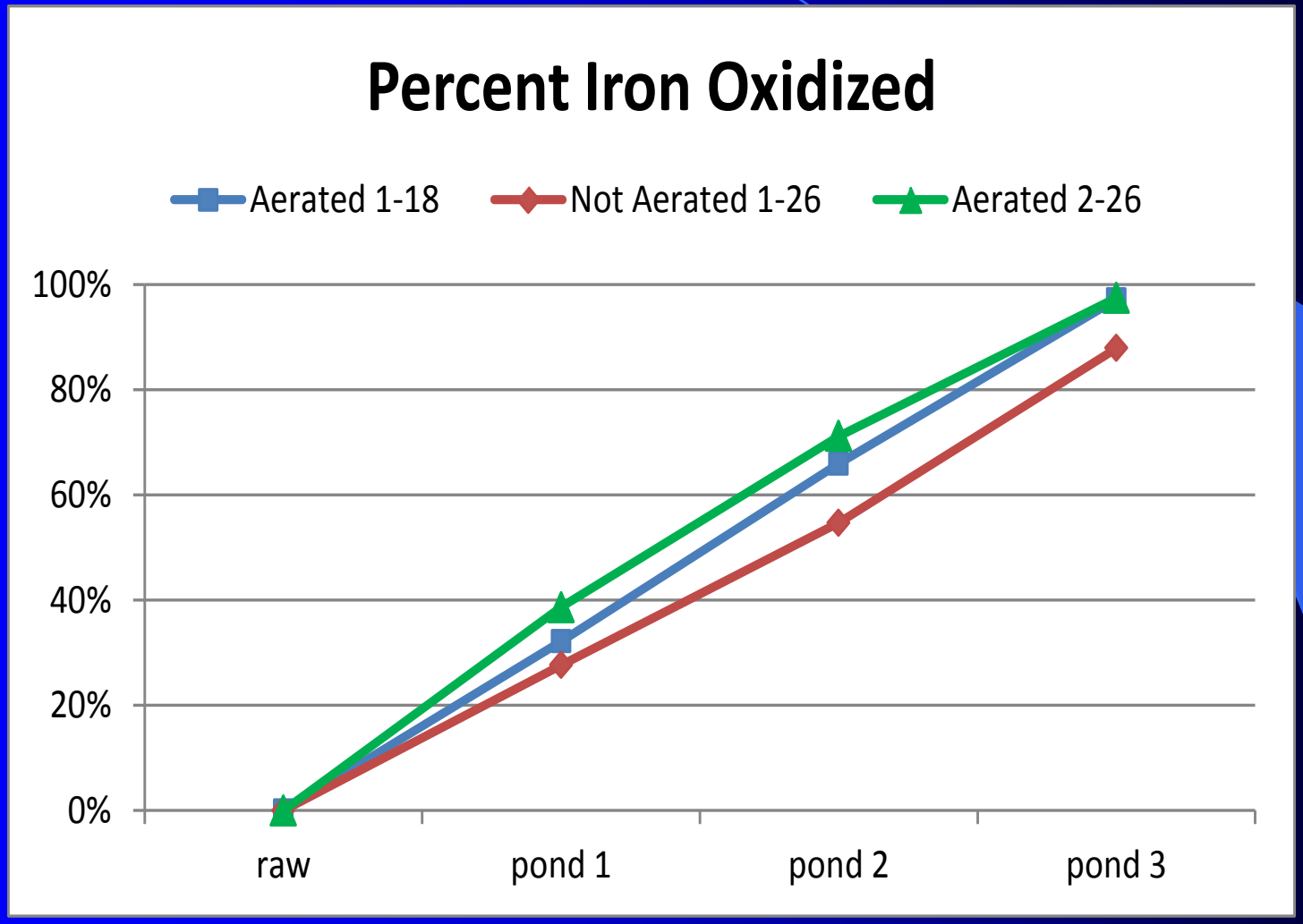

Curley DO
2-26-11
12
10
8
6
4
2
0
Raw
Plunge pool
Bridge
Pond 2 Inlet
Pond 2 Outlet
Base cascade
Trompe in
Trompe out
Pond 4 out

pH Rising

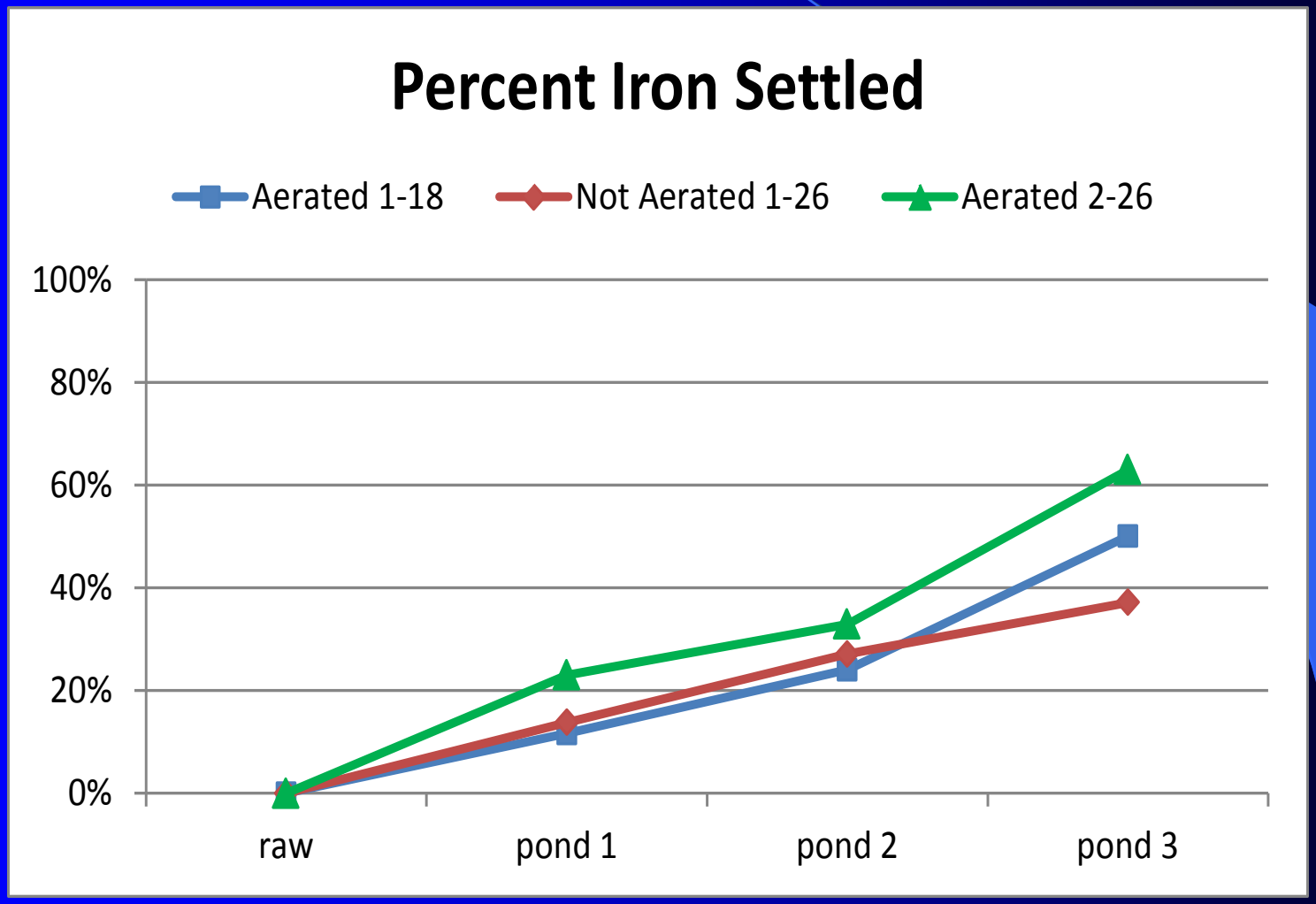

Curley pH
2-26-11
8
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
6
Raw
Plunge pool
Bridge
Pond 2 Inlet
Pond 2 Outlet
Base cascade
Trompe in
Trompe out
Pond 4 out

Enhanced Iron Oxidation

Curley Results



Curley Results

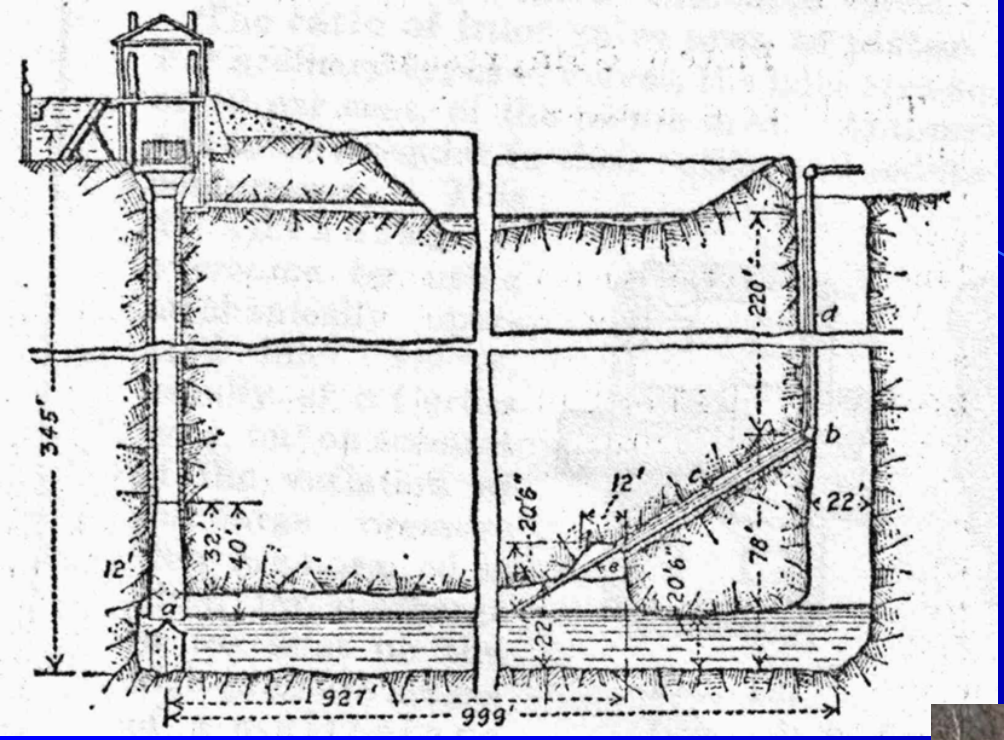


Conclusions

- Multiple TROMPEs have been successfully designed and installed at both North Fork and Curley passive treatment systems.
- The TROMPE is providing aeration to the raw water and has increased the DO level at the bridge from 3.28 to 6.21 mg/l.
- There is an 11 to 16 percent increase in iron oxidation at the end of Pond 2.
- At the end of pond 3 iron oxidation has increased from 87.9% to between 97.3% and 97.5% as a result of TROMPE aeration.

Conclusions continued

- Sufficient oxygen is present in the water to fully oxidize the ferrous iron present. However, dissolved carbon dioxide is believed to be retarding the rate of iron oxidation by keeping the pH below the level it would achieve if the carbon dioxide were in equilibrium with the atmospheric carbon dioxide partial pressure.
- The amount of iron settled increased significantly as a result of aeration, particularly in pond 3.



Questions?