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Field Trial of a Pulsed Limestone Diversion Well

P. L. Sibrell
USGS Leetown Science Center, Kearneysville, WV 25430
C. F. Denholm, M. H. Dunn
Stream Restoration Inc., Mars, PA

U.S. Department of the Interior
U.S. Geological Survey

AMD at Jennings

Vertical Flow Pond

Quonset Hut

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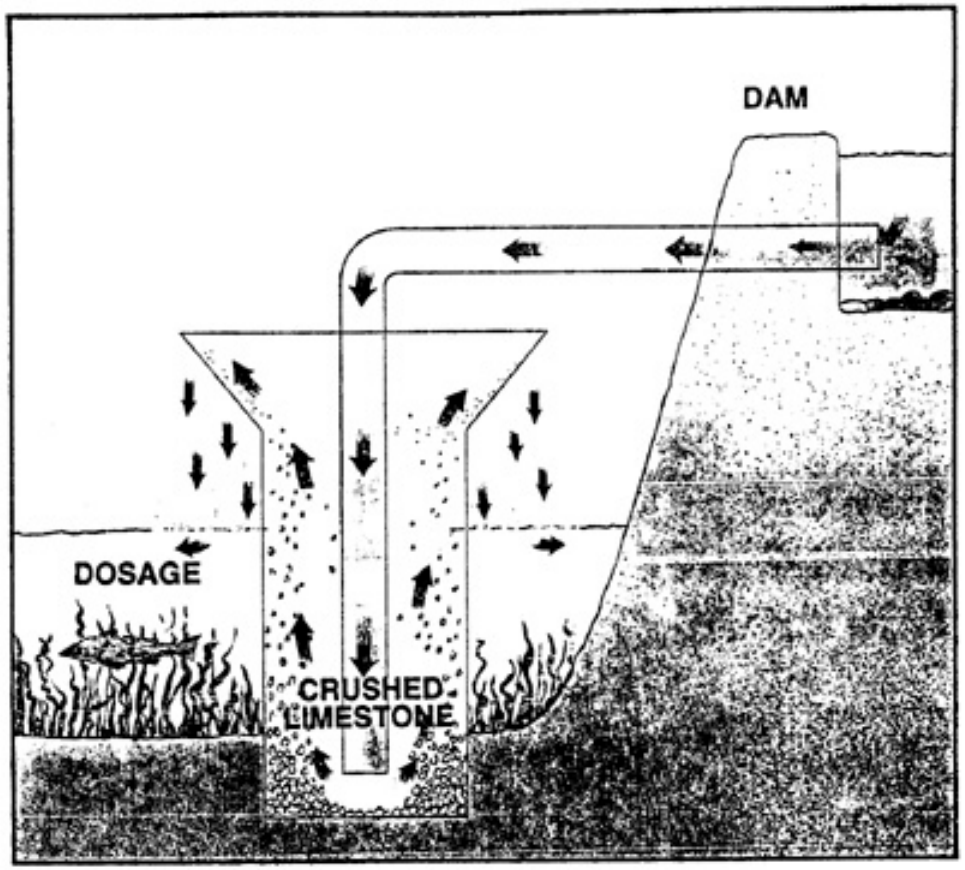
Diversion Well Schematic



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Pulsed Limestone Bed System

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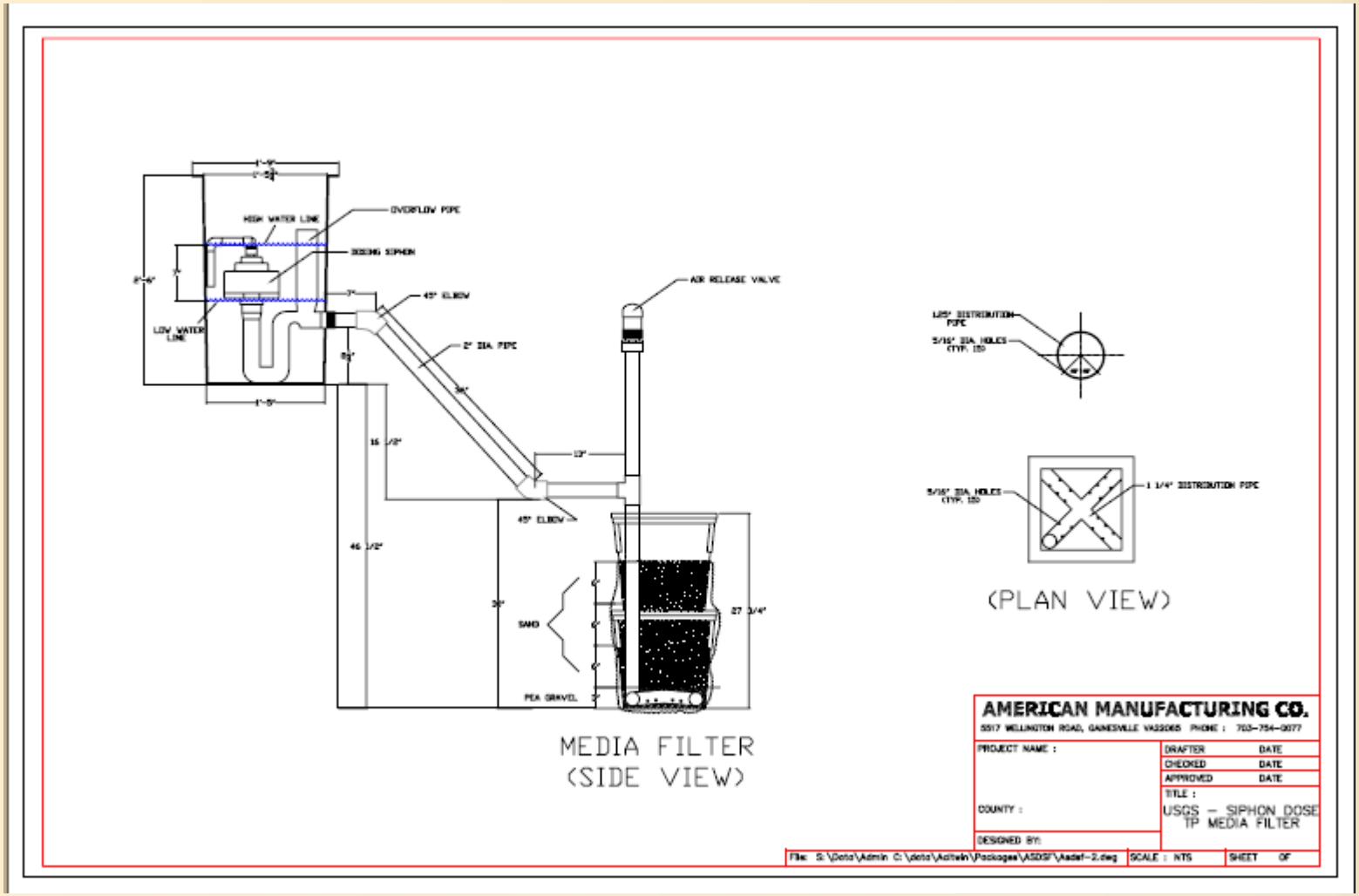
Pulsed Diversion Well



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Pulsed Diversion Well Advantages

- Provides reproducible flow conditions at any flow rate up to design maximum.
- Utilizes sand sized limestone for greater reactivity and increased rate of acid neutralization.
- More attrition due to movement of intermittently fluidized limestone sand bed scours particles and reduces potential for armoring.
- May be able to recycle CO_2.

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Limestone Dissolution Rate Expression (Sverdrup, 1985)

$$\frac{-dm}{dt} = \left\{ \frac{D}{\Delta r} \cdot \left[H^{+}\right] + k_2 \left[CO_2\right] + k_W - k_B \cdot \left[Ca^{+2}\right] \cdot \left[HCO_3^{-}\right] \right\} \cdot \frac{3 \cdot m}{p \cdot r}$$

Reaction with hydrogen ion

Reaction with carbon dioxide

Reaction with H_2O

Backward reaction rate

Mineral surface area

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Siphon Doser Assembly

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Siphon Sump

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Limestone Sand Sump

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Complete System

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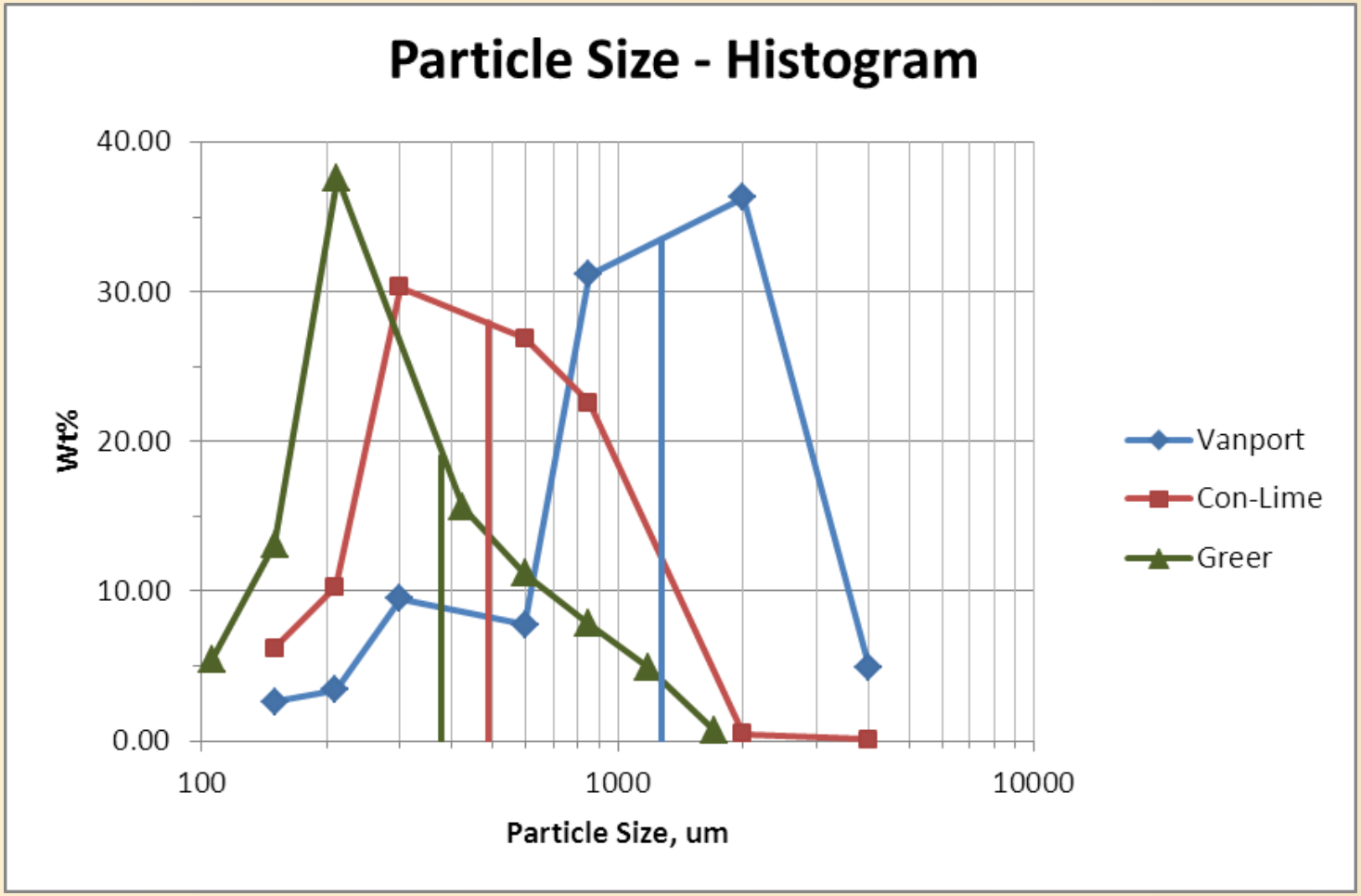
Limestone Size Distributions



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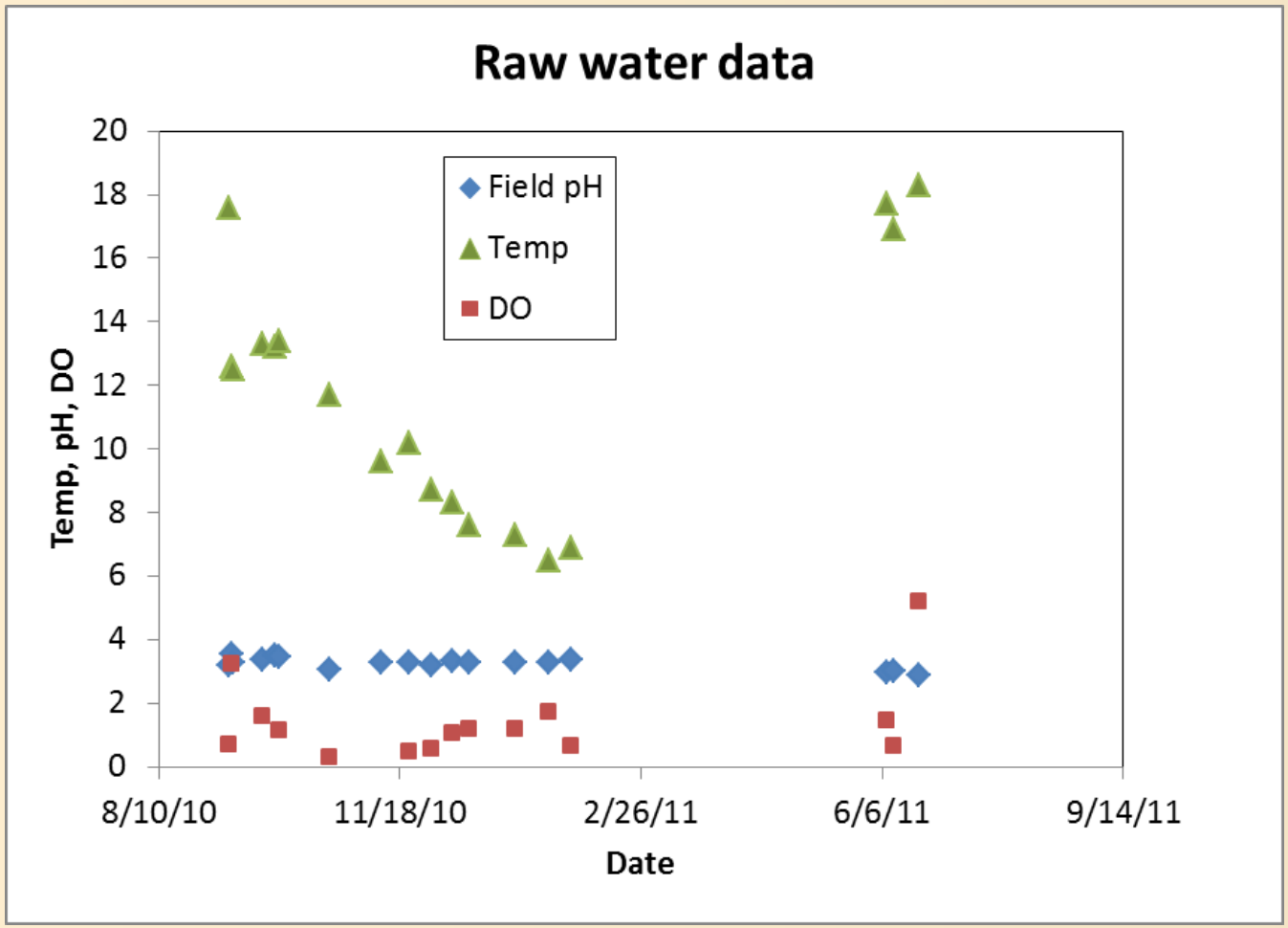
Influent water quality parameters



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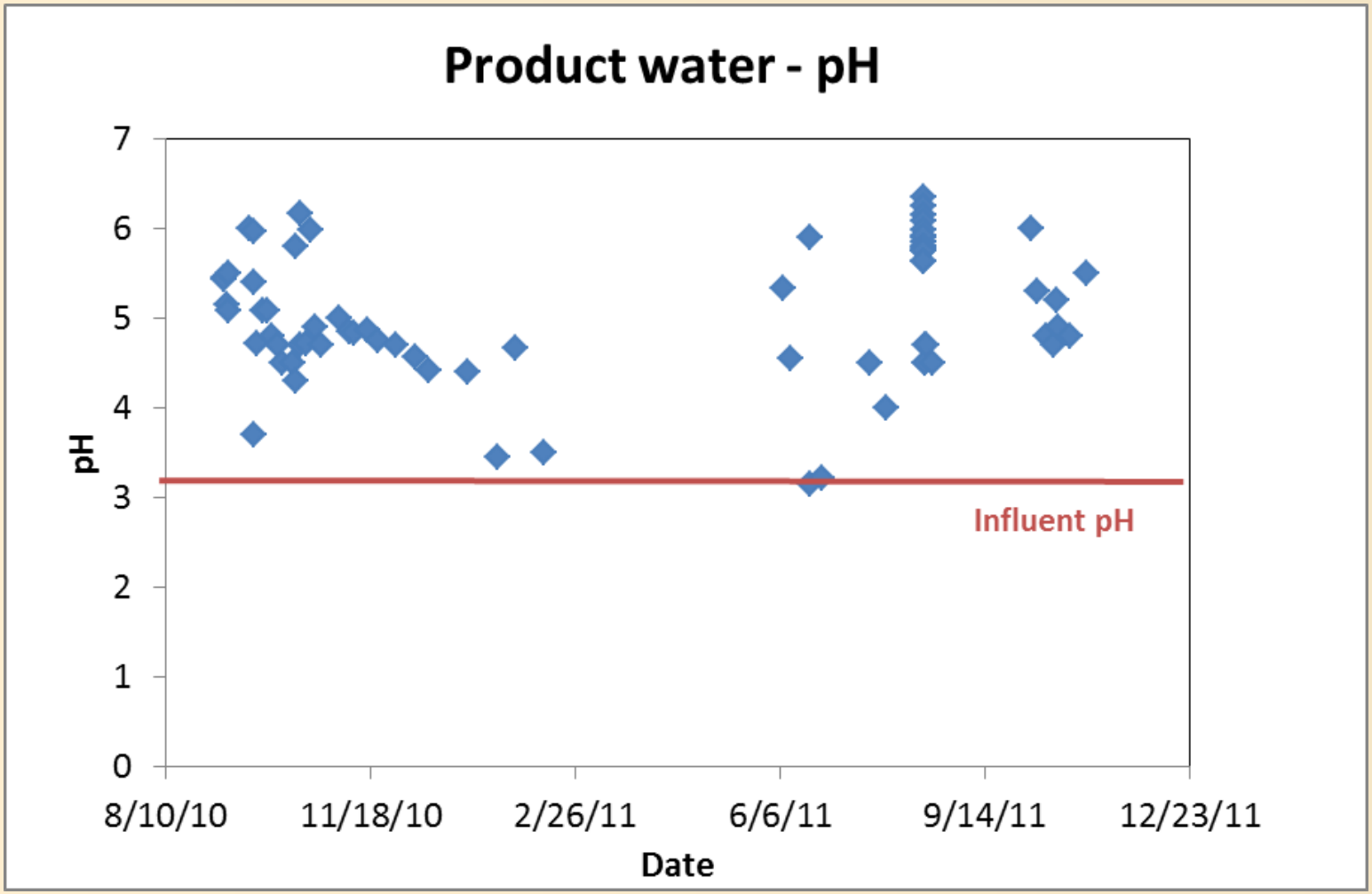
Results – pH of Treated Water



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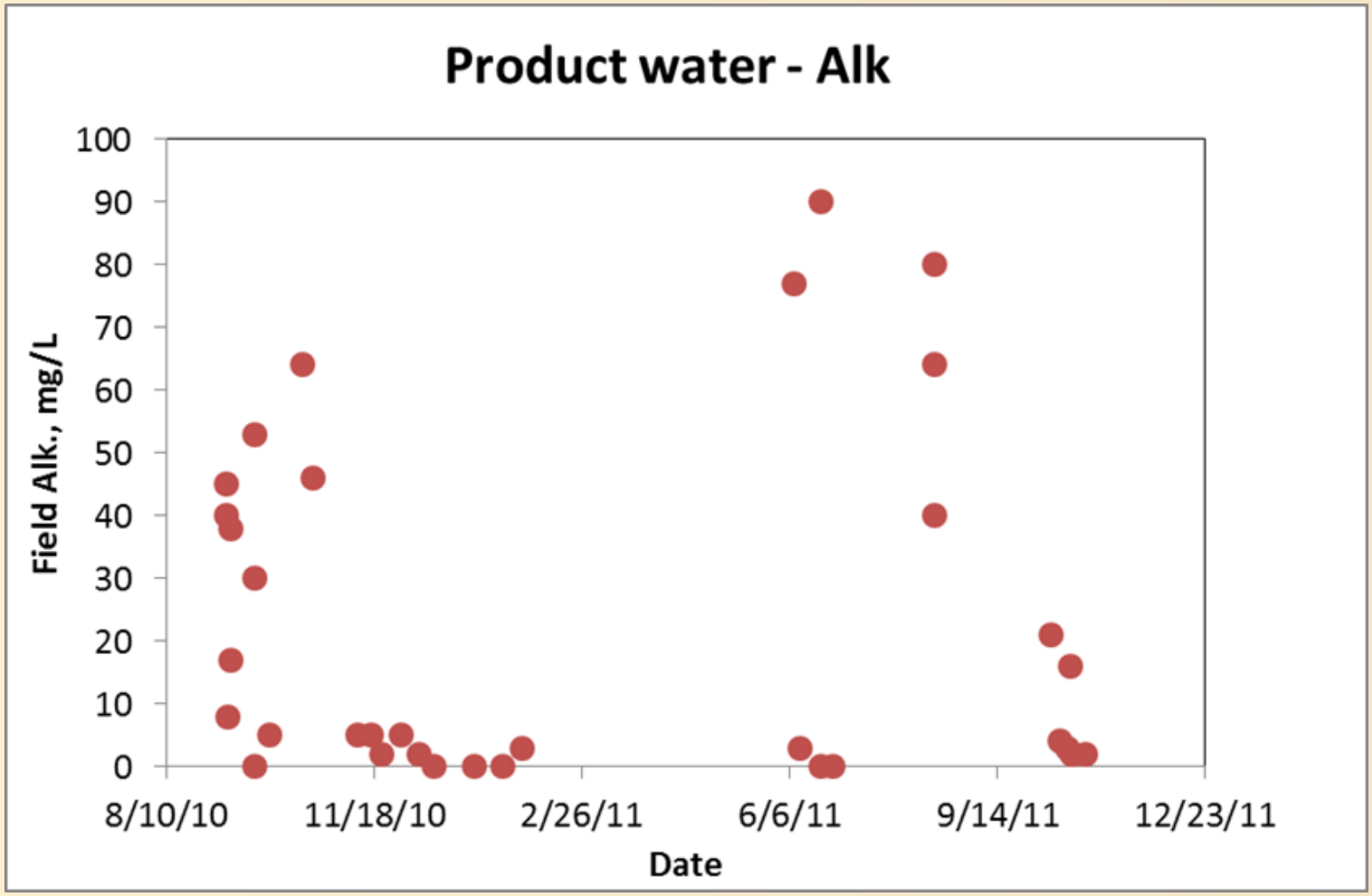
Results – Alk of Treated Water



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Laboratory Analysis

SAMPLE ID	SAMPLE Date	Q L/min	LAB PH	Alk. mg/L	Acidity mg/L	Fe		Mn		Al		SO4 mg/L
						Total mg/L	Soluble mg/L	Total mg/L	Soluble mg/L	Total mg/L	Soluble mg/L	
RAW	9/22/2010	18.9	3.33	ND	235.8	51.0	47.6	19.3	19.0	24.2	20.5	806.1
PDW1	9/22/2010	18.9	3.47	ND	223.2	47.9	45.6	20.3	19.1	21.3	20.6	740.8
PDW2	9/22/2010	18.9	5.64	20.32	77.0	44.0	41.9	19.1	18.6	7.9	2.5	535.2
PDW3	9/22/2010	7.6	6.16	49.62	43.8	43.4	37.4	20.1	18.6	7.7	0.9	559.3
RAW	10/20/2010	7.6	3.23	ND	275.0	44.9	43.1	21.8	21.1	22.8	21.5	580.3
PDW	10/20/2010	7.6	5.97	31.51	60.5	39.5	37.4	21.8	21.7	6.5	2.3	630.1
RAW	11/10/2010	7.6	3.33	ND	269.6	62.6	21.7	24.3	23.8	27.8	24.9	657.9
PDW	11/10/2010	7.6	4.53	ND	168.9	50.9	48.2	25.1	24.6	19.7	14.5	676.4
RAW	10/26/2011	3.6	3.22	ND	437.8	83.2	79.1	22.3	21.4	40.4	39.5	1084.8
PDW	10/26/2011	3.6	4.4	ND	273.2	51.2	49.5	23.4	21.5	30.9	29.8	910.9

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Winter Conditions

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Plugging problems

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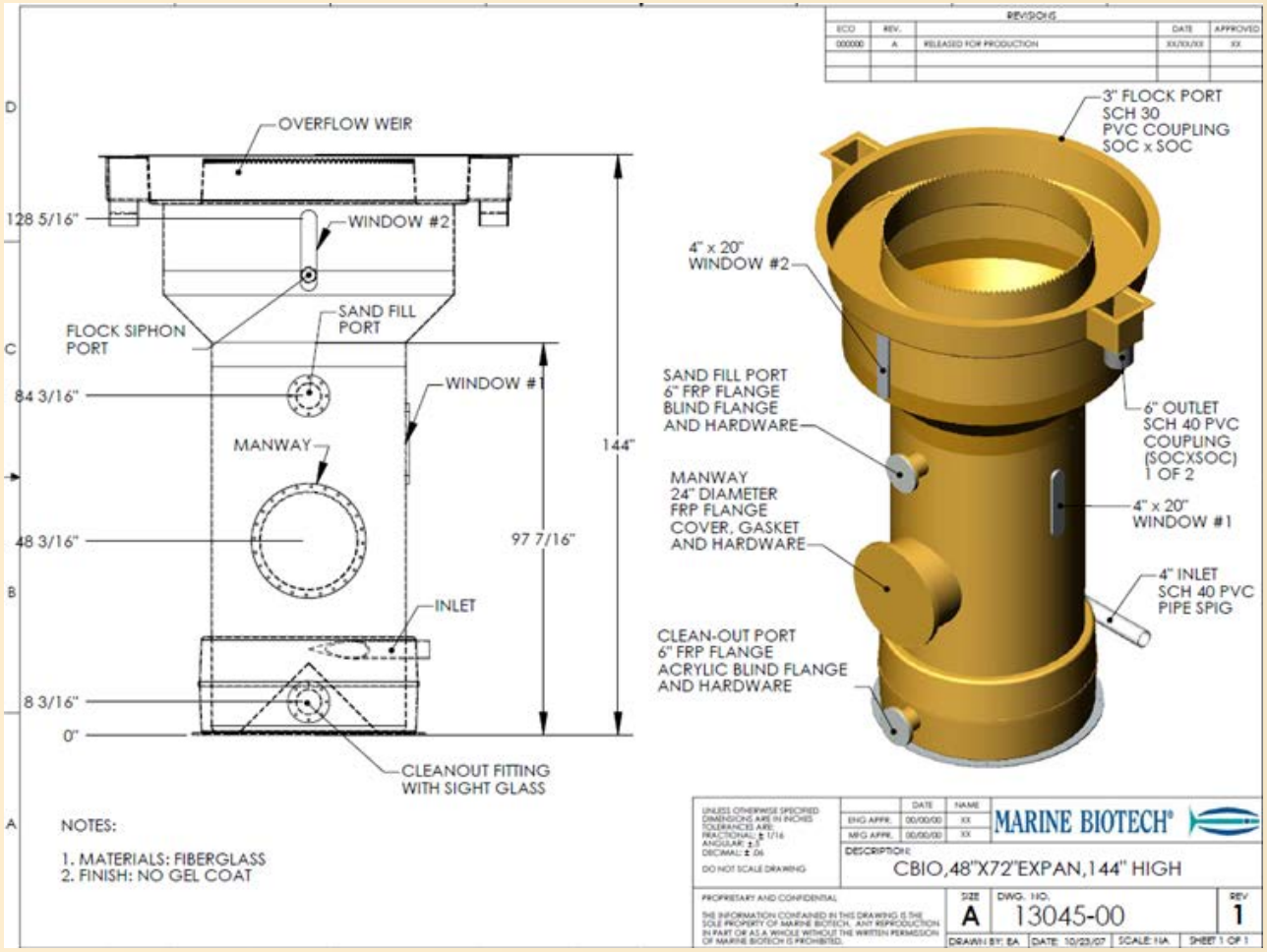
CycloBio Reactor



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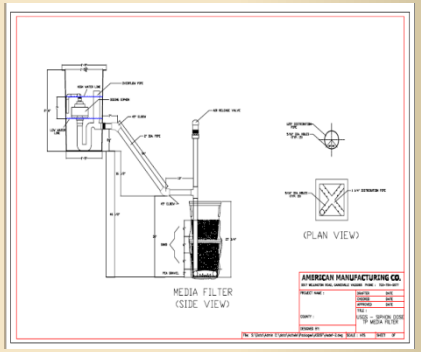
Bottom Line

- Modifications to the traditional diversion well, including use of a siphon doser and smaller limestone particle size, appear to offer advantages in acid neutralization and AMD treatment.
- Air release from the delivery piping prior to the sand bed is an important consideration and must be allowed for.
- Plugging of delivery lines and manifold orifices had a detrimental impact on performance.
- Objectives for future testing include pipeline pigging and use of a CycloBio reactor to minimize plugging issues.



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