

# Water Intensity Baseline for Breweries

*Evan Meffert, Sustainability Specialist  
Bell's Brewery*

**WHY?**

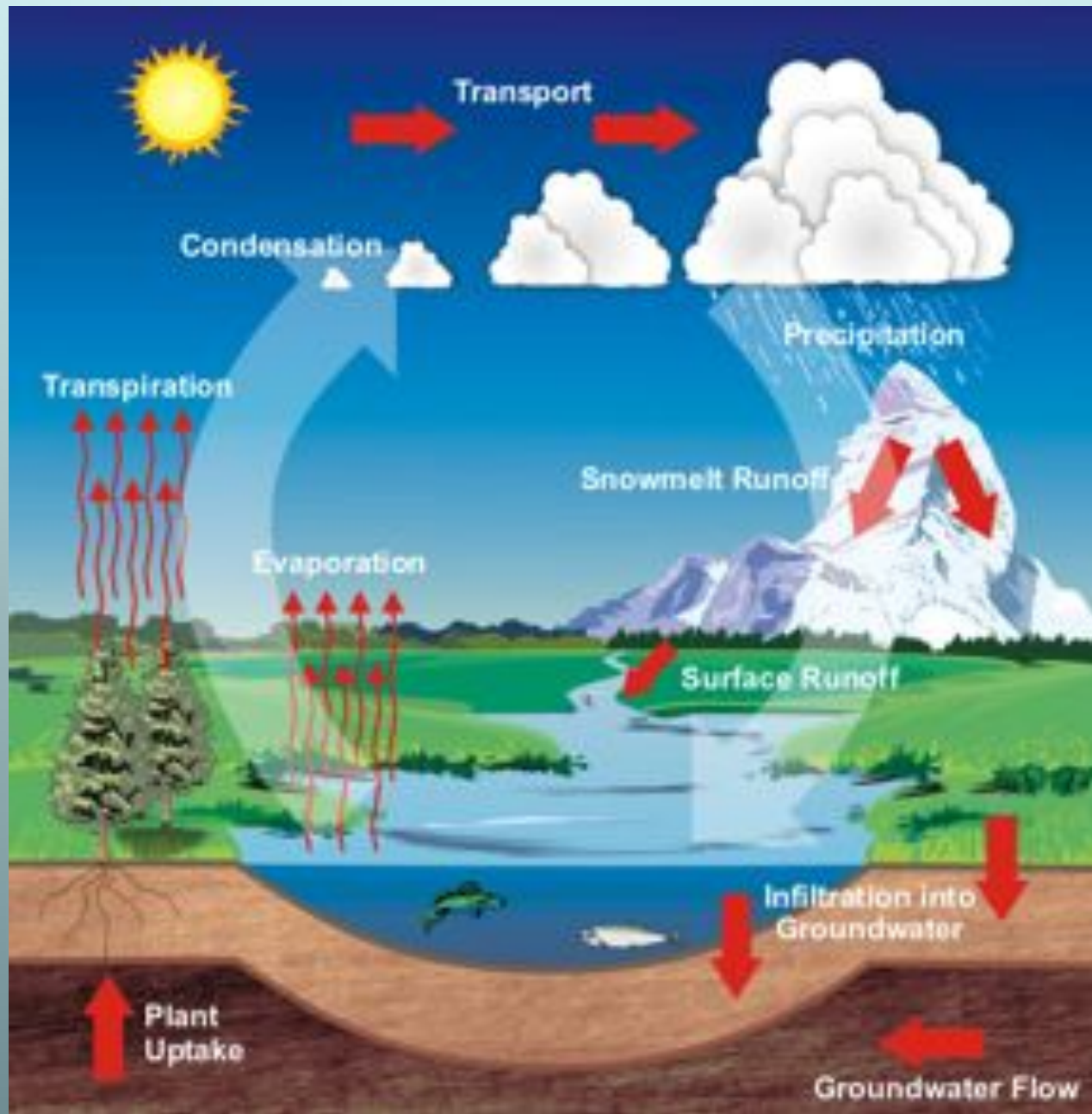
Ethics

Money

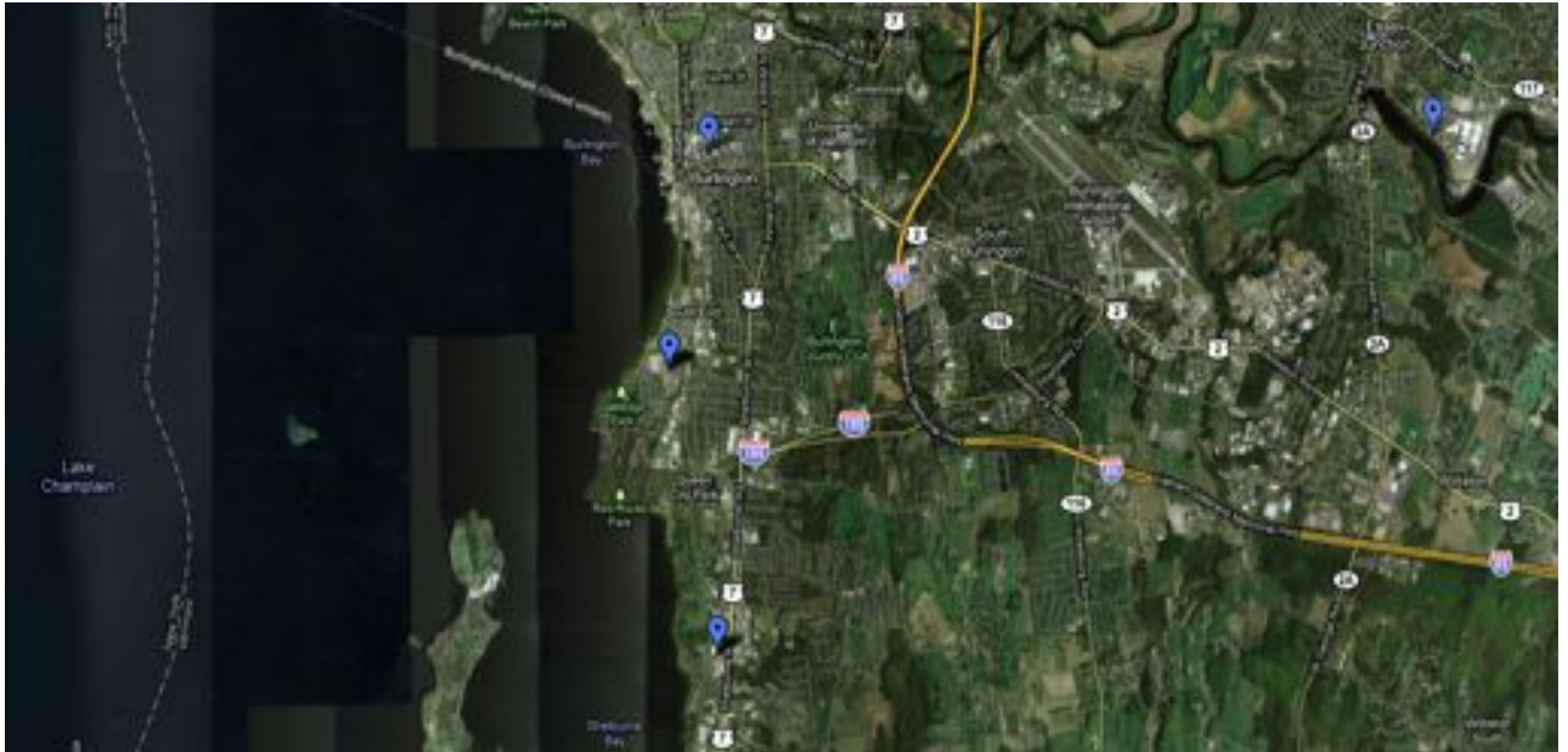
Or... Both?

“We live under the tyranny  
of the water cycle.”

-Malin Falkenmark, Hydrologist



“Arizona, California, New Mexico, and Nevada are already facing water shortages. In the farm belt states of the Midwest, the Ogallala aquifer, which is the largest underground body of water on the continent, is being drained fourteen times faster than nature can replenish it.”



IBM's utility plant creates nine custom varieties of water. Each brand of water costs 4, 5, and 10 times more than the cost of raw water itself...

Water is so important that although it seems far removed from the final product, the computer chips, it could actually be a competitive advantage.

-“A Sea of Dollars”, *Fast Company*, April 2011

# Bloomberg's ESG Index

- Environment, Social, and Governance (ESG) Data
- Companies with high ESG scores, tend to be more profitable... duh.
- High Environmental Risk + EPA = High Operating Costs

# Bloomberg

“The financial community likes the E (Environment) because it’s easy to quantify. And within the E is the big C: carbon. And within that C is another C: cost... If companies wake up one day to find it costs \$15 to emit a ton of CO<sub>2</sub>, ExxonMobil would see it emitted 128 million metric tons in 2009... [adding] \$2 billion to the oil giant’s operating costs.”

-Curtis Ravenel, Bloomberg Sustainability Director

**HOW?**

# Saving Water

- Seek C-level Commitment
- Appoint a Water Manager
- **Gather Baseline Data**
- Identify Improvement Opportunities
- Prepare Water Management Plan and Prioritize
- Report the Results

1,152.0651

gpd/person

(USGS, 2005)

962

gpd/person

(USGS, 1957)

“...water has been so abundant and so much taken for granted in the United States that hardly any authentic statistics on its use in manufacturing and otherwise were gathered before the 1954 Census of Manufactures... we still don't have complete or accurate figures for the states; we have very few for Michigan.”

*-Wixom, Zeisler 1966*

# Flow Measurement

- How accurate does data need to be?
- Does the data need to be trended or will a one-off measurement suffice?
- What is size and material of pipe?
- Operating pressure and temperature?
- What is the expected flow range, min to max?
- Are there existing meters that can be connected to a datalogger or transmitter?

# Data-based Decisions:

*Data reveals the inconsistency. The inconsistency illuminates the problem. Creativity finds the solution, once the problem has been revealed.*

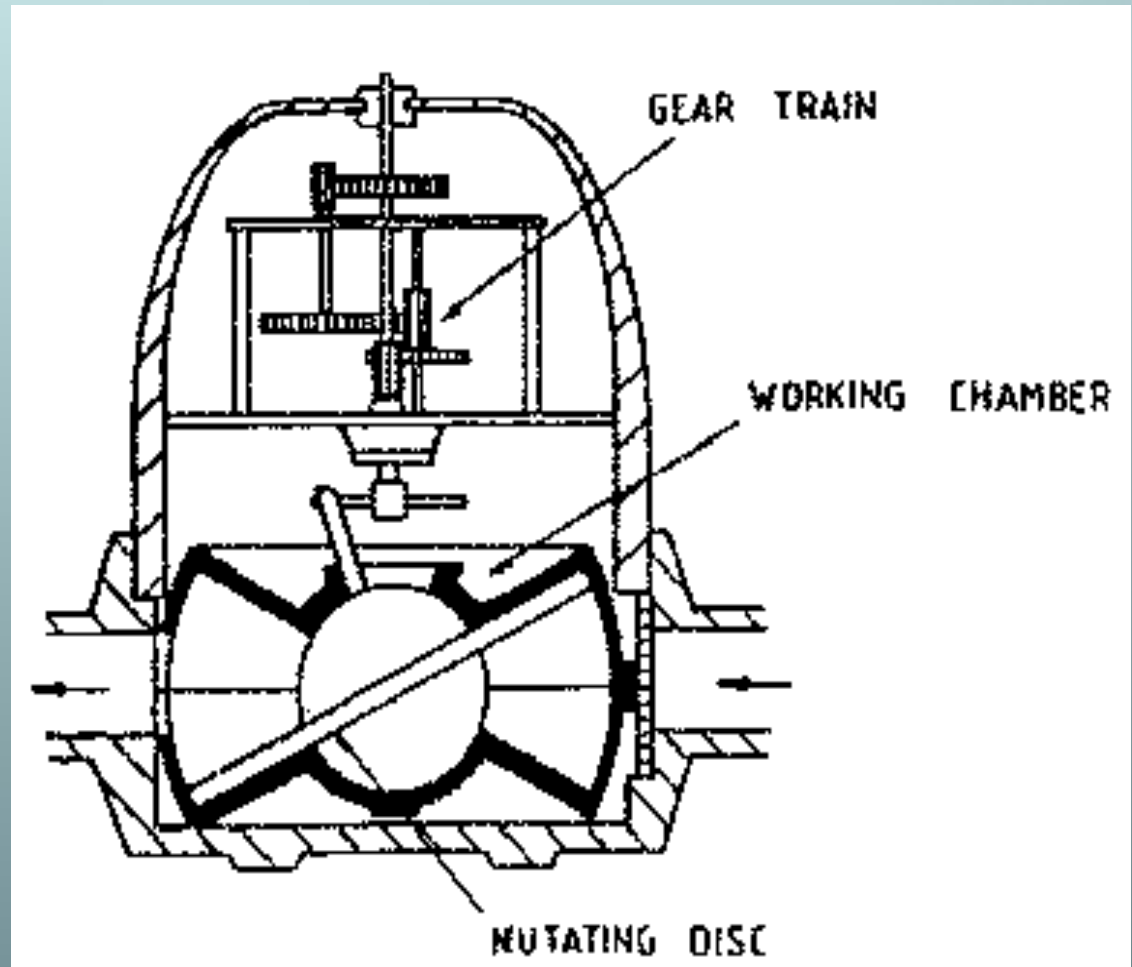
- Data Stewardship: technical, precise, formal
- Data based Decision-making: creative, accessible, collaborative, failure as a teacher

# Flow Measurement Principles

- Positive Displacement
  - Nutating Disk
  - Oval Gear
  - Rotating Vane
  - Oscillating Piston
  - Reciprocating Piston
- Velocity
  - Mechanical
    - Turbine
    - Paddlewheel
    - Multijet
    - Rotameters
  - Ultrasonic

# Positive Displacement: Nutating Disk

- Sensing Element displaces specific volume for each cycle
- Low and Steady Flow
- High Accuracy
- Low Pressure Head Loss
- Great for Batch Mixing
- Expensive Maintenance



# Mechanical Velocity: Turbine Meter

- Turbine suspended axially to direction of flow.
- Clean Water
- Relatively Low Cost
- High Flow (3" and greater)
- High Turndown w/
- Good Accuracy
- Paddlewheel and Multijet

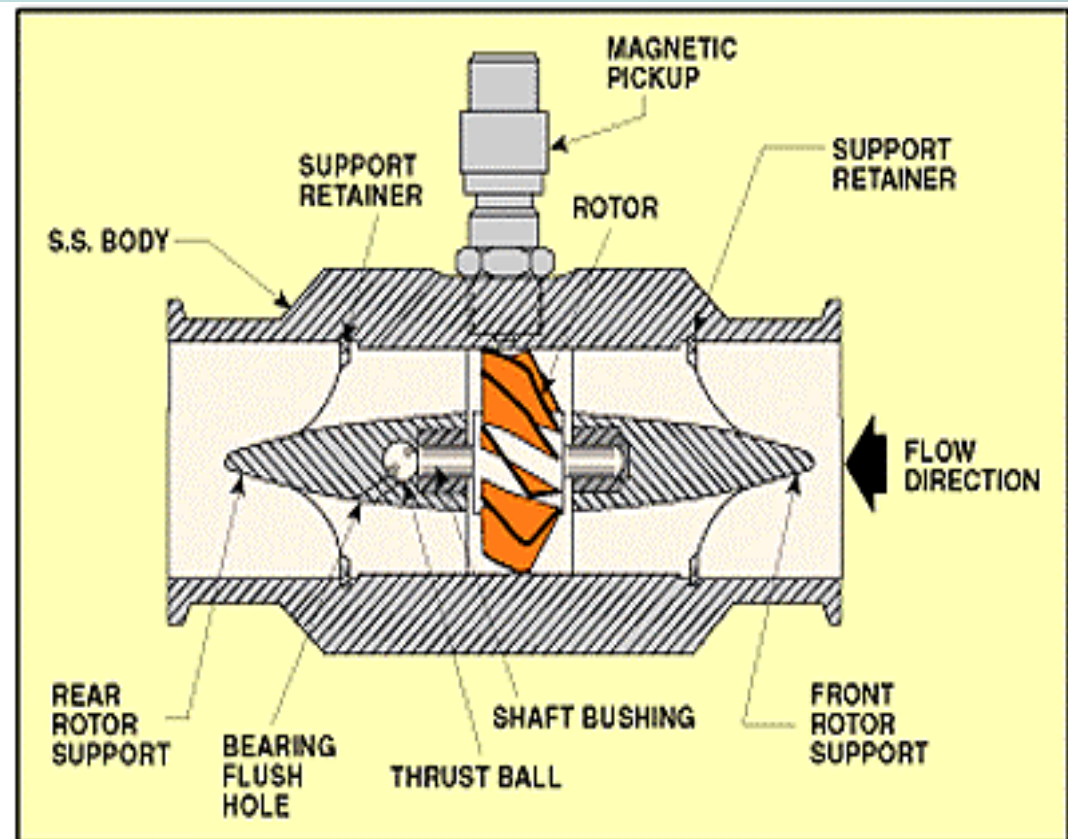
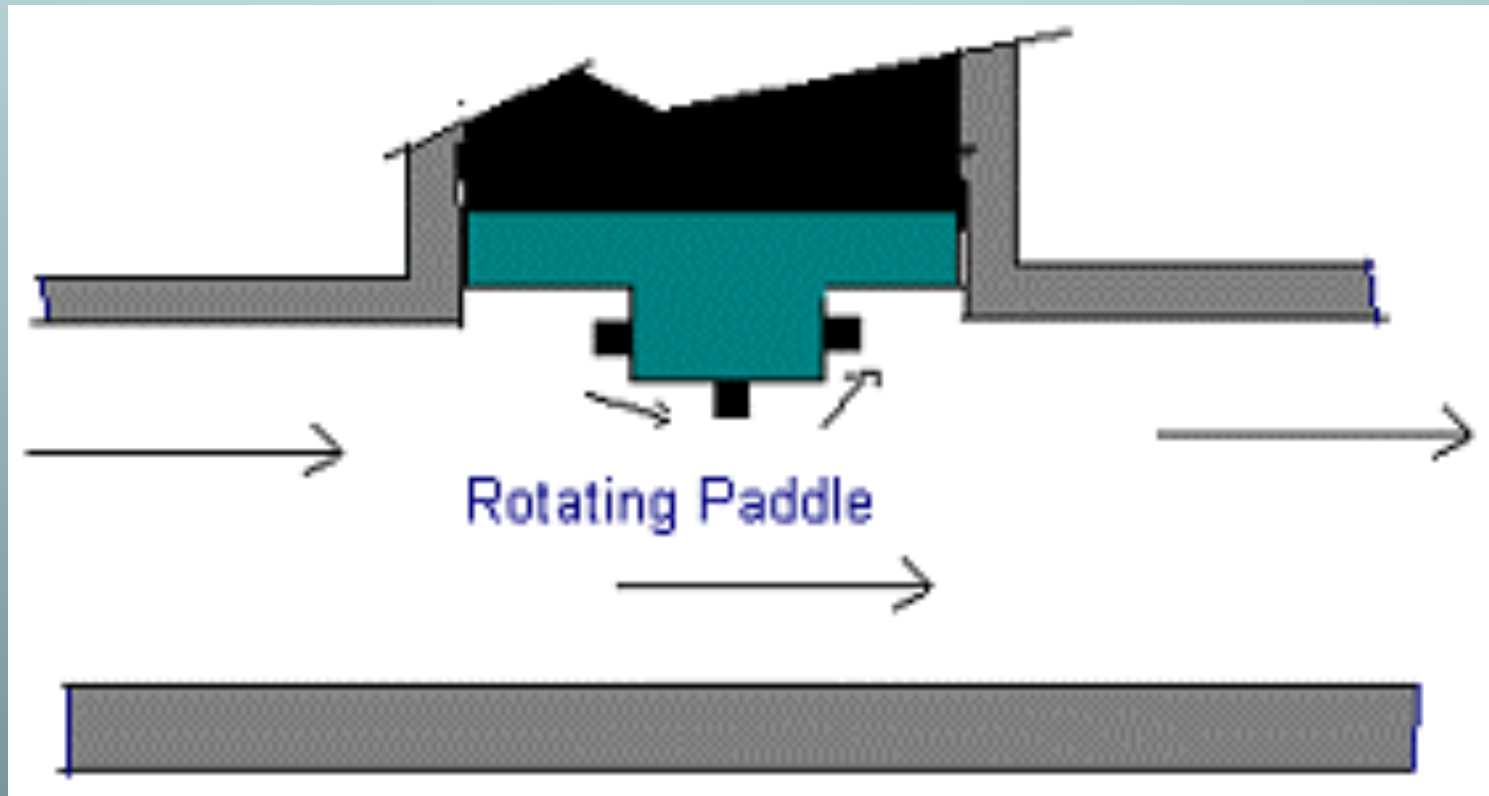


Figure 5: Turbine flowmeter consists of a multiple-bladed, free-spinning, permeable metal rotor housed in a non-magnetic stainless steel body. In operation, the rotating blades generate a frequency signal proportional to the liquid flow rate, which is sensed by the magnetic pickup and transferred to a read-out indicator

# Paddlewheel

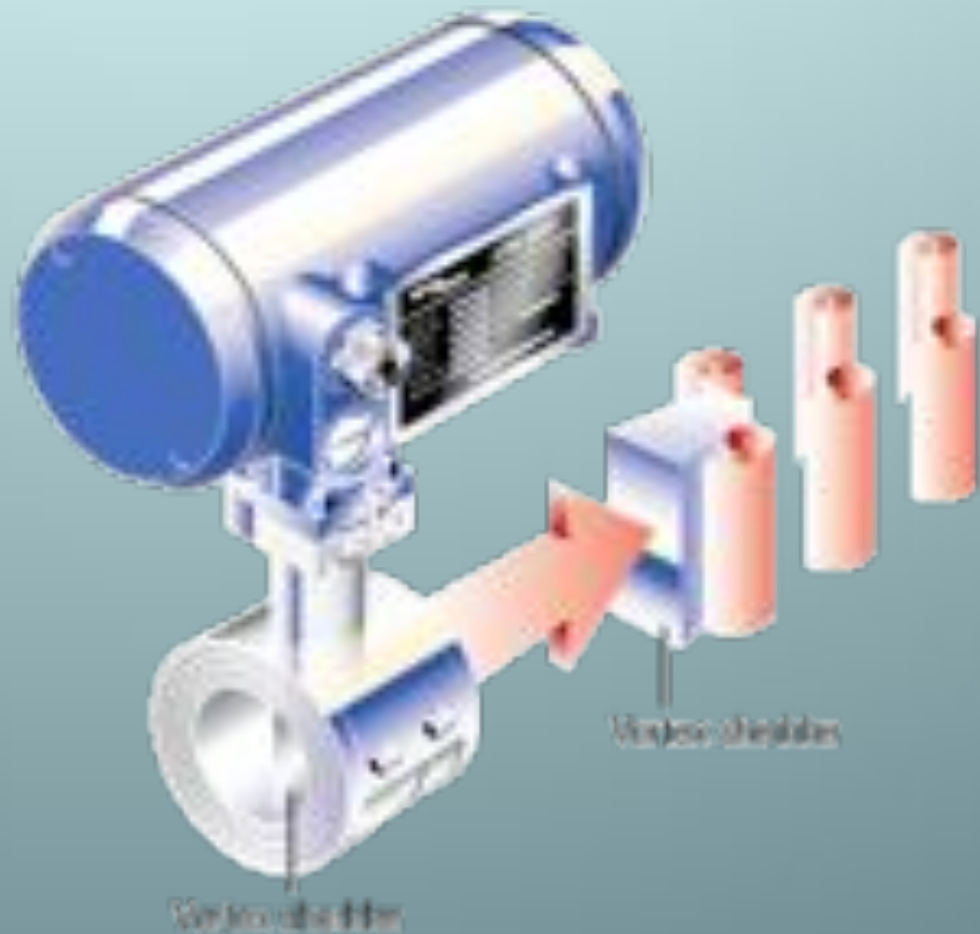


# Ultrasonic Meters

- Transit Time
  - Calculates velocity based on time difference for impulse to pass between transducers.
  - Velocity calculated as difference between upstream and downstream transmission time.
- Doppler-type
  - Measure frequency of sound signals sent through flow from transducer
  - Signals reflected back from entrained particles

# Shedding Vortex

- Shedder creates oscillations or vortex
- Vortex increase as flows increase
- Relatively short upstream and downstream linear pipe
- Expensive
- Clean Liquids



# Meter Selection

- Budget?
- Permanent Install?
- Clean or dirty water?
- Constant flow?
- Approximate turndown?
- Acceptable pressure loss?
- Output signal?
- Available straight pipe?
- Horizontal or vertical orientation?
- Is there downtime available for install?

# Dataloggers

- Static
  - Good for ON/OFF datapoints
  - Logger logs until you retrieve data
- Dynamic
  - Set up on a communication network to continuously log and trend data as it is acquired
- HOBO dataloggers

# Methods

- No Cost Methods
  - Buckets and Bills
- Low Cost Methods
  - \$300 - \$700 per datapoint
  - Mechanical: Turbine, Multijet, Paddlewheel
- Rolls-Royce Methods
  - \$1,000 - \$5,000 per datapoint
  - Shedding Vortex, Mag Meters, Ultrasonic

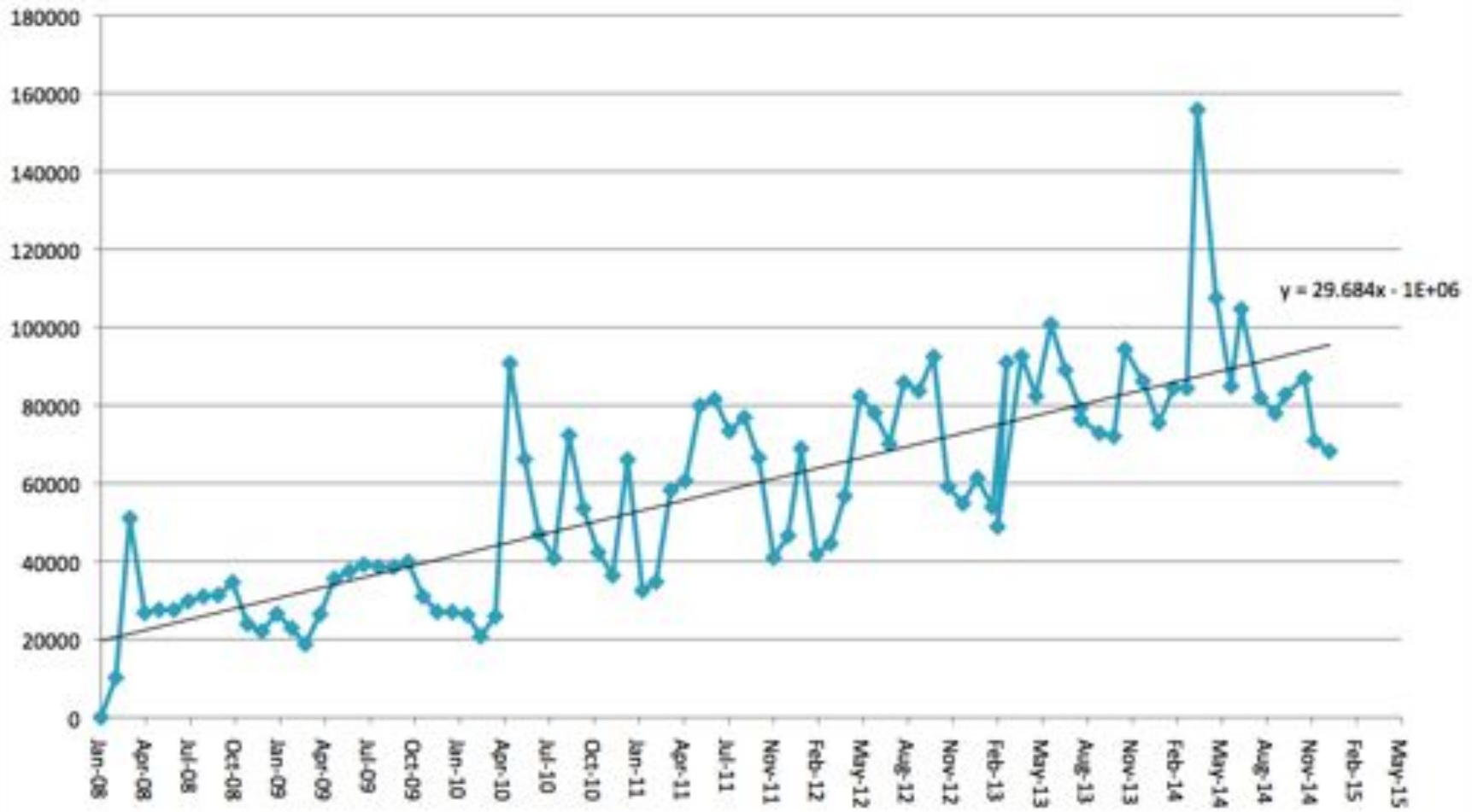
# Billing Data

Period	Read	Usage	Water Cost	Sewer	Sewer Cost	\$/water	\$/sewer	Gallons	Gallons Sewer	Week Days	Gallons/Week day	BBL Beer	Water/Beer	Sewer/Beer
Feb-10	4370	6070	\$ 2,270.18	5270	\$ 3,989.39	\$ 0.37	\$ 0.76	1,603,694	1,391,280.00	19	84405	6708.0	7.7	6.7
Mar-10	4977	6070	\$ 2,270.18	4210	\$ 3,186.97	\$ 0.37	\$ 0.76	1,603,694	1,111,440.00	19	84405	6709.0	7.7	5.3
Apr-10	6569	15920	\$ 5,954.00	14920	\$ 11,294.44	\$ 0.37	\$ 0.76	4,206,064	3,938,880.00	27	155780	16650.6	8.1	7.6
May-10	7220	6510	\$ 2,434.74	3611	\$ 2,733.53	\$ 0.37	\$ 0.76	1,719,942	953,304.00	16	107496	16651.6	3.3	1.8
Jun-10	8184	9640	\$ 3,605.36	7453	\$ 5,641.92	\$ 0.37	\$ 0.76	2,546,888	1,967,592.00	30	84896	18338.1	4.5	3.5
Jul-10	9095	9110	\$ 3,407.14	7228	\$ 5,471.60	\$ 0.37	\$ 0.76	2,406,862	1,908,192.00	23	104646	15782.5	4.9	3.9
Aug-10	9746	6510	\$ 2,434.74	4819	\$ 3,647.98	\$ 0.37	\$ 0.76	1,719,942	1,272,216.00	21	81902	14181.1	3.9	2.9
Sep-10	395	6490	\$ 2,427.26	5299	\$ 4,011.34	\$ 0.37	\$ 0.76	1,714,658	1,398,936.00	22	77939	9987.3	5.5	4.5
Oct-10	1053	6580	\$ 2,460.92	5363	\$ 4,059.79	\$ 0.37	\$ 0.76	1,738,436	1,415,832.00	21	82783	10205.4	5.5	4.5
Nov-10	1777	7240	\$ 2,707.76	5929	\$ 4,488.25	\$ 0.37	\$ 0.76	1,912,808	1,565,256.00	22	86946	10995.1	5.6	4.6
Dec-10	2394	6170	\$ 2,307.58	5039	\$ 3,814.52	\$ 0.37	\$ 0.76	1,630,114	1,330,296.00	23	70875	9481.2	5.5	4.5
Jan-11	2936	5420	\$ 2,027.08	4044	\$ 3,061.31	\$ 0.37	\$ 0.76	1,431,964	1,067,616.00	21	68189	11547.0	4.0	3.0

### Water/Sales Beer



### Water/Weekday (gallons)







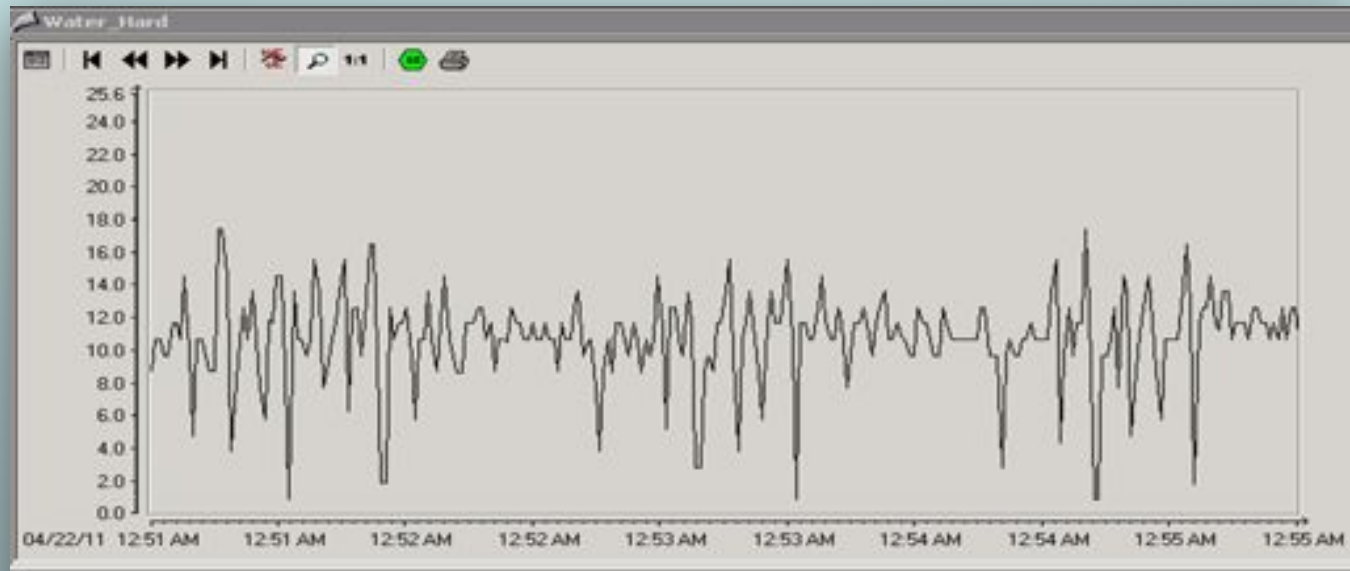


# Multijet Meter

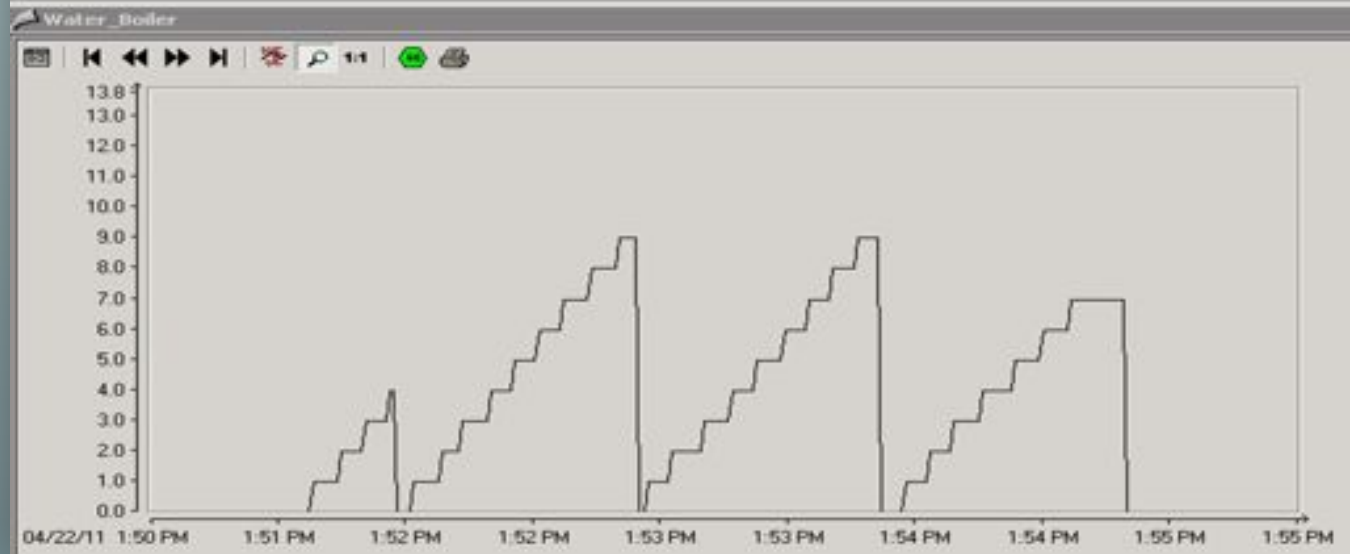


# Multijet Data

Paddlewheel  
Meter  
w/ Digital Pulse



Multijet  
Meter  
w/ Reed Switch



# Multijet Meters

- Pros
  - Inexpensive
  - Continuous Monitoring and Trending
- Cons
  - Invasive Install
  - Low-resolution data

# Ultrasonic Flowmeters

(Katronic Katflow 200)



# (Full Disclosure)

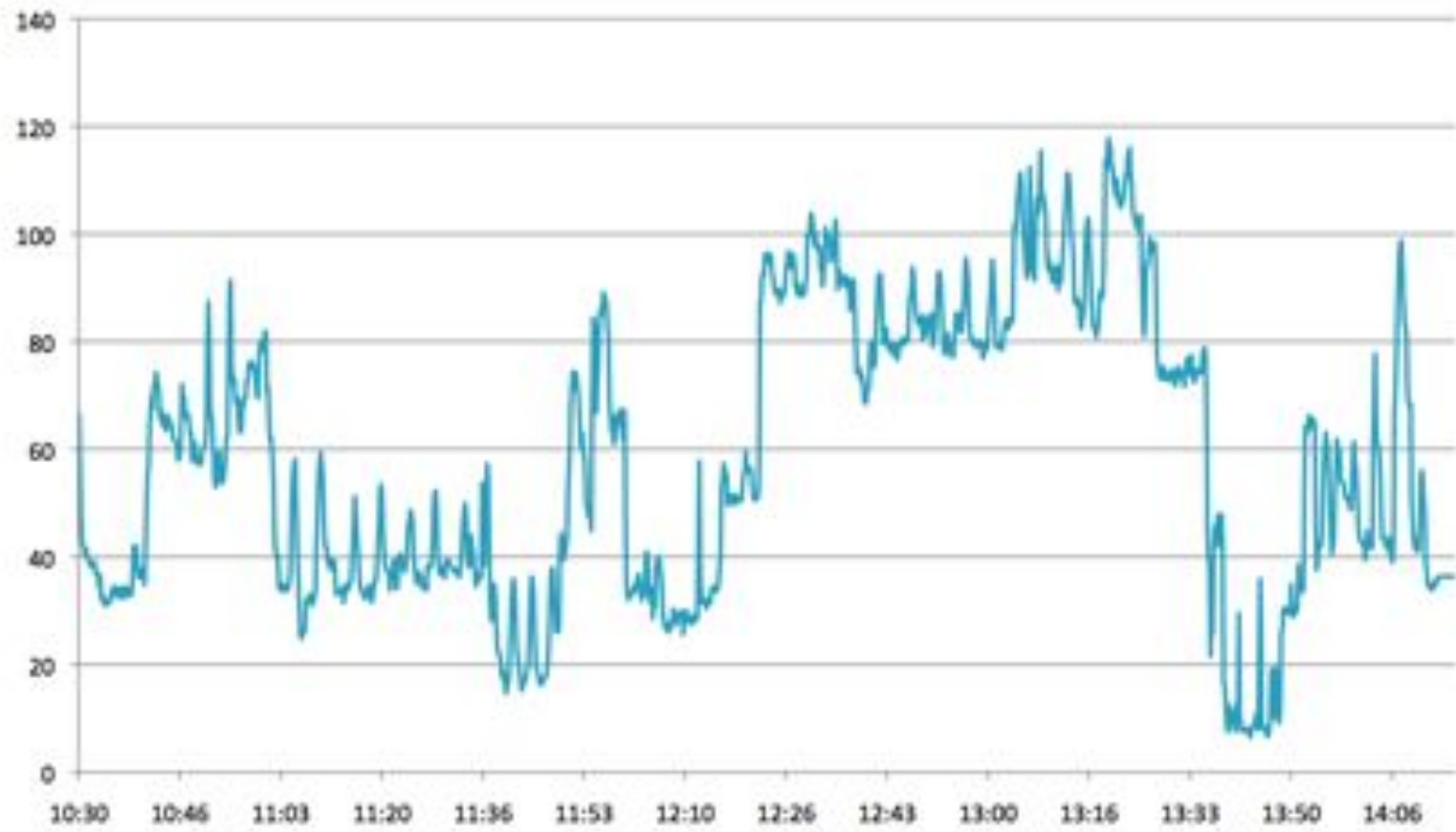
## Katronic: Katflow 200

- Lightweight and robust hand-held flowmeter with one measurement channel and graphic LCD display
- For commonly used pipe materials and diameters from 10 mm to over 3.0 m
- Intuitive menu, Setup Wizard and Audible Sensor Positioning Assistant for easy and quick setup and installation
- Transit-time correlation measurement using dual DSP-technology for better measurement accuracy
- Internal datalogger for up to 100,000 samples and PC download software

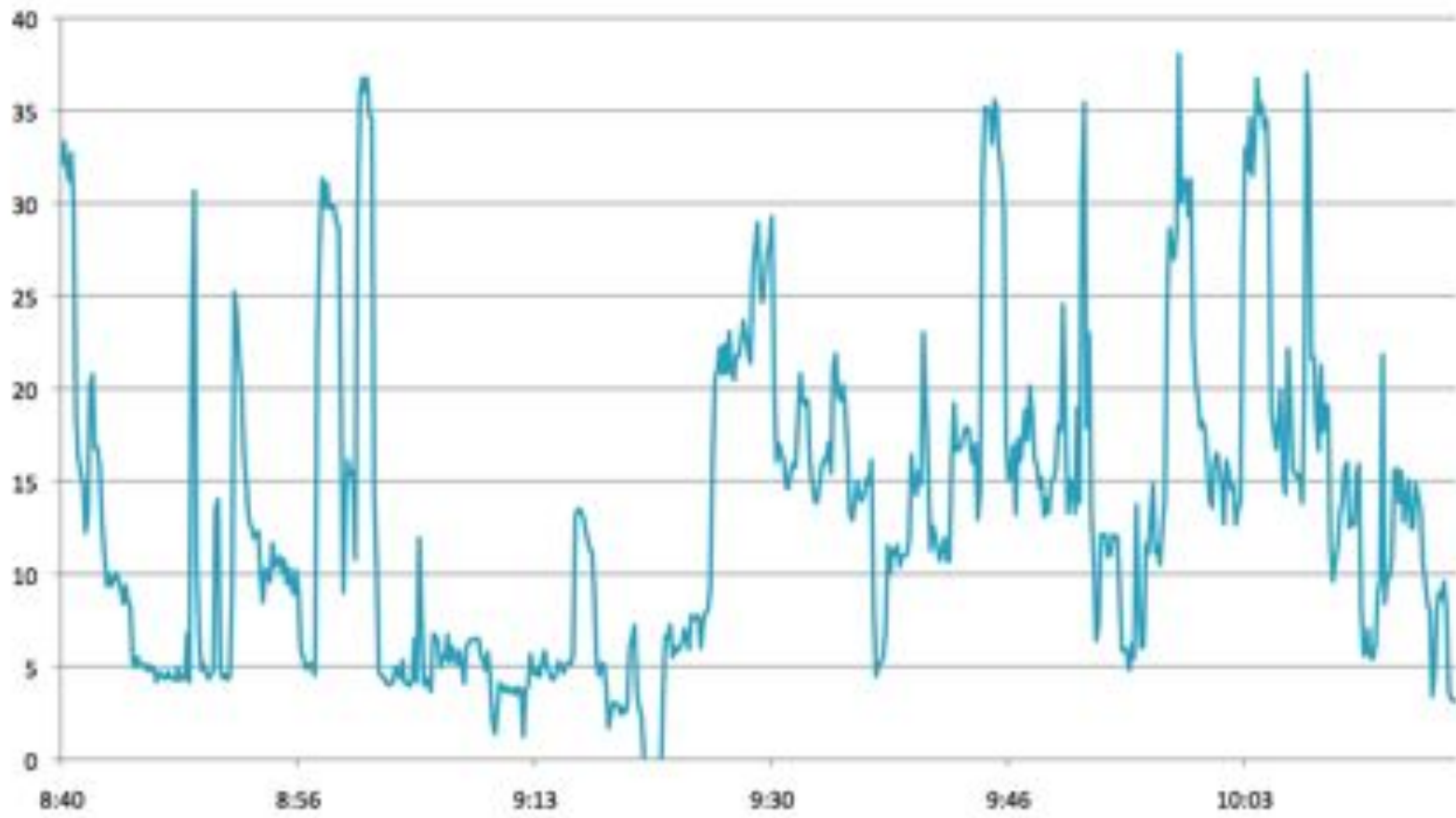
# CSV Files

	CH1:PV[USgall/min]	CH1:+TOT[USgall]	CH1:-TOT[USgall]			
#HEADER	-29.114	0	0	-28.756	0	0
1 115/10/10 14:40:49	-28.607	0	0	-28.643	0	0
Product KF200 20000046	-28.136	0	0	-28.273	0	0
HW 1.1 1.1SW	-27.587	0	0	-28.417	0	0
#PARAMETER	-27.366	0	0	-28.478	0	0
CHANNEL 1	-27.871	0	0	-28.084	0	0
SENSOR K1-9999	-27.793	0	0	-28.372	0	0
PIPE	-27.638	0	0	-28.311	0	0
MATERIA	-27.638	0	0	-27.878	0	0
L Copper	-28.087	0	0	-27.995	0	0
OUTSIDE	-27.951	0	0	-27.928	0	0
DIAMETE	-27.831	0	0	-27.928	0	0
R 53.975mm	-28.205	0	0	-27.68	0	0
WALL	-28.374	0	0	-27.71	0	0
THICKNES	-28.353	0	0	-27.746	0	0
S 1.778mm	-28.808	0	0	-27.742	0	0
PIPE C-	-29.101	0	0	-28.072	0	0
SPEED 2260m/s	-29.036	0	0	-28.27	0	0
PIPE CIRC 169.5675mm	-28.415	0	0	-28.268	0	0
ROUGHN	-28.591	0	0	-28.424	0	0
ESS 0.1mm	-28.235	0	0	-28.44	0	0
FLUID Water	-28.672	0	0	-28.026	0	0
KINEMATI	-28.648	0	0	-28.129	0	0
C VISC 1.01mm2/s	-28.917	0	0			
DENSITY 998.74kg/m3	-29.045	0	0			
MEDIUM	-29.132	0	0			
C-SPEED 1481.817m/s	-28.756	0	0			
TEMPERA						
TURE 20°C						

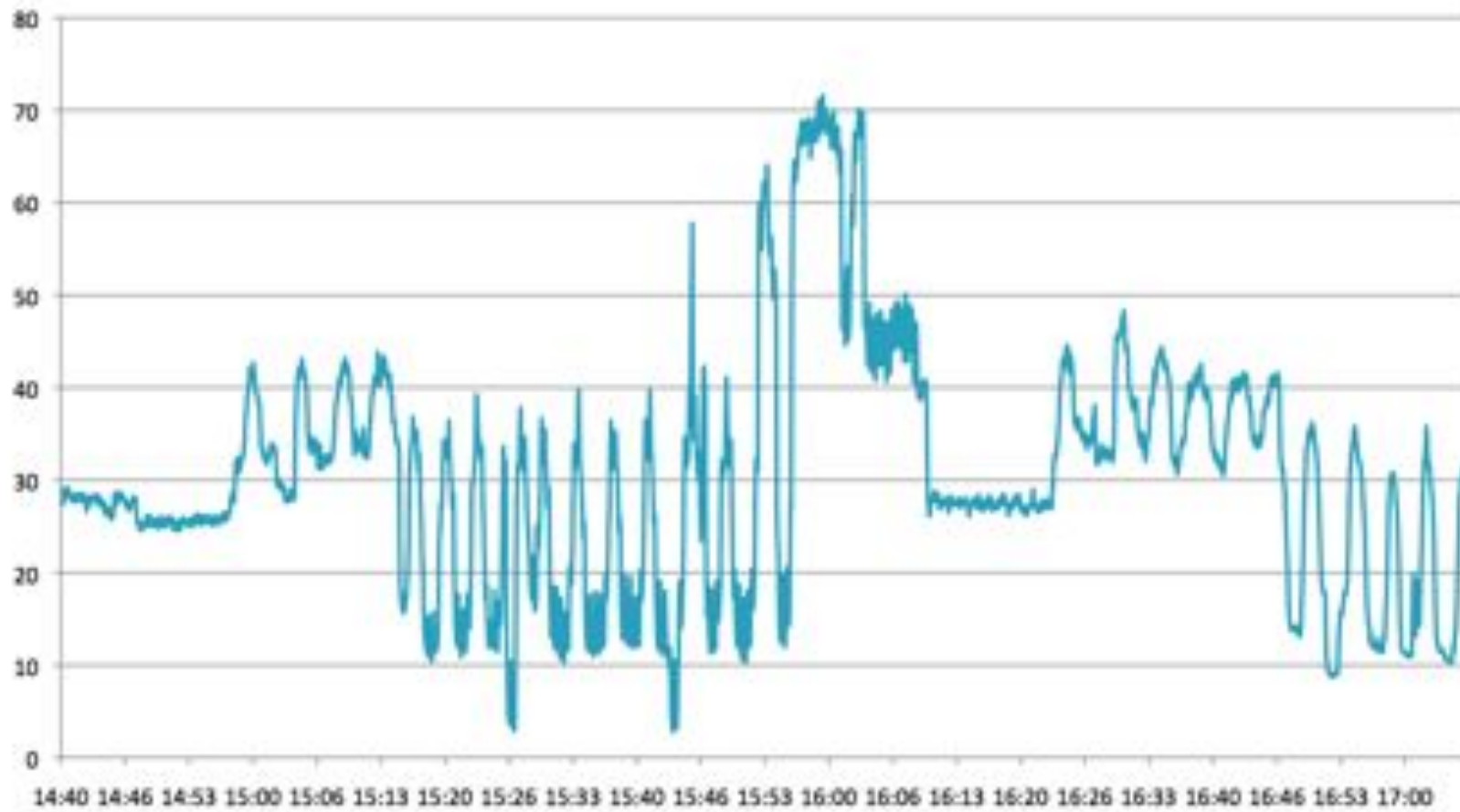
### Water Main Flow (gpm)



### Total Soft Water Flow (gpm)



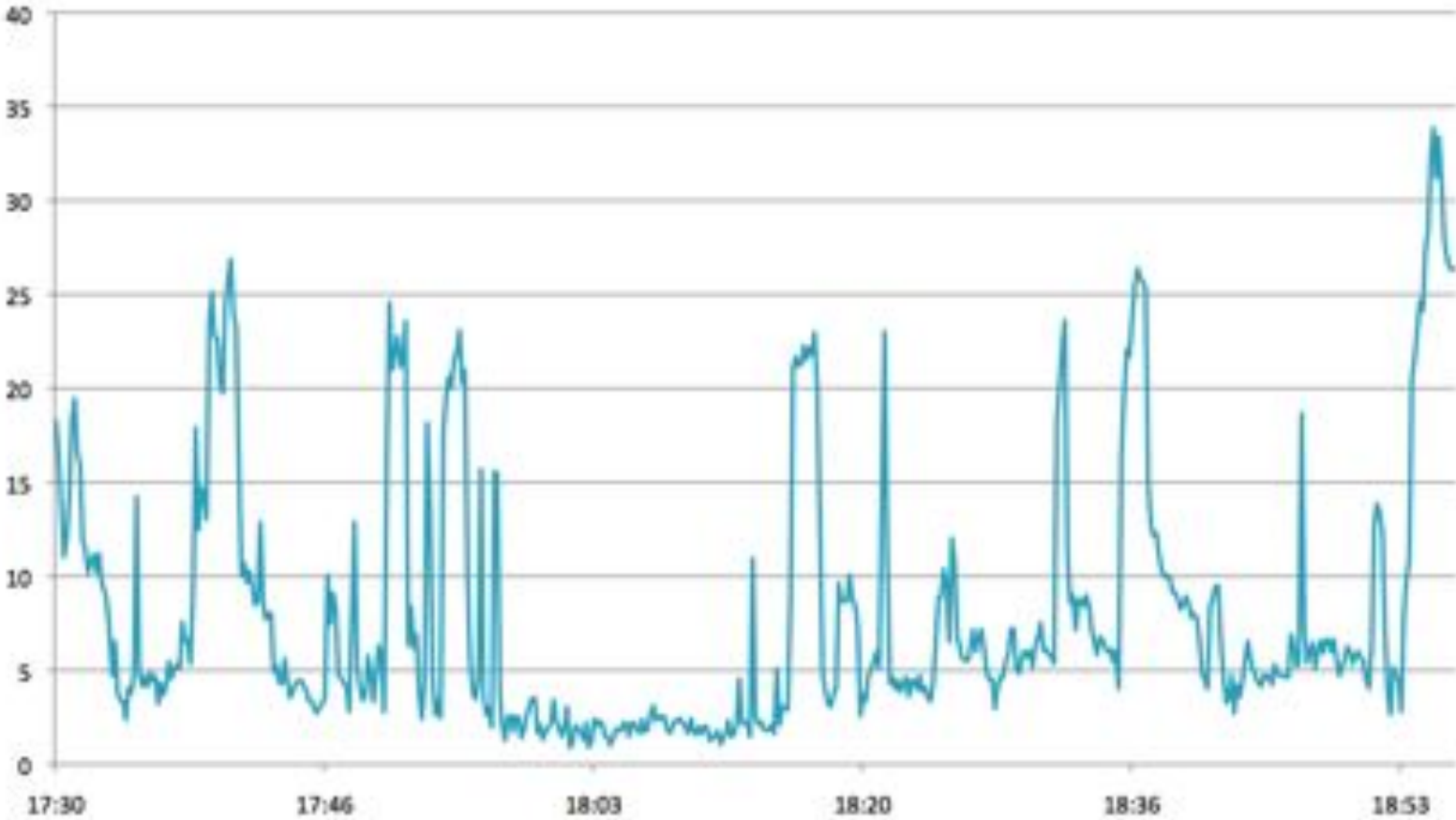
### Ambient Liquor Flow (gpm)



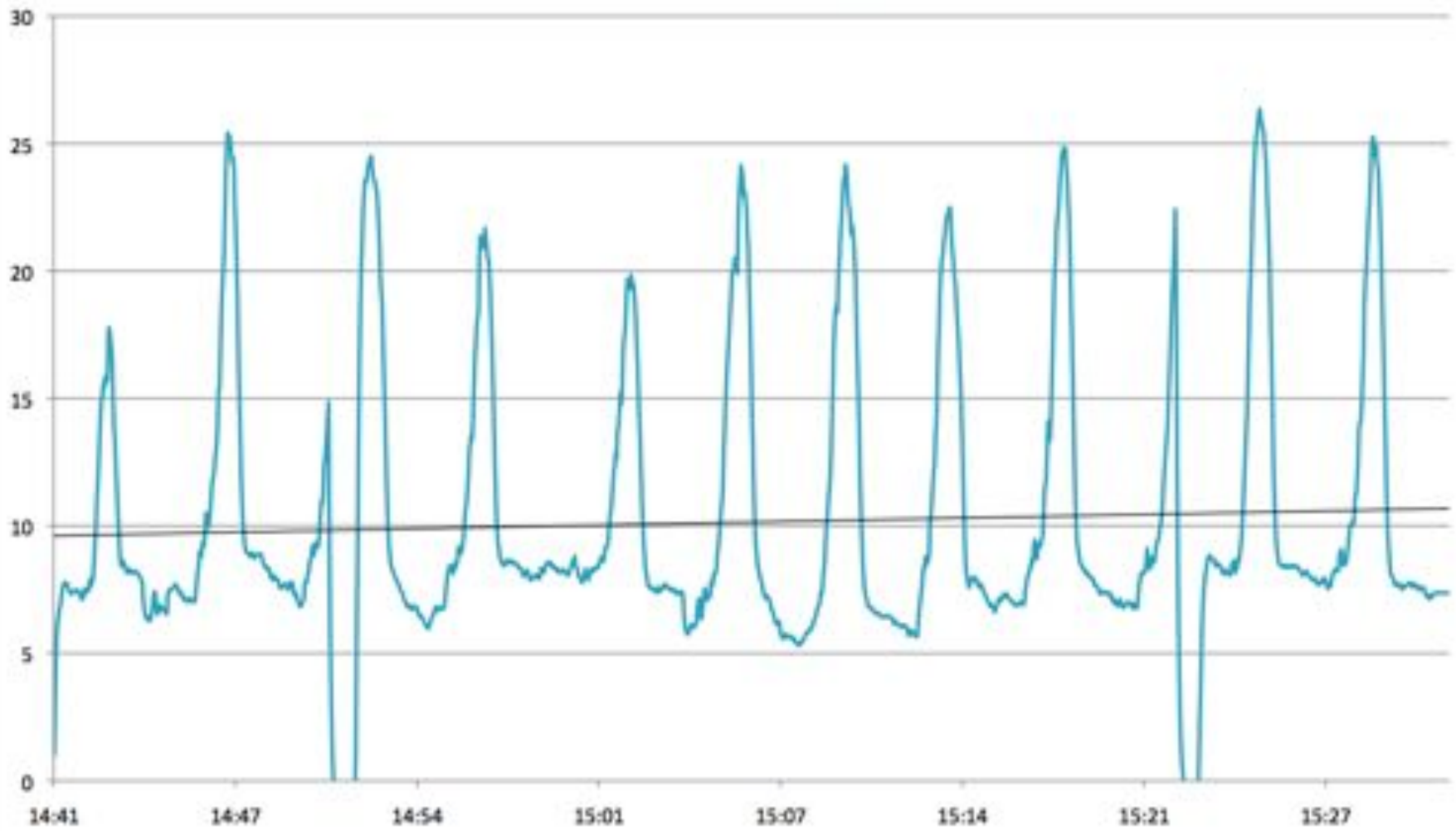
### Chilled Liquor Flow (gpm)



### Packaging Soft Water Flow (gpm)



### Kettle Stack Flow (gpm)



# Ultrasonic Meters

- Pros
  - Troubleshooting/Maintenance
  - Data for expansions
  - Non-invasive
  - Versatile
  - Works on most forms of liquid in breweries
- Cons
  - Less control data with variable logging environment
  - Doesn't work for high purity water
  - Limited trending intervals
  - Labor intensive
  - Expensive (\$3500 - \$5000)

# Signet Paddlewheel Digital Output

Approx. \$270 ea.



# Block PLC and Integration

Approx. \$1,300 for 7 Datapoints

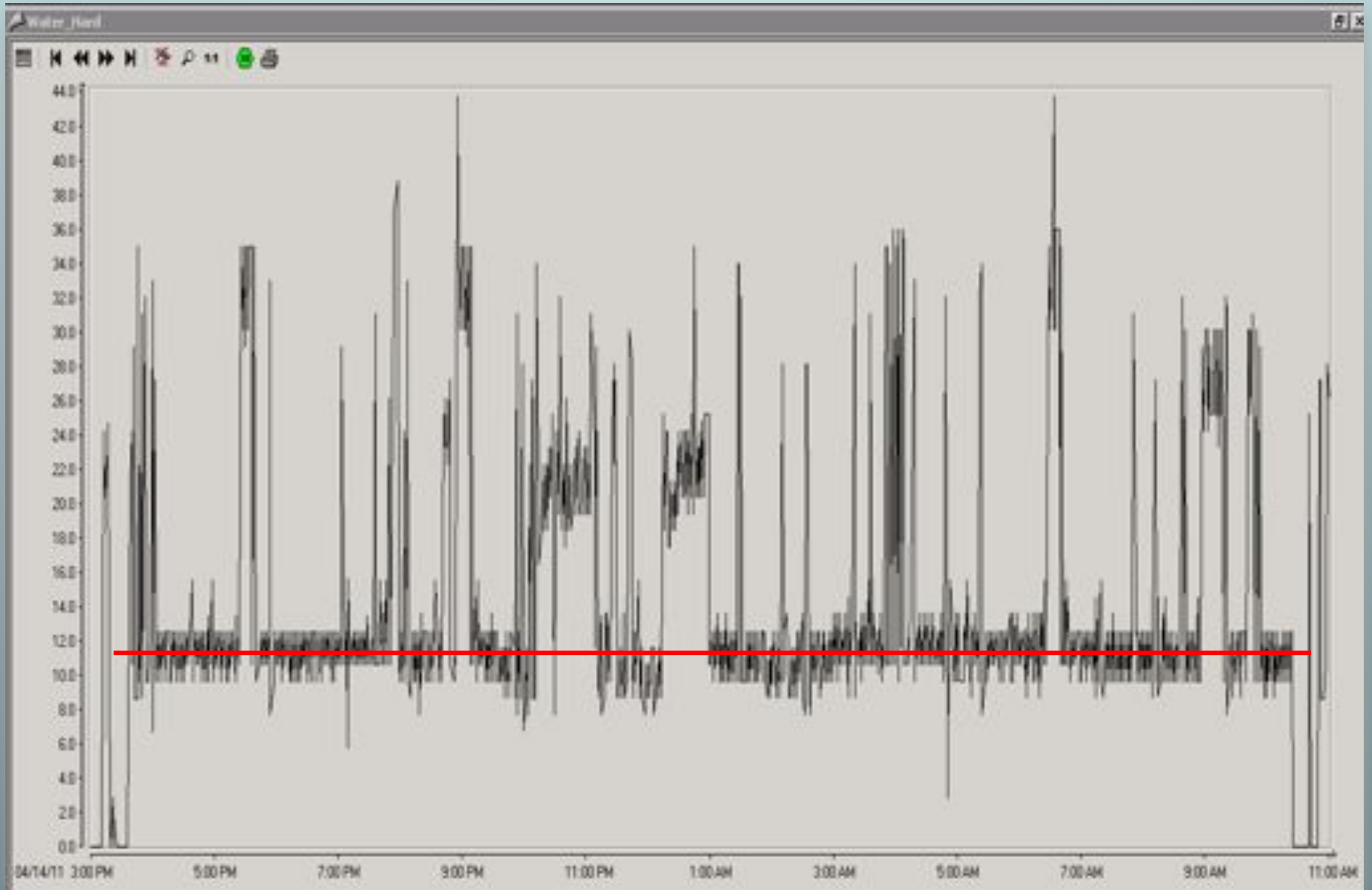


# Signet Paddlewheel Analog Output

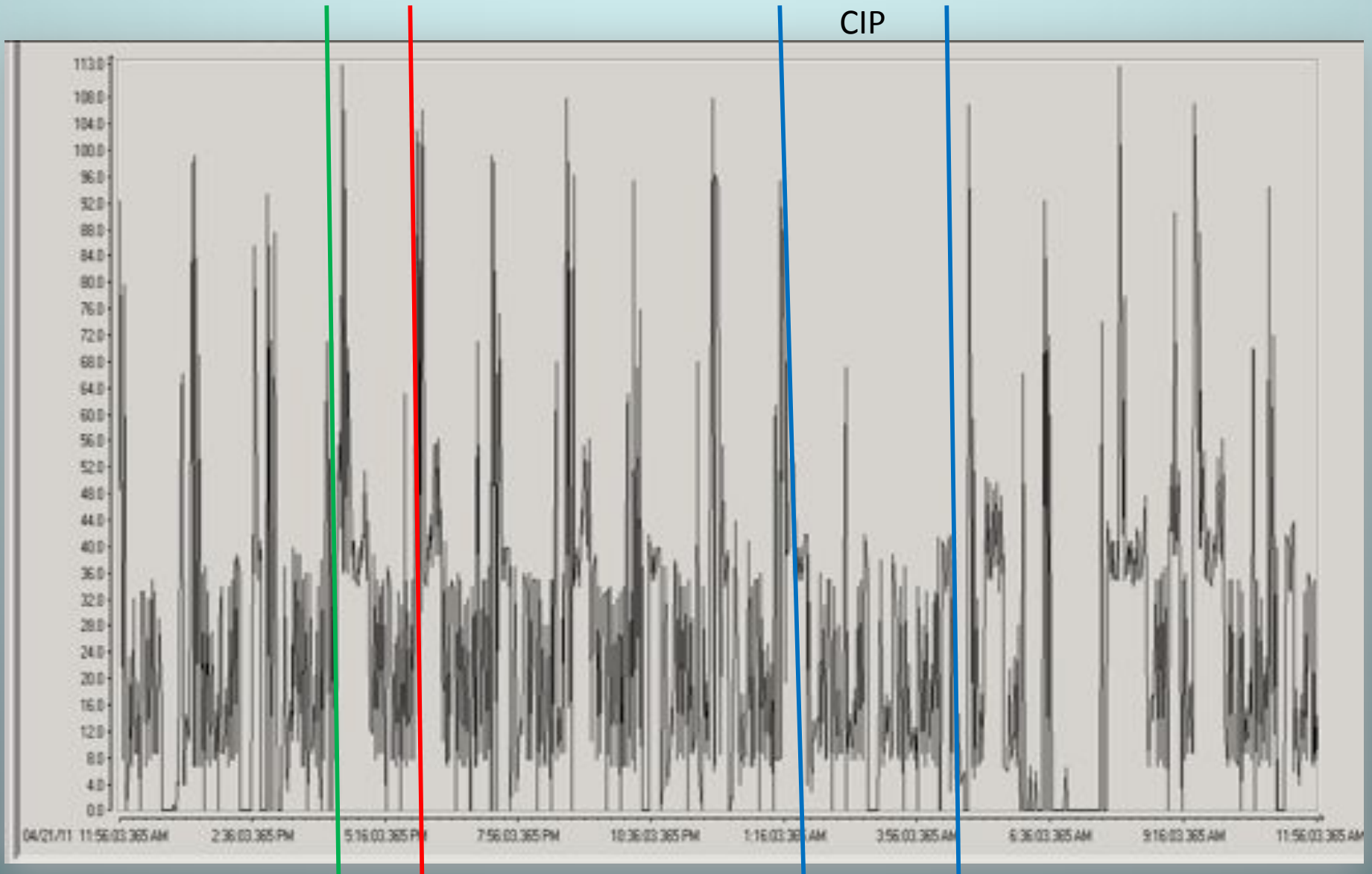
Approx. \$500 ea.



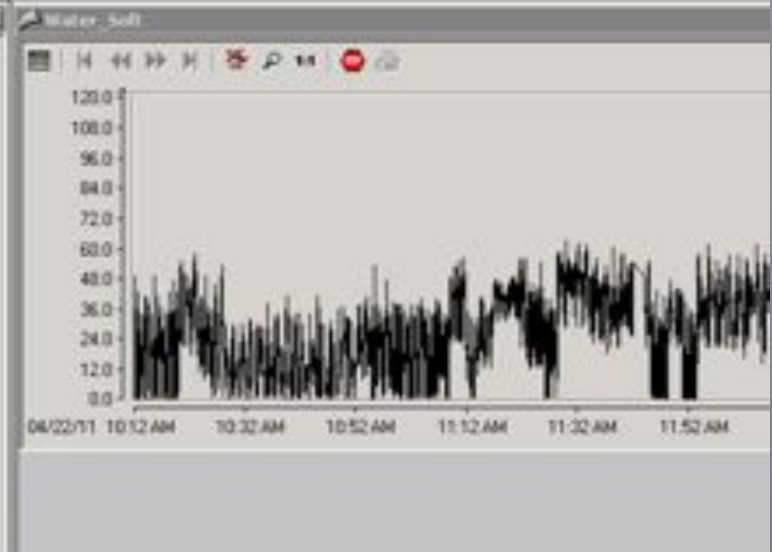
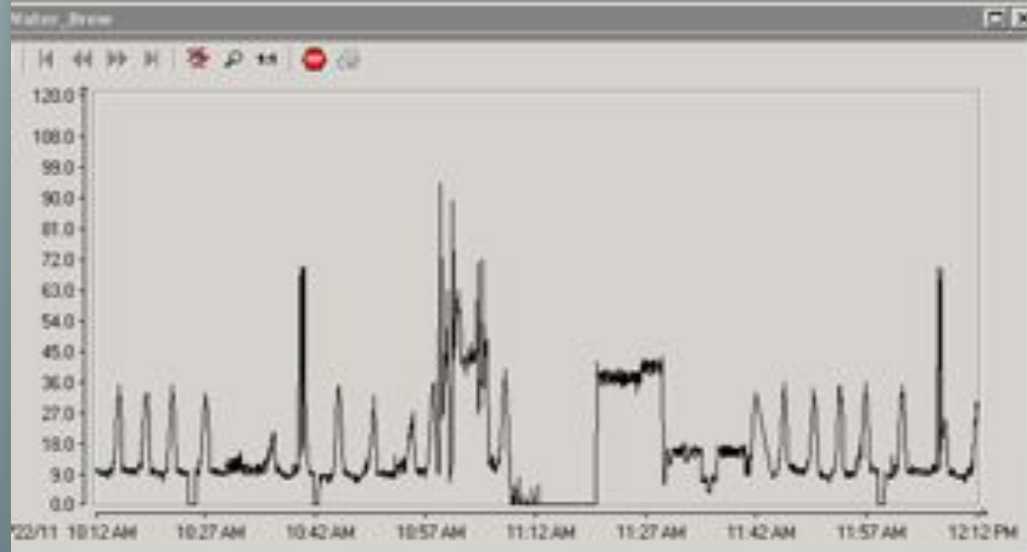
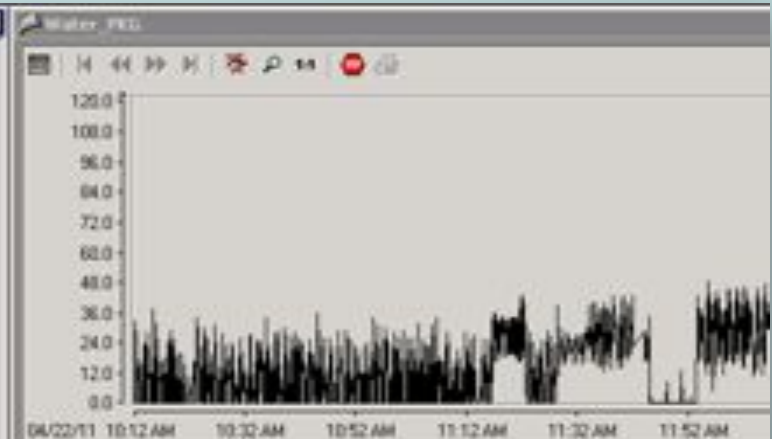
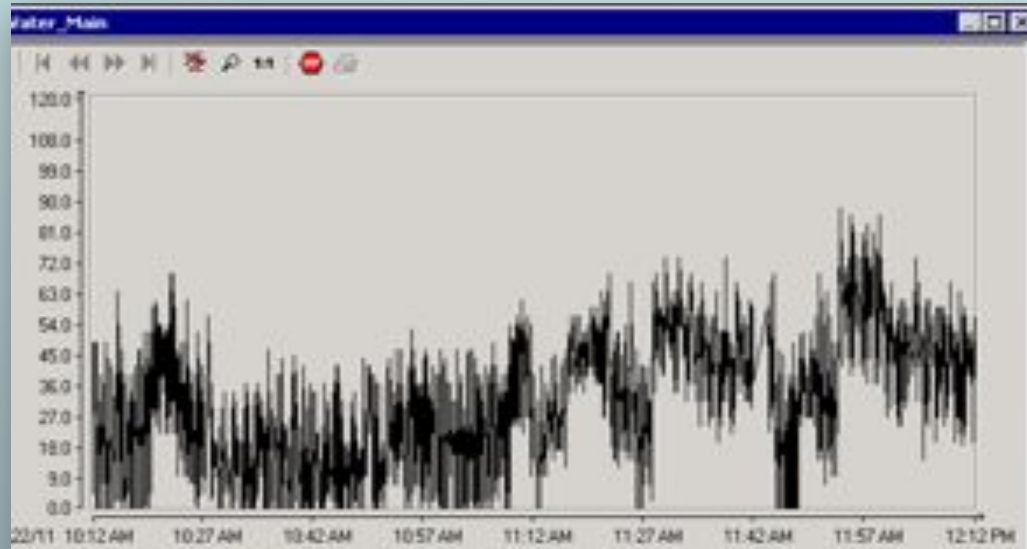
# Two Hearted High-Ferment



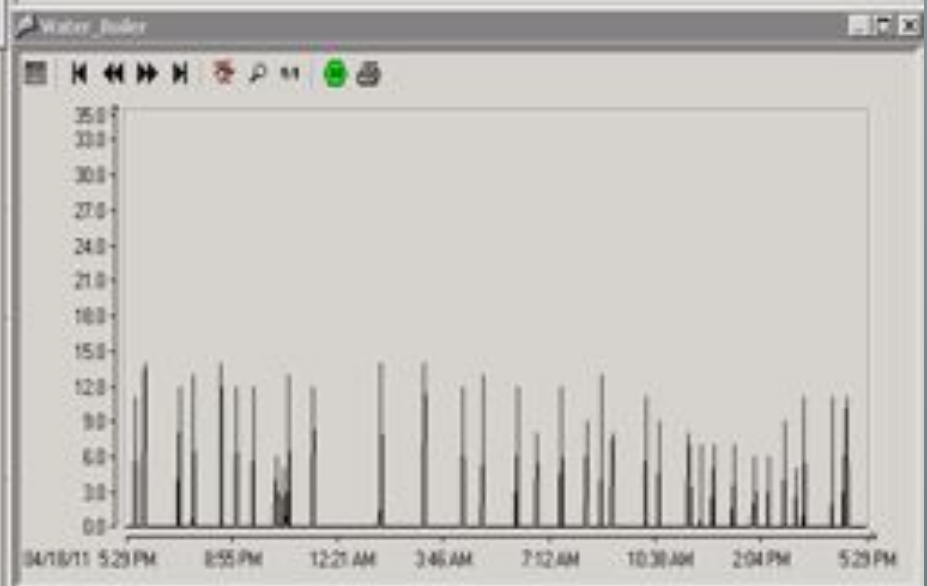
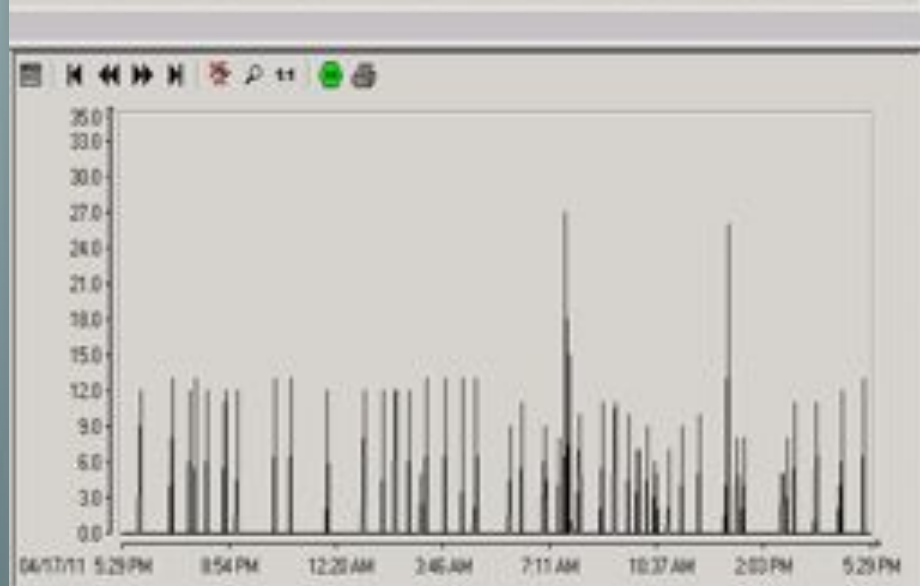
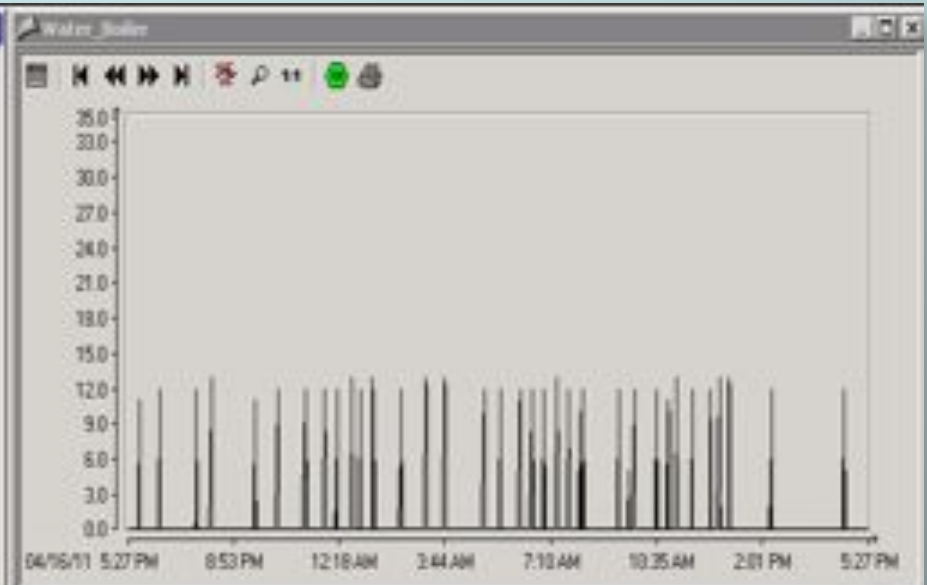
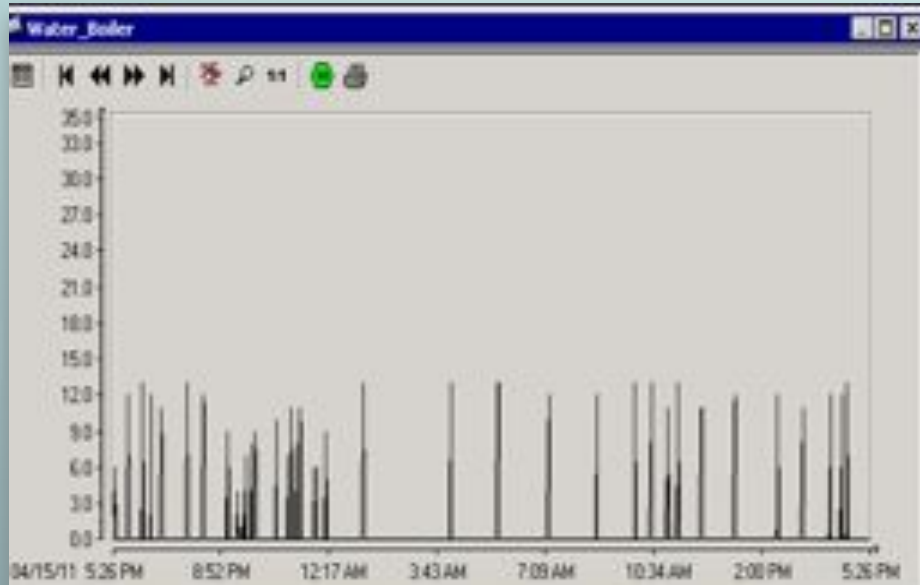
# Brewhouse Turns



# 2-Hour Process Water Correlation



# 4-Day Boiler Makeup Comparison



# Paddlewheel Meters

- Pros
  - Medium Cost
  - Good Data Resolution
  - Continuous Monitoring and Trending
  - Low Labor Cost after Install
  - AO = Relatively Simple PLC Integration
- Cons
  - Invasive Install
  - DO High K Factor = Possible Integration Difficulty

# Baselining for Breweries

- Know why you are collecting data
- Ask preliminary questions
- Identify needs
- Determine appropriate technology for application
- Work smart, not hard
- Practice data stewardship and creative decision making
- Use your data to track any intensity metric you find useful

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