UW-Madison Graduate Research Synopsis – Energy & Efficiency

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Project Objectives

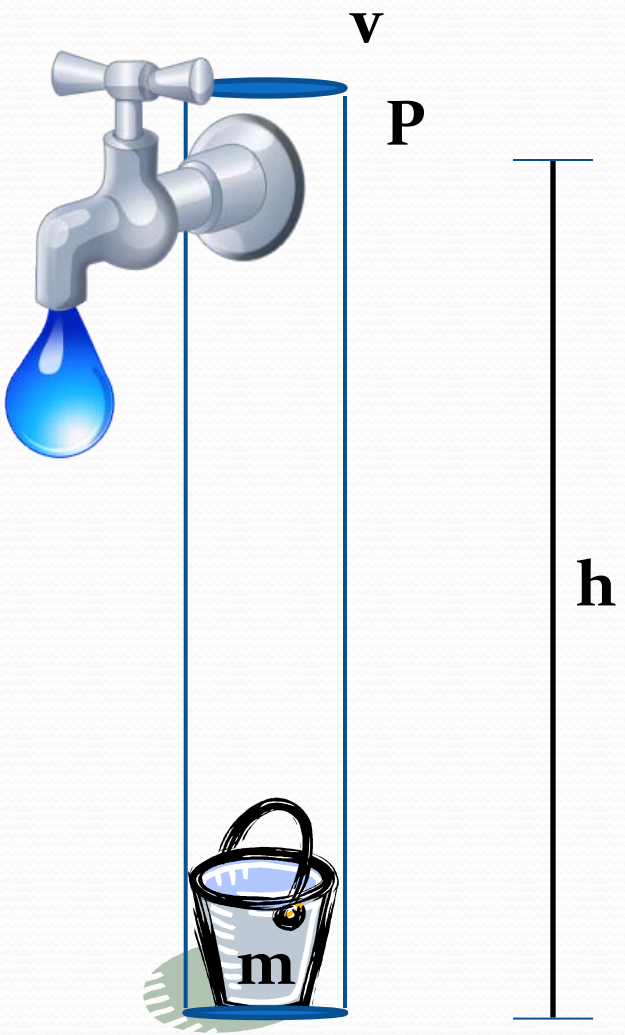
1. Determine the consumption of energy by location.
   - Unit Wells & Booster Stations
2. Understand the causes of **inefficiencies** at locations.
   - Pumps, motors, friction losses, etc.
3. Develop a method to **monitor, predict, and reduce energy** use at locations

Energy Concepts

Potential: (mass) x (height) x (g)

Kinetic: ½ (mass) x (velocity)^2

Pressure: P



1000 gal up 100 ft = 0.31 kWh

$$\text{Efficiency } (\eta) = \frac{\text{Energy Required}}{\text{Energy Used}} = \frac{Mass \times (P+h+v)}{Measured\ E}$$

Site Evaluation

- Utility consumes 1.9 kWh/kgal (vs. 2.0 state avg. for similar facilities)
- Visited Unit Wells 6, 9, 14, 25, 26, 29 and Booster Station 118
- Example Results from Unit Well 14:
  - 1.2 kWh/kgal
  - Frequent cycling increase energy use
  - 0.6 kWh/startup; 71 startups per week
  - Reducing startups to 10/week can save ~1900 kWh/year
  - Several alternatives for improvement

Overarching Conclusions

- >99% of energy used to pump water
- Efficiency can be measured via SCADA
- No single variable can predict site efficiency
  - **Age ≠ Efficiency**
- Site specific recommendations

Future Research Work

- Minimize Drawdown
- Analyze additional sites
  - Filtration & air stripping
  - VFDs
- Distribution system losses

Acknowledgments

UW-Madison

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Madison Water Utility

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- MWU employees

Consultants

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- Brian Brodersen (Layne)

Others

- Peers & Coworkers
- Family

Questions?


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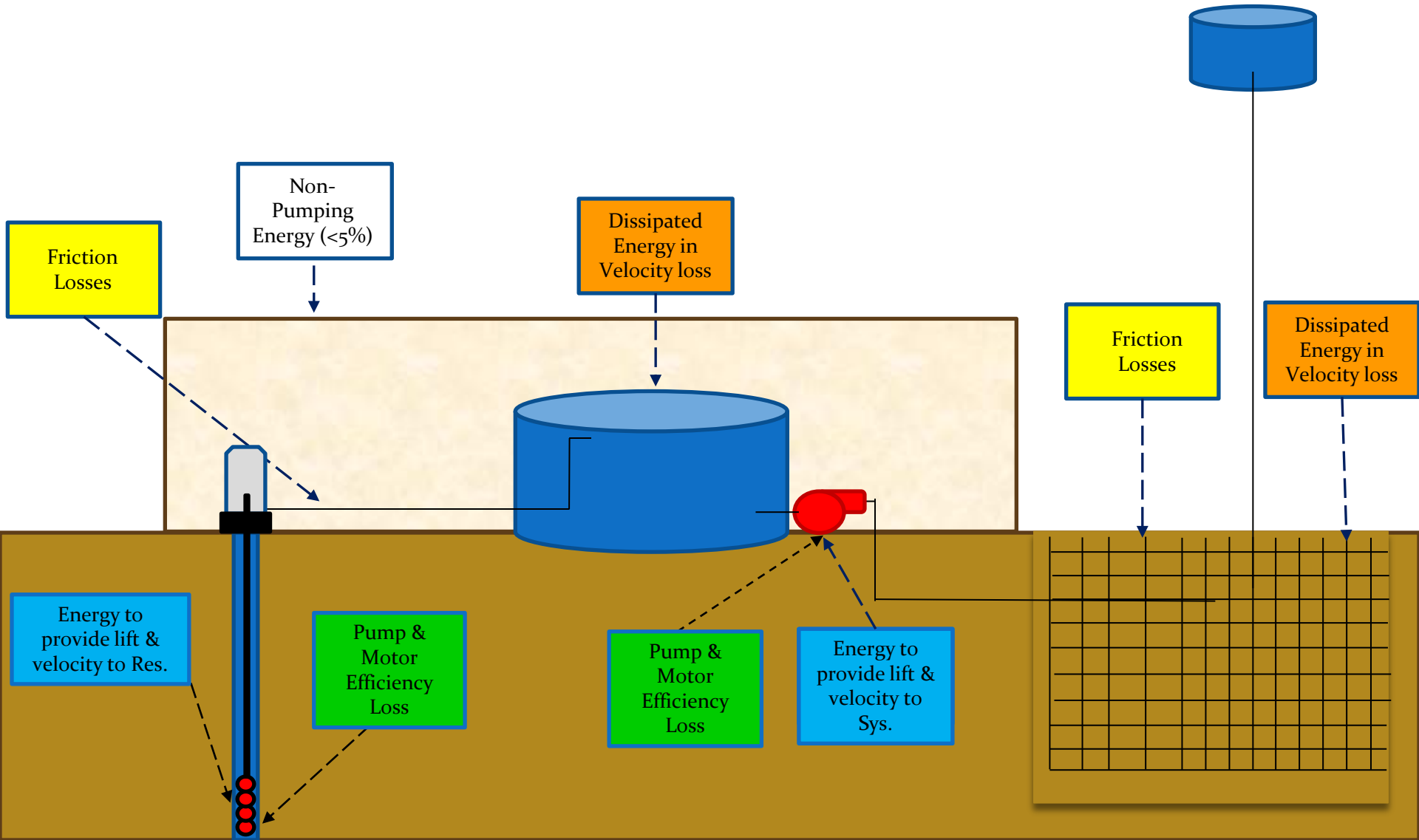
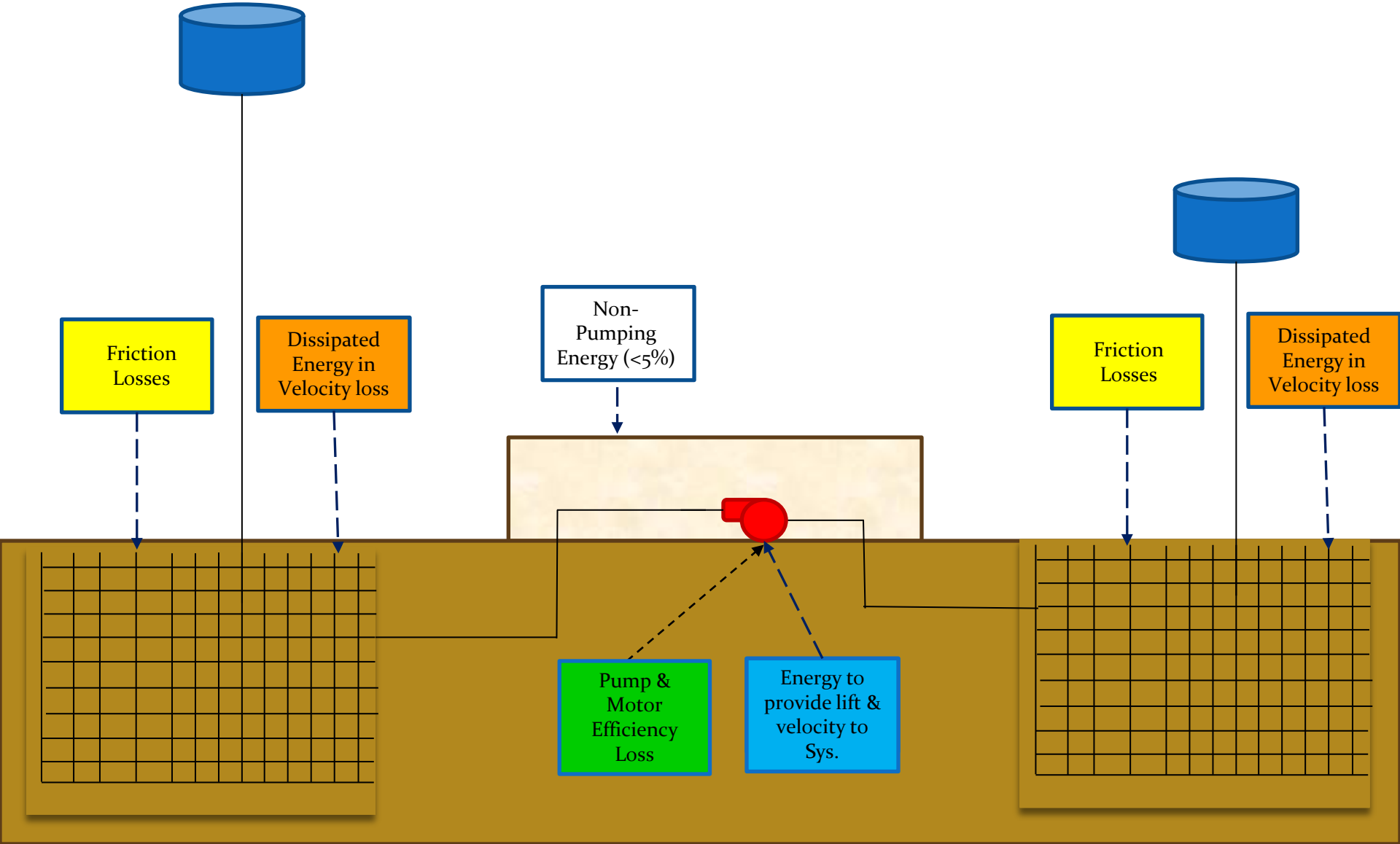
Unit Well Energy Diagram



Booster Station Energy Diagram

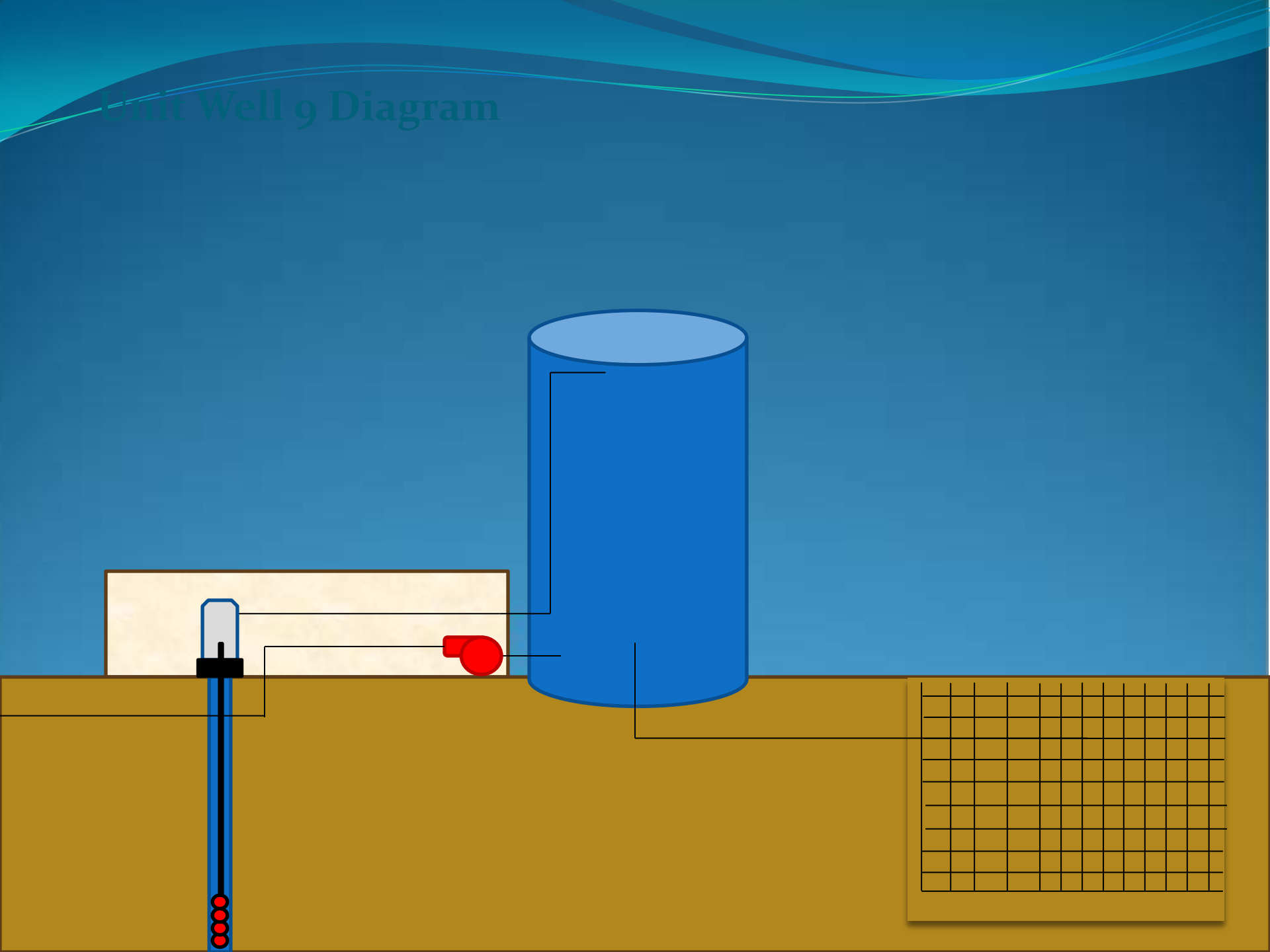


Variables to Measure

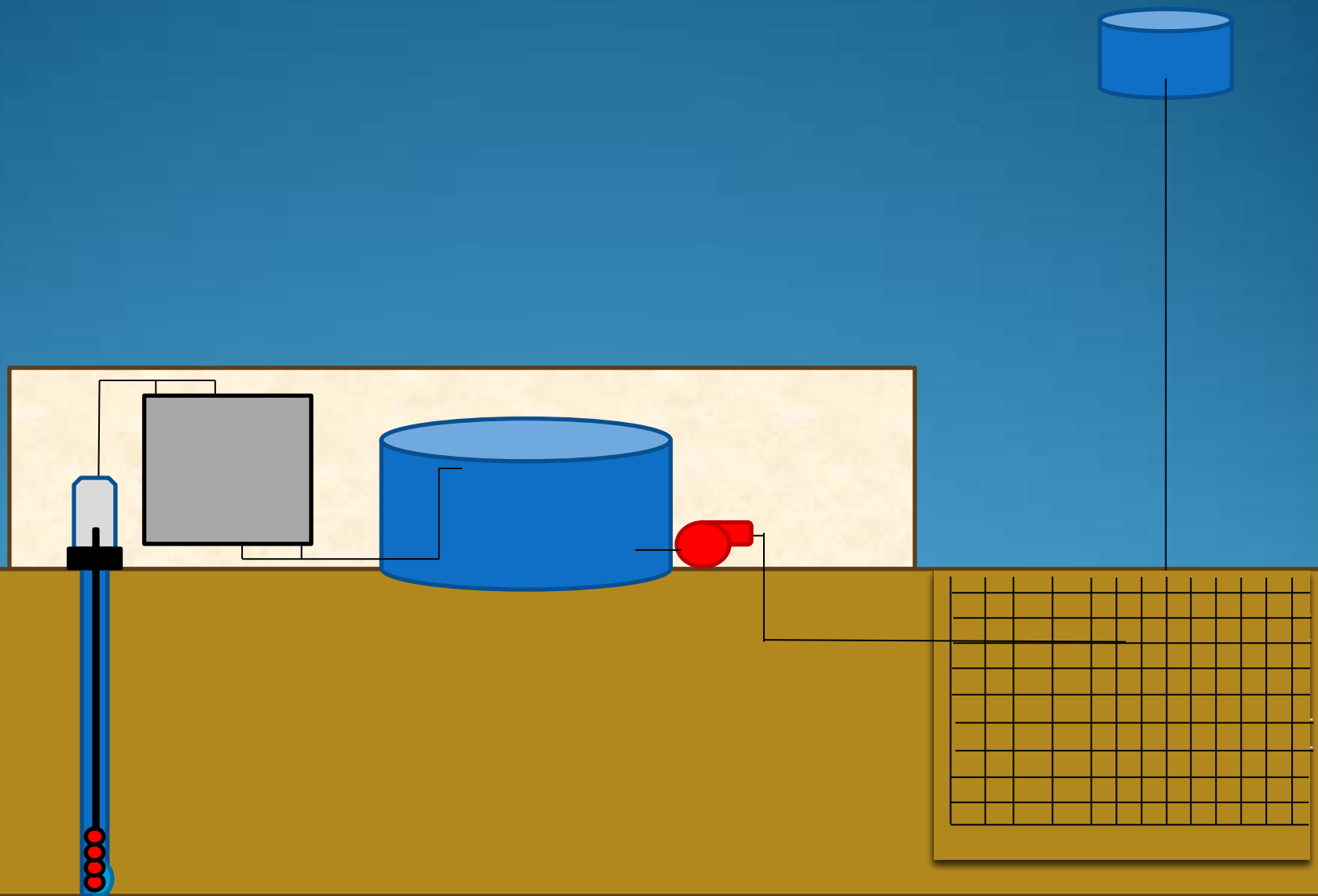
Variable	Frequency
Energy**	Weekly – Hourly
Pumping Level (avg, min, max)	Weekly – Hourly
Pump Flow Rate (avg) & Total Flow	Weekly – Hourly
Pump Starts	Hourly
Pump Run	Hourly
Res Level (avg, min, max, last)	Weekly – Hourly
Discharge PSI (avg)	Weekly - Hourly

Extraneous Variables
Amperage**
Vibration Level

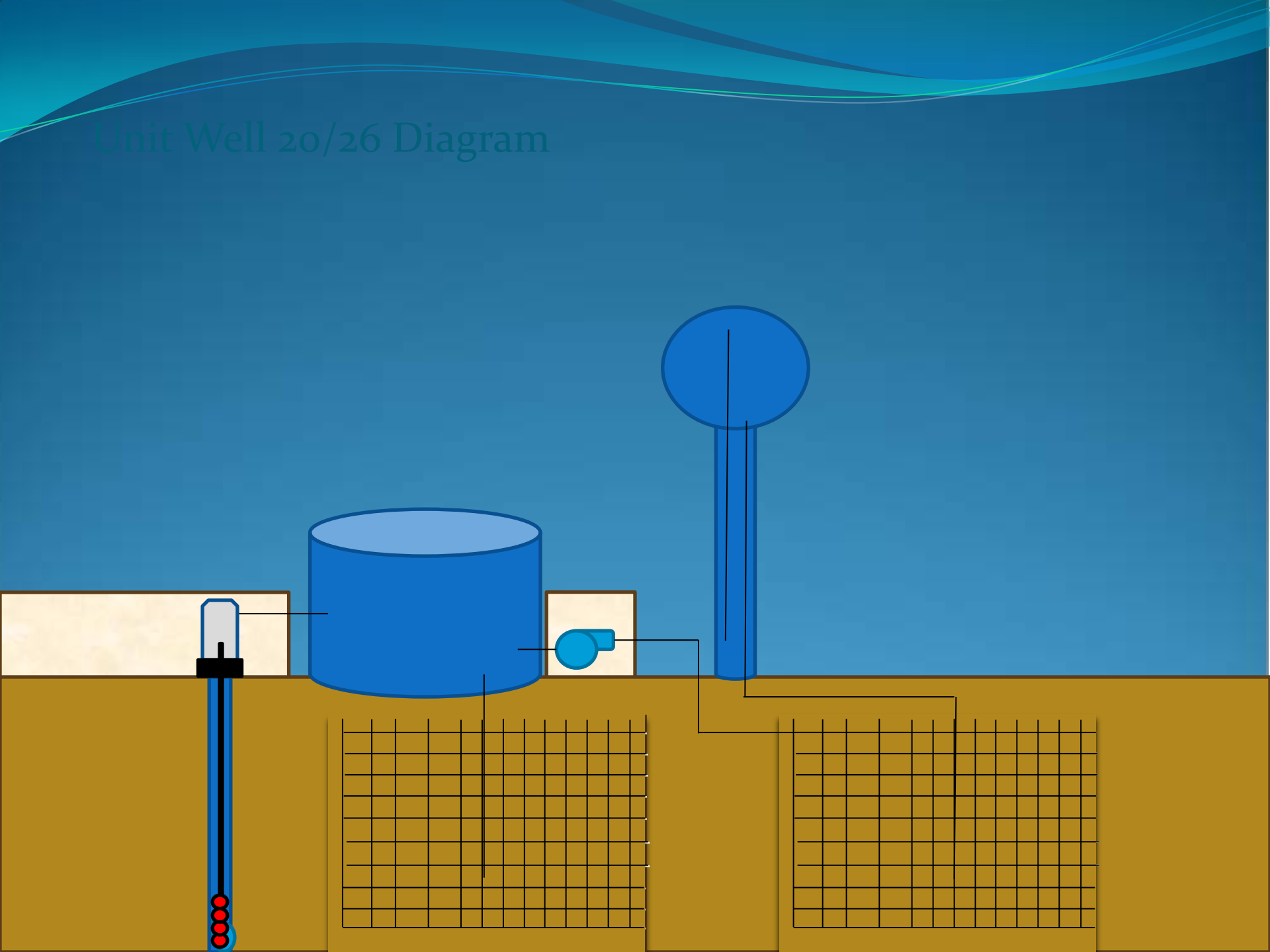
Unit Well 9 Diagram



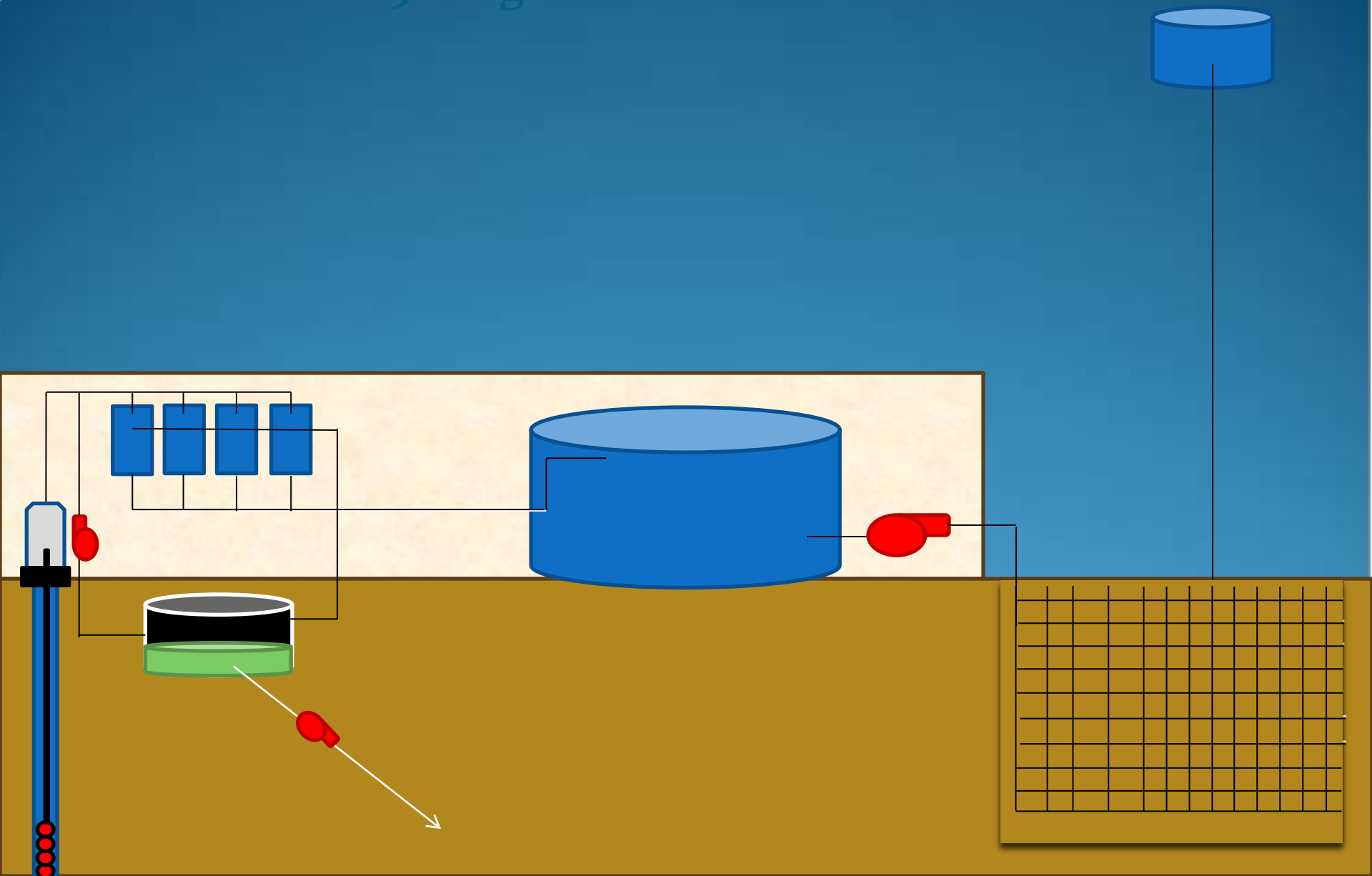
Unit Well 15 Diagram



Unit Well 20/26 Diagram



Unit Well 29 Diagram



Booster Station 118 Sampling Averages

Pump η	73%	75%	76%	75%	75%	
VFD η	95%	94%	95%	97%	97%	
KWh	4.44	4.47	5.91	7.26	7.85