

# Colorado Water Watch

An Overview



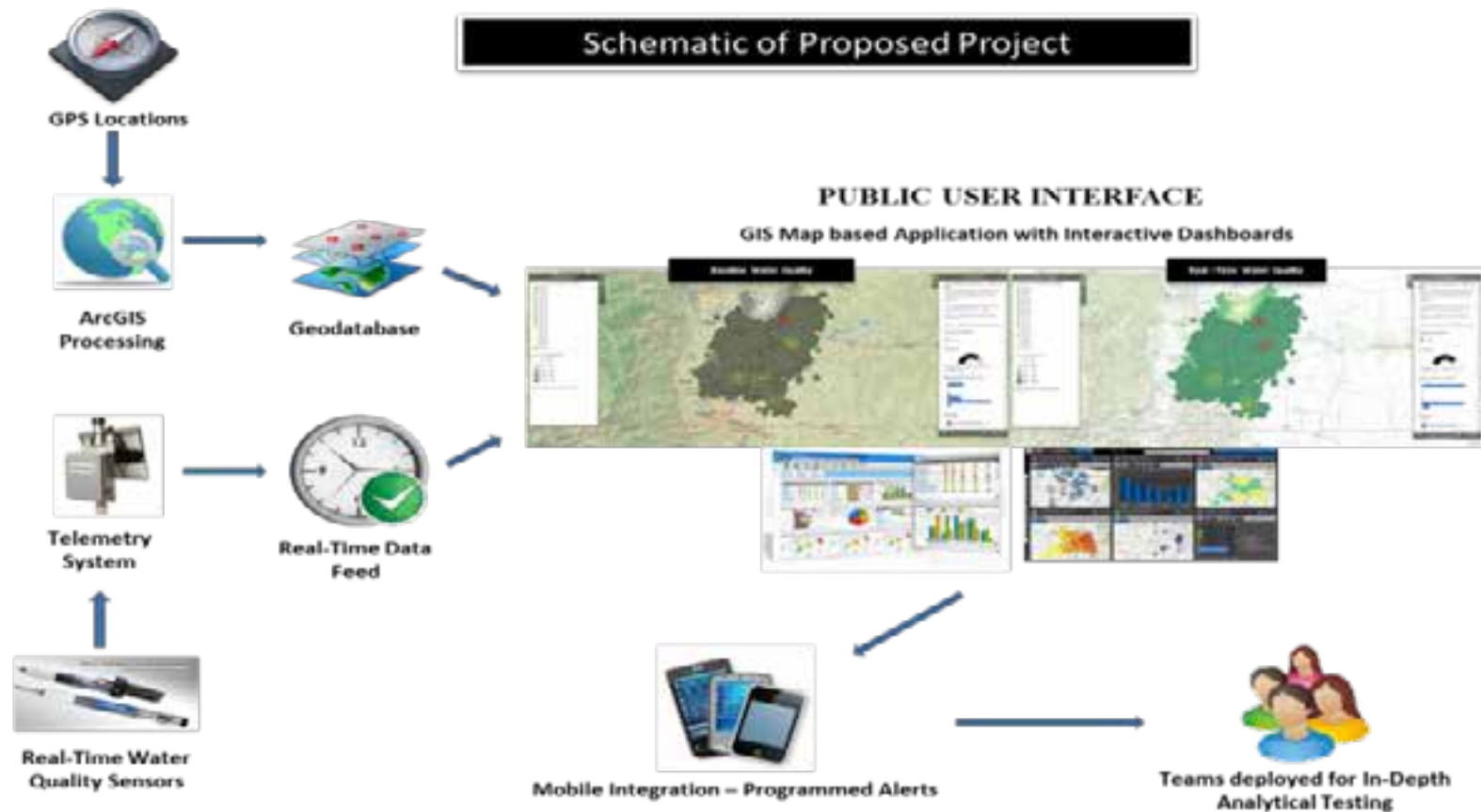
Colorado Water Watch

# PROJECT OBJECTIVES

- Install and operate a real-time water-monitoring network in proximity to significant hydraulic fracturing and oil and gas development activity
- Using real-time surrogate water quality measurements, develop a baseline and monitor for deviations that indicate a change in water quality
- Develop and implement web based tool for presenting information and data related to water quality to stakeholders including government, community, industry and environmental

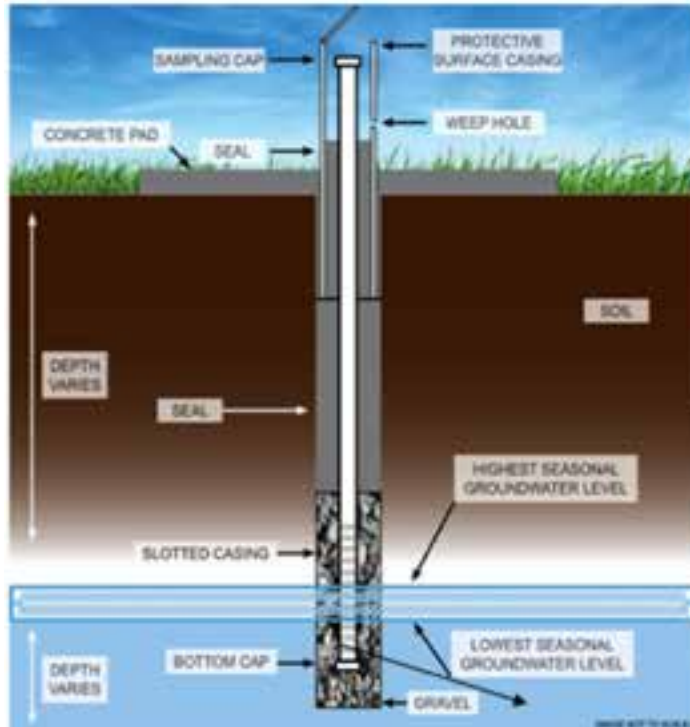


# Schematic of Proposed Project



# DATA ACQUISITION

Example design of a groundwater monitoring well



Multi-probes installed into the wells

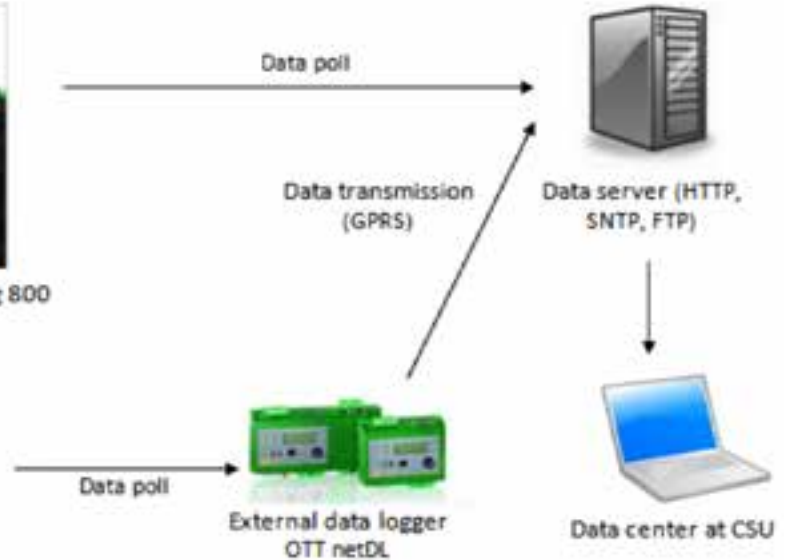


OTT ecoLog 800

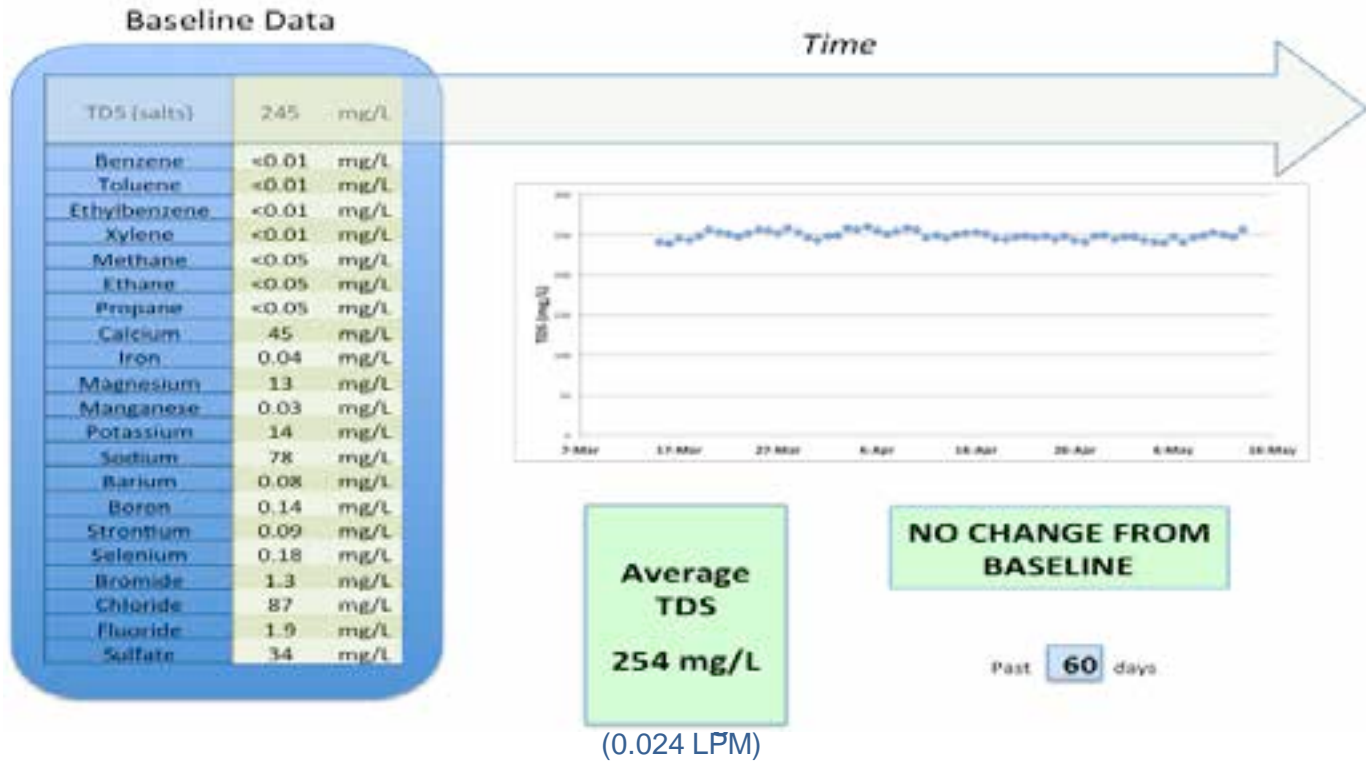


Hydrolab M55

Data collection



# REAL-TIME MONITORING RELATED TO COGCC DATA



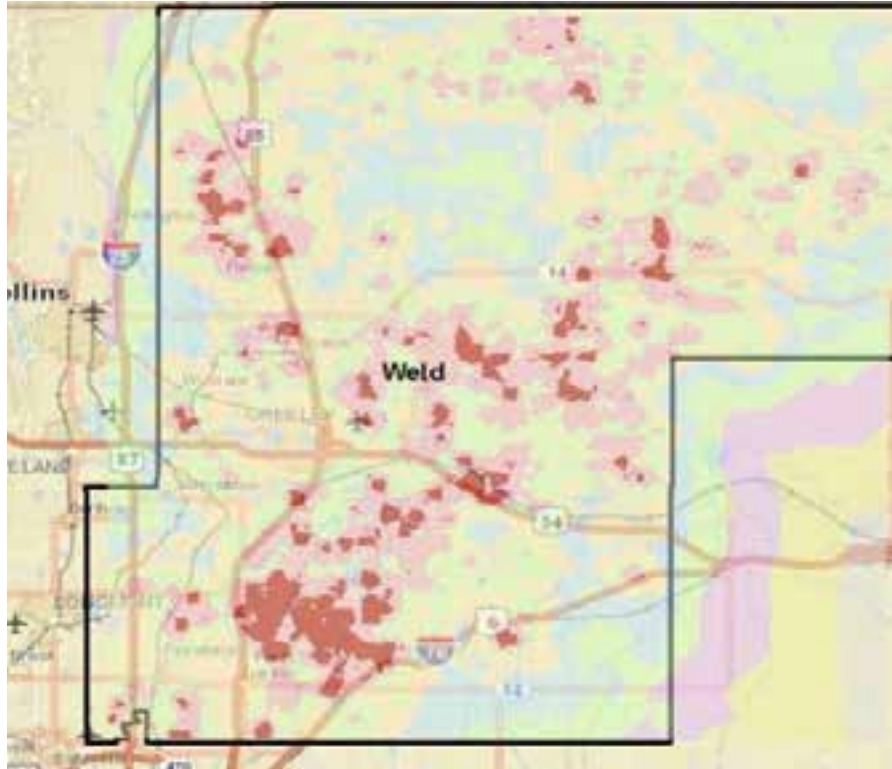
# MONITORING SITE SELECTION

Selected monitoring sites to be in close proximity to

- Existing Horizontal Oil & Gas Wells
- Permitted Horizontal Oil & Gas Wells
- Domestic & Municipal Groundwater Wells
- COGCC Baseline Water Quality Monitoring Sites



# SUITABLE AREAS FOR SITE SELECTION



## Legend



Criteria Weighted:

Existing Horizontal Oil & Gas Well (40%)

Permitted Horizontal Oil & Gas Wells (20%)

Domestic & Municipal Groundwater Wells (30%)

COGCC Baseline Water Quality Monitoring Sites (10%)



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# EC vs. TDS

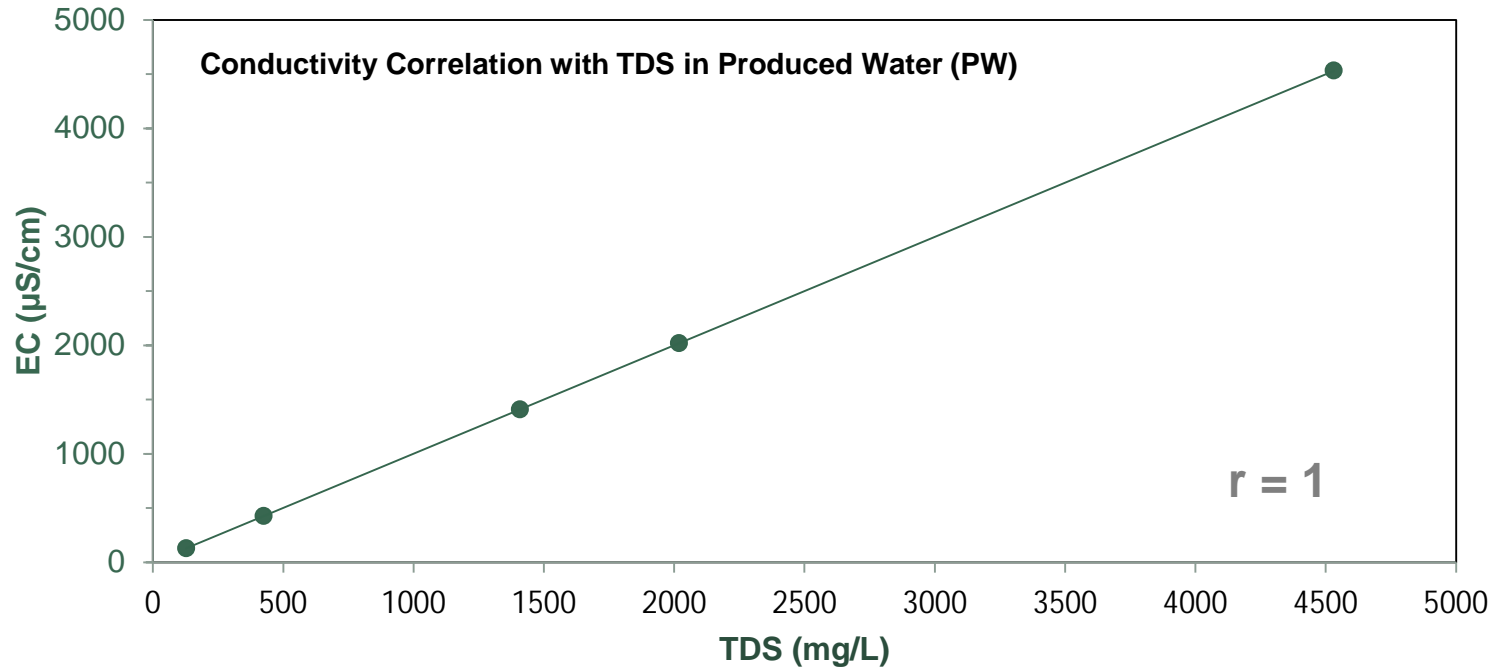
Electrical conductivity (EC) is a useful indicator of total dissolved solids (TDS) because the conduction of current in an electrolyte solution is primarily dependent on the concentration of ionic species (e.g., Wood, 1976; Hem, 1985; Lloyd and Heathcote, 1985).

Measurement of EC is **fast** and **inexpensive**. Therefore, under suitable conditions, EC measurements offer a significant advantage over the direct determination of TDS by sampling and chemical analysis. This is particularly true for continuous monitoring of water chemistry using an automated system or for geophysical imaging of soil and groundwater. (Hayashi, 2003)

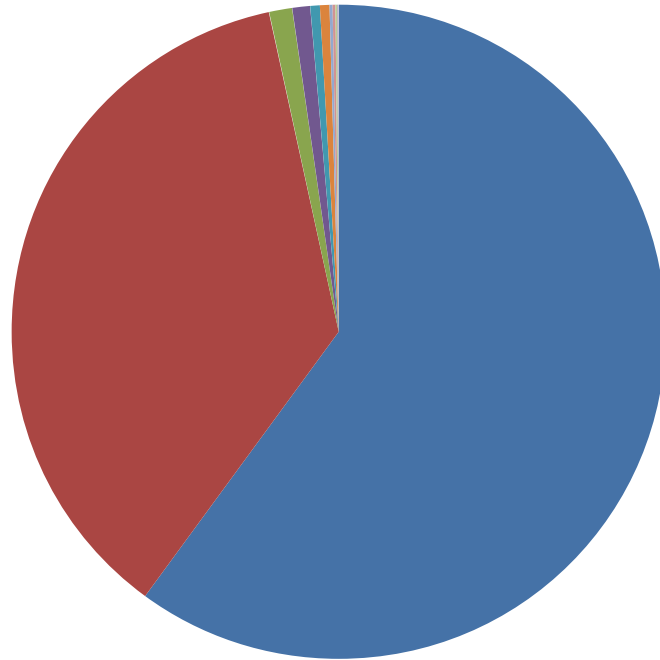




# I. TDS SURROGATE TEST



## PRODUCED WATER (TDS: 34,359 mg/L)

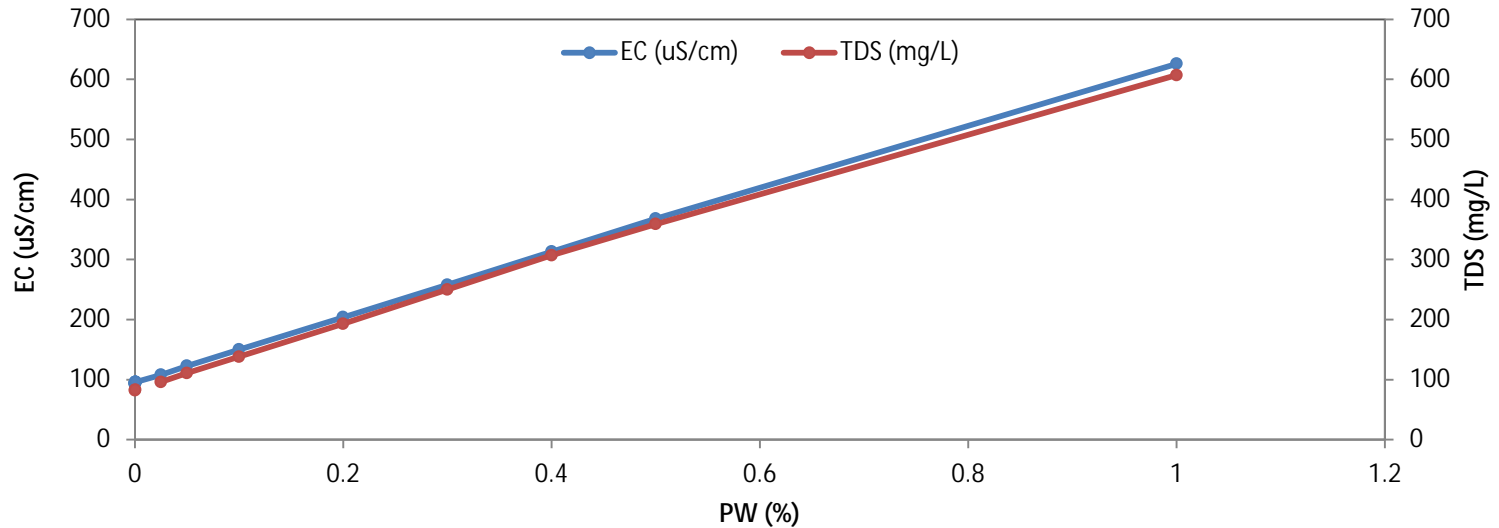


- Cl (60.09 %)
- Na (36.52 %)
- HCO3 (1.14 %)
- Ca (0.89 %)
- Fe (0.47 %)
- K (0.47 %)
- Sr (0.15 %)
- Mg (0.14 %)
- Ba (0.09 %)
- B (0.06 %)
- Mn (0.01 %)



# EC vs. PW

- Confined test



**Correlation between EC and TDS: 0.9998**

**TDS of raw PW (WR 14-63): 34,359 mg/L**

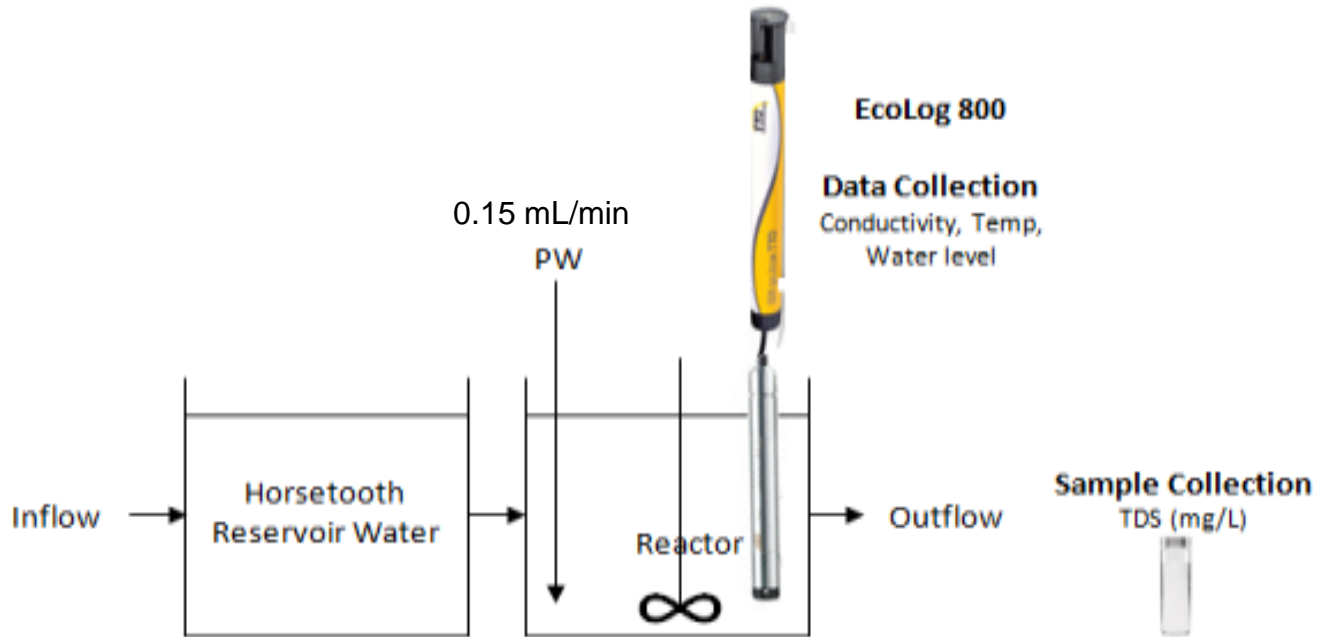
**TDS of Horsetooth Reservoir water: 82 mg/L**

**Mean of background EC: 93.6  $\mu$ S/cm**

**Limit of detection (LOD): 95.1  $\mu$ S/cm ( $0.00045 < \text{PW} (\%) < 0.00055$ ;  $\mu+0.15 < \text{TDS} (\text{mg/L}) < \mu+0.19$ )**

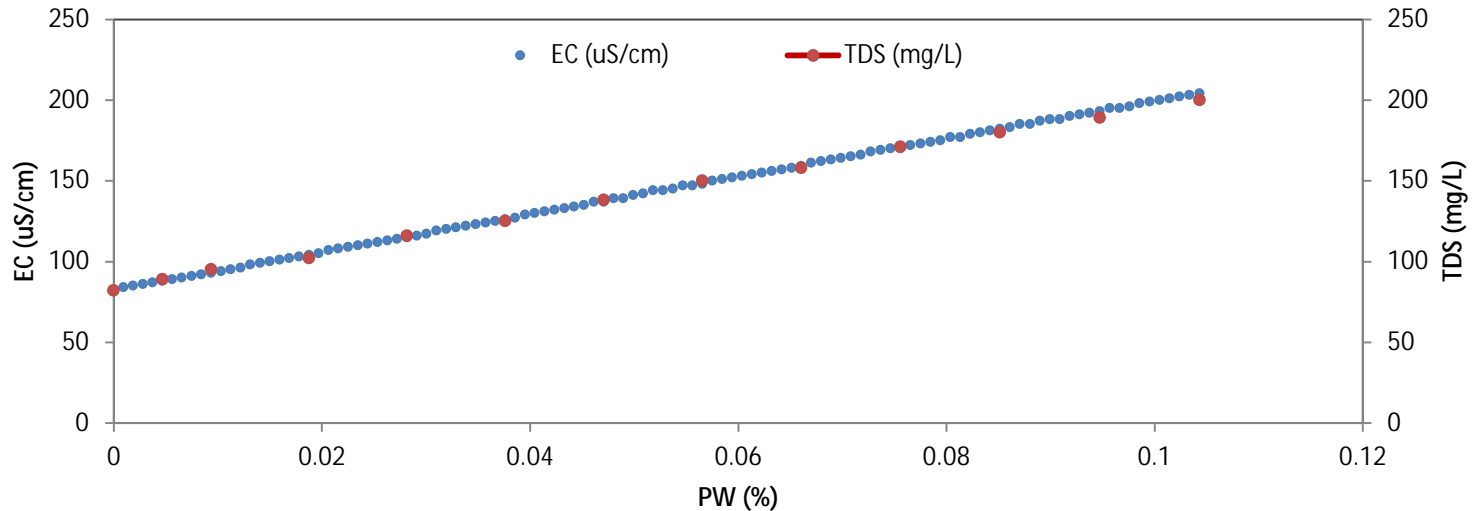


# CONTINUOUS FLOW TEST



# EC vs. PW

- Continuous flow test (flow: 0.15 mL/min)



**Correlation between EC and TDS:** 0.9994

**TDS of raw PW (WR 14-63):** 34,359 mg/L

**TDS of Horsetooth Reservoir water:** 82 mg/L

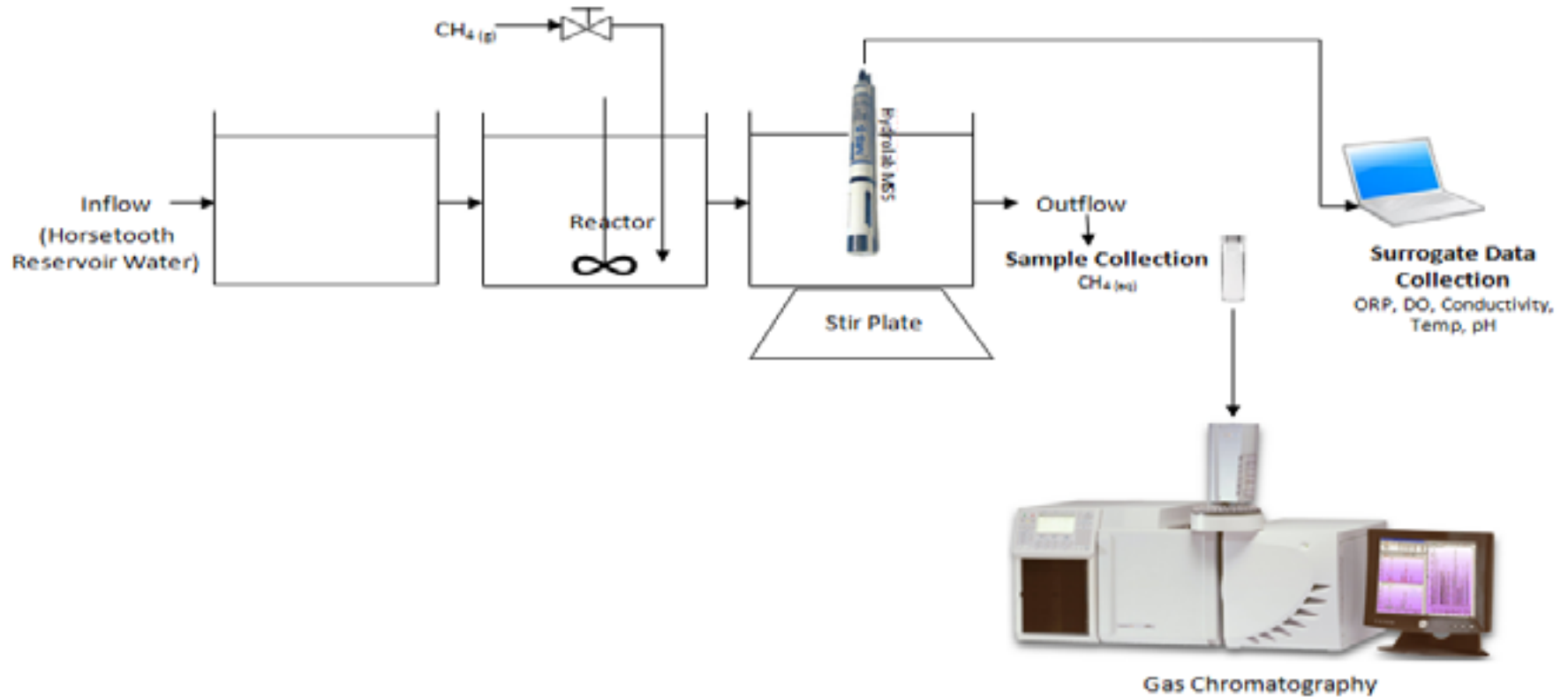
**Mean of background EC:** 82.0  $\mu$ S/cm

**LOD:** 85.2  $\mu$ S/cm ( $0 < PW (\%) < 0.00095$ ;  $\mu+0 < TDS (mg/L) < \mu+0.32$ )



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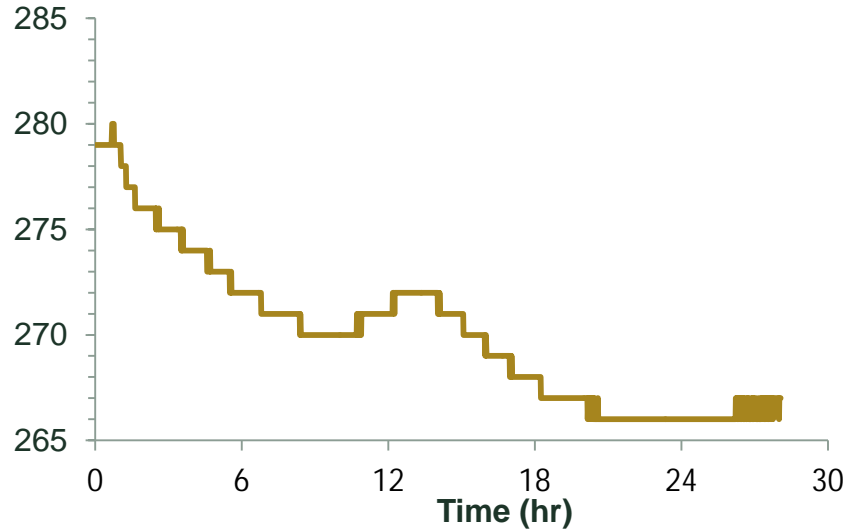
## II. METHANE SURROGATE TEST



# METHANE SURROGATE TEST-1

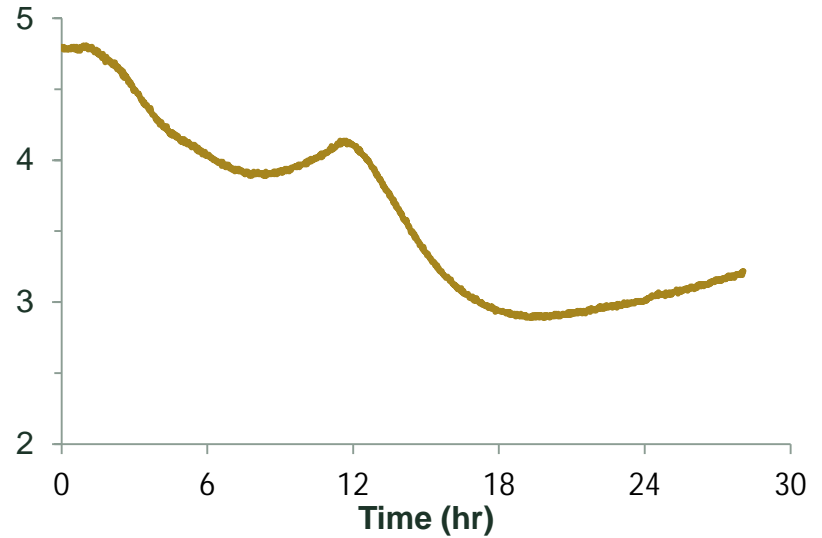
Water Inflow: 0.58 LPM

## ORP (mV)



Methane gas on  
(0.024 LPM)

## DO (mg/L)

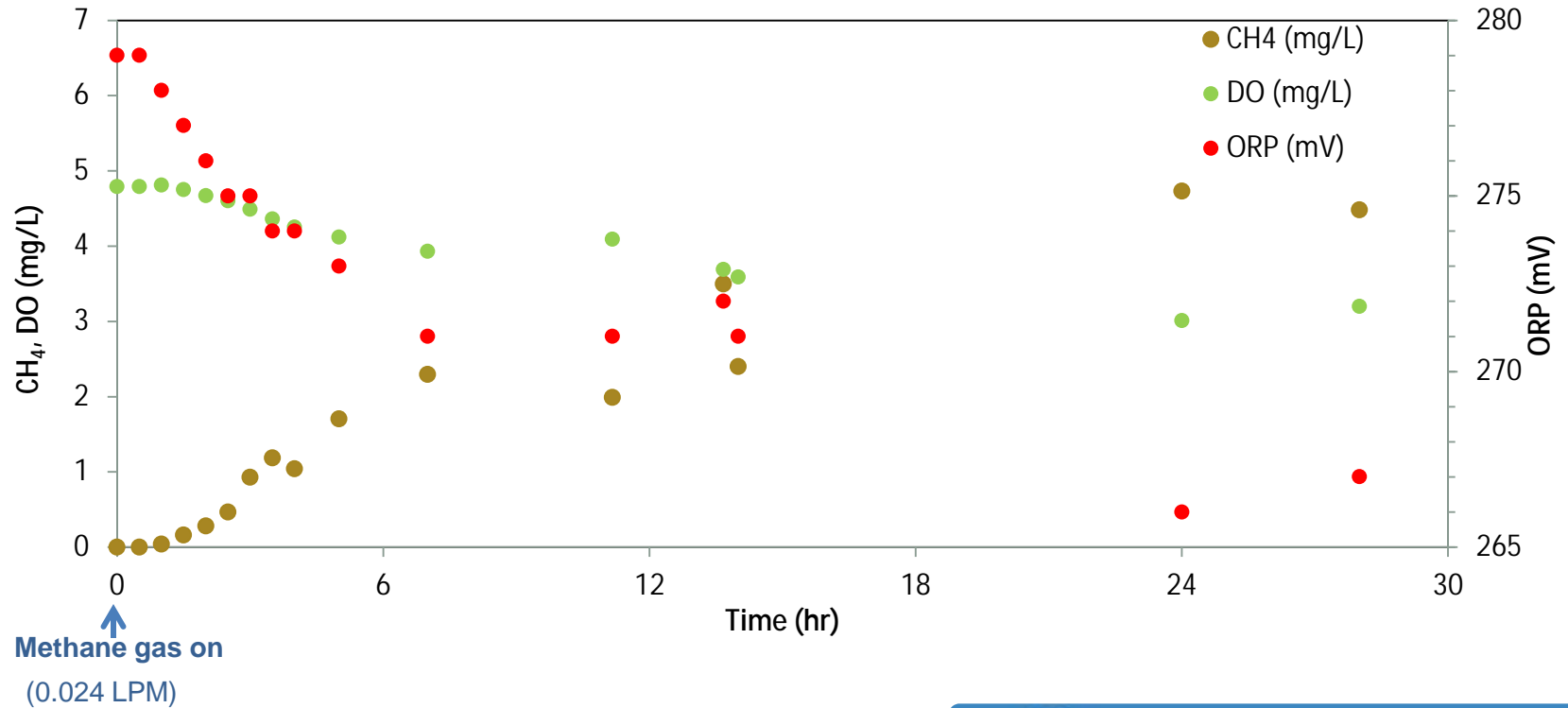


Methane gas on  
(0.024 LPM)



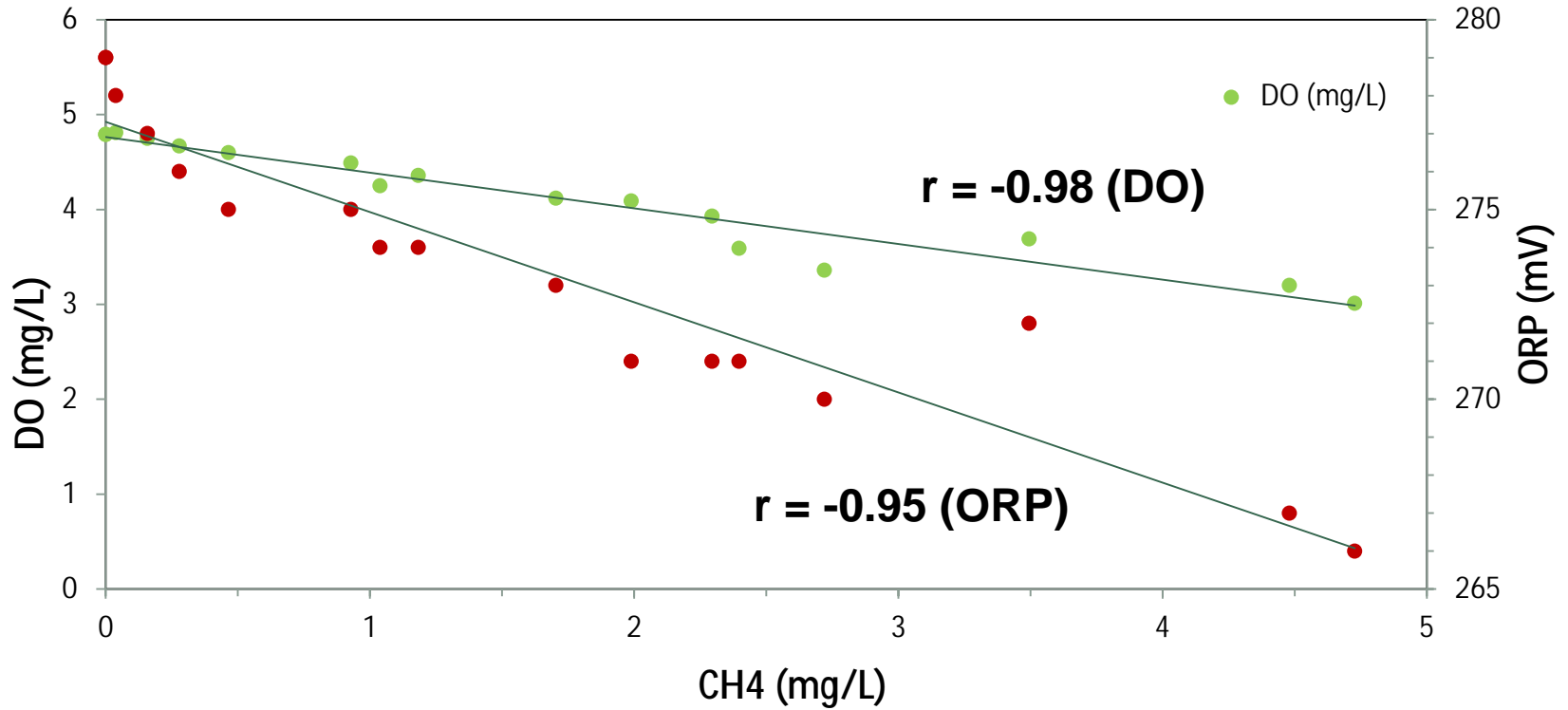
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## Water Inflow: 0.58 LPM

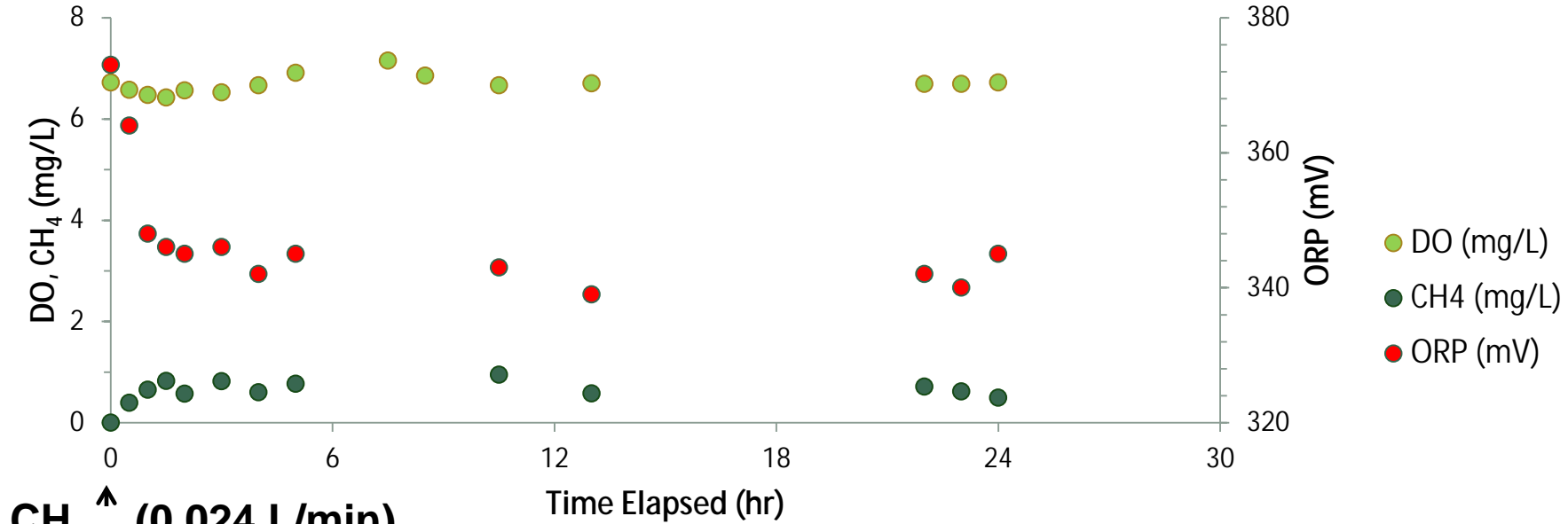




# DO AND ORP CORRELATIONS WITH METHANE



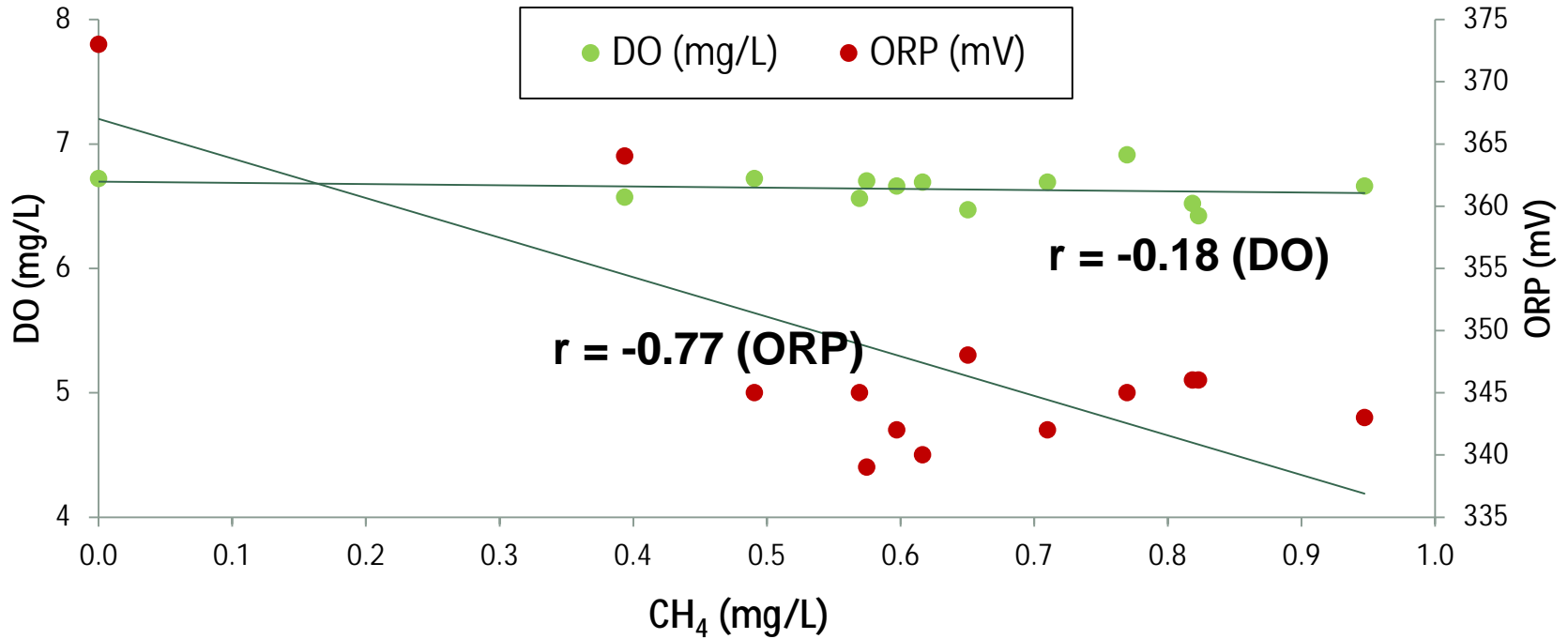
# METHANE SURROGATE TEST-2



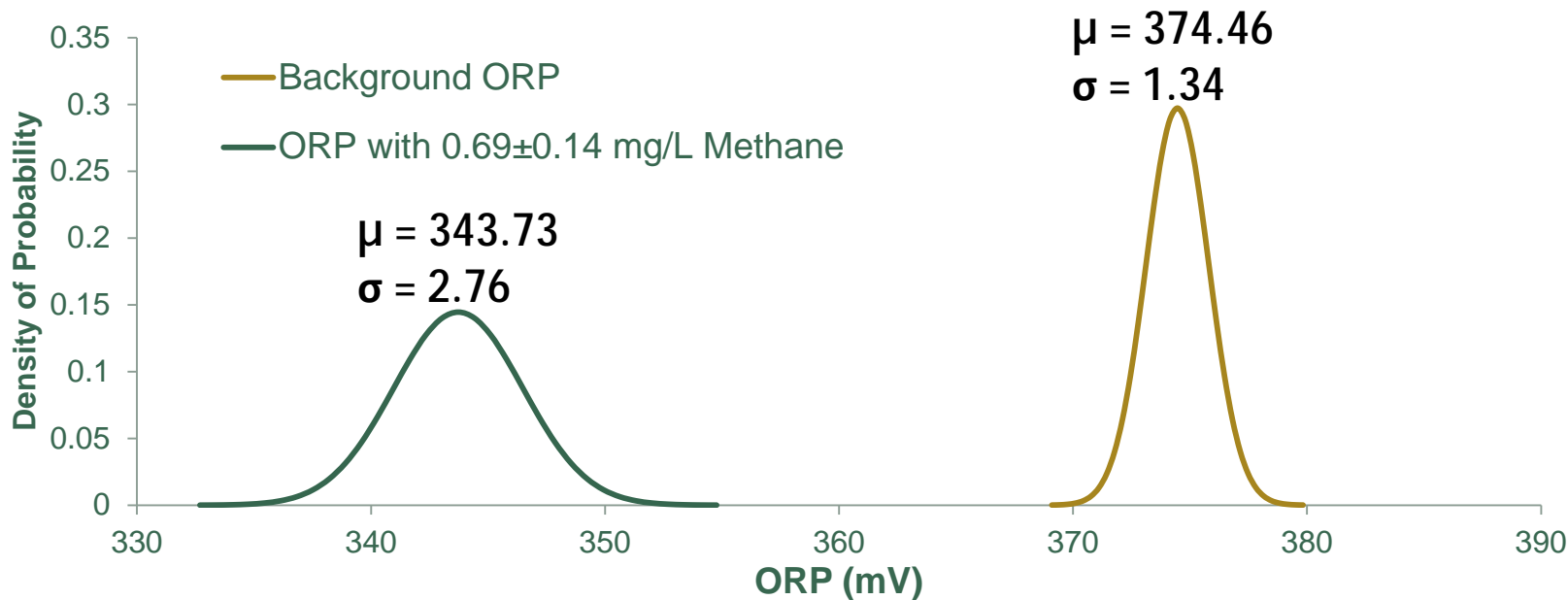
**CH<sub>4(g)</sub> (0.024 L/min)**  
**Horsetooth Water (2.3 L/min)**



# DO AND ORP CORRELATIONS WITH METHANE



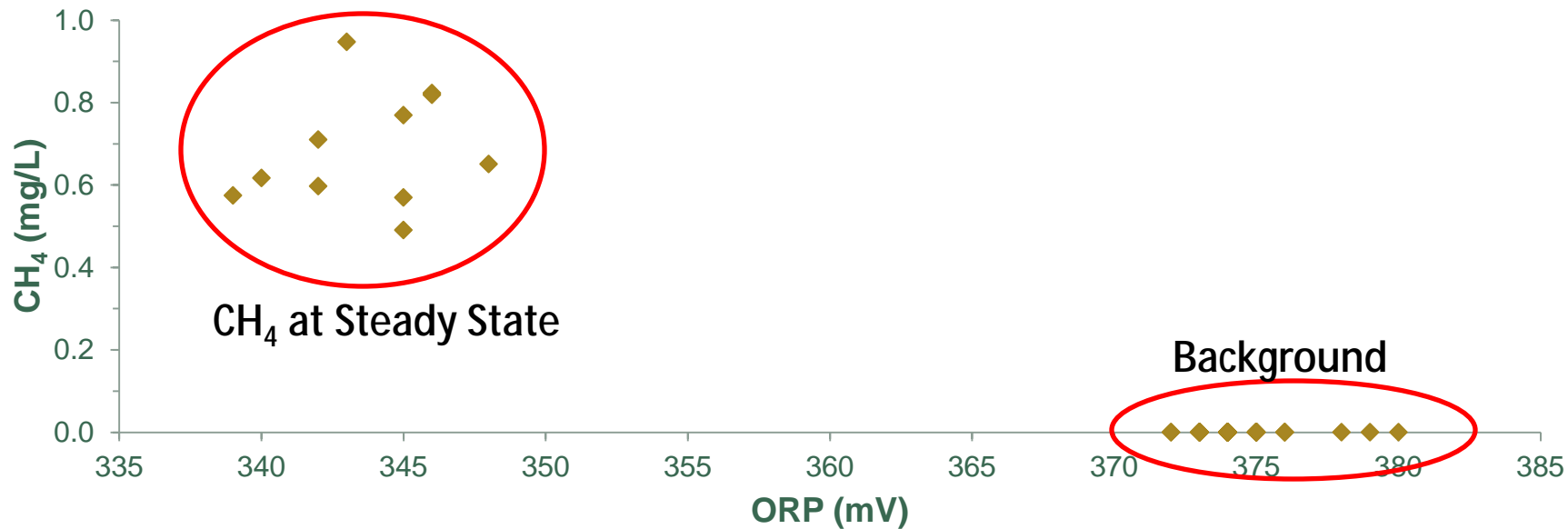
# NORMAL DISTRIBUTION OF BACKGROUND ORP (n=62) AND ORP AT THE STEADY STATE (n=11)



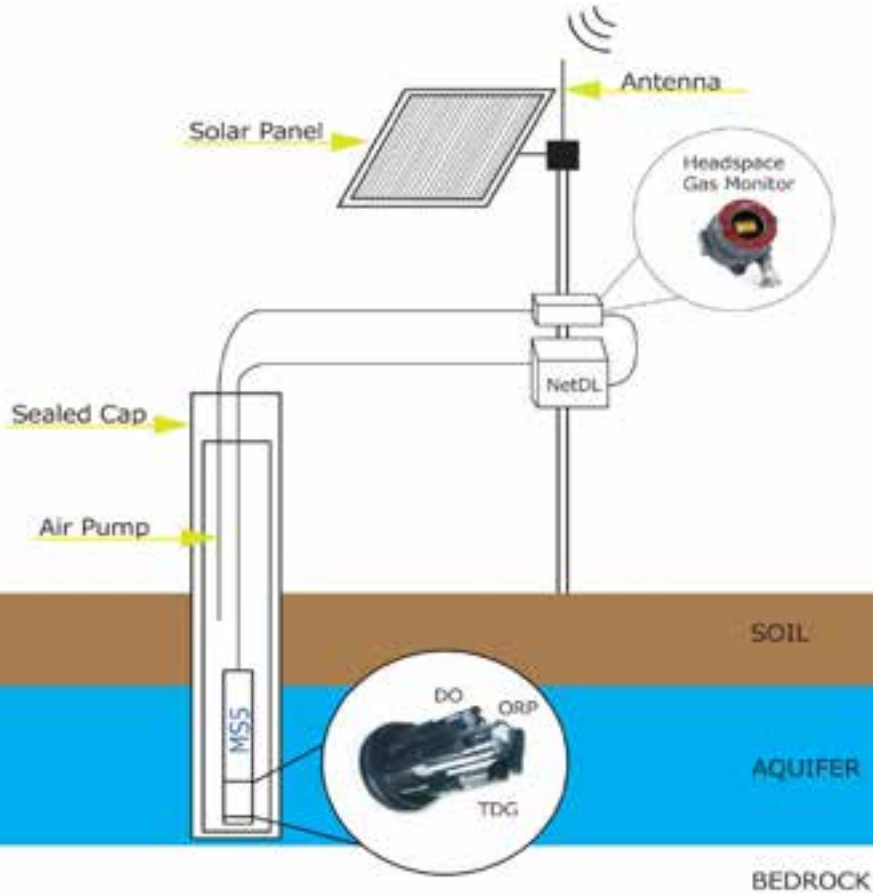
Two groups of data are statistically different ( $p = 9.37E-46$ )



# DISTRIBUTION OF DATA



# ALTERNATIVES OF METHANE SURROGATE



- Oxidation Reduction Potential (ORP)
- Dissolved Oxygen (DO)
- Total Dissolved Gases (TDG)
- Total Hydrocarbons in Headspace



# WEBSITE

**Colorado Water Watch** Keeping an Eye on Colorado's Groundwater

Home Learn Monitor  Search Login Register

Oil/gas and environmental experts agree that the rules Colorado has put in place regarding fracking and oil and gas development are some of the most comprehensive in the nation.

Colorado State University and the Colorado Energy-Water Consortium are setting up about 10 new groundwater-monitoring sites in Weld County. These sites will provide additional monitoring to the groundwater testing that will take place because of new state rules.

Currently there are no Alerts. Monitoring site #6 (Eaton) is now online!

### Water Watch Dashboard

Number of Sites

Month	2012 Completed	2013 Planned
Dec	1	0
Jan	1	0
Feb	1	0
March	1	0
April	1	0
May	1	0
June	1	0
July	1	0
August	1	0
September	1	0
October	1	0
November	1	0
December	1	0

Water Watch Results

Baseline Measures  
Current Measures

Latest Data: June 10, 2013

Click on a site to view detailed WATER WATCH results.

Site	Location	Water Watch	Alert
1	FL Lupton		
2	Greeley		
3	FL Collins		
4	La Salle		
5	FL Morgan		
6	Eaton		

### In the News

Colorado State University Obtains \$1.4 Million DOE Grant to Improve Water Management during Shale Oil and Gas Production. [More ...](#)

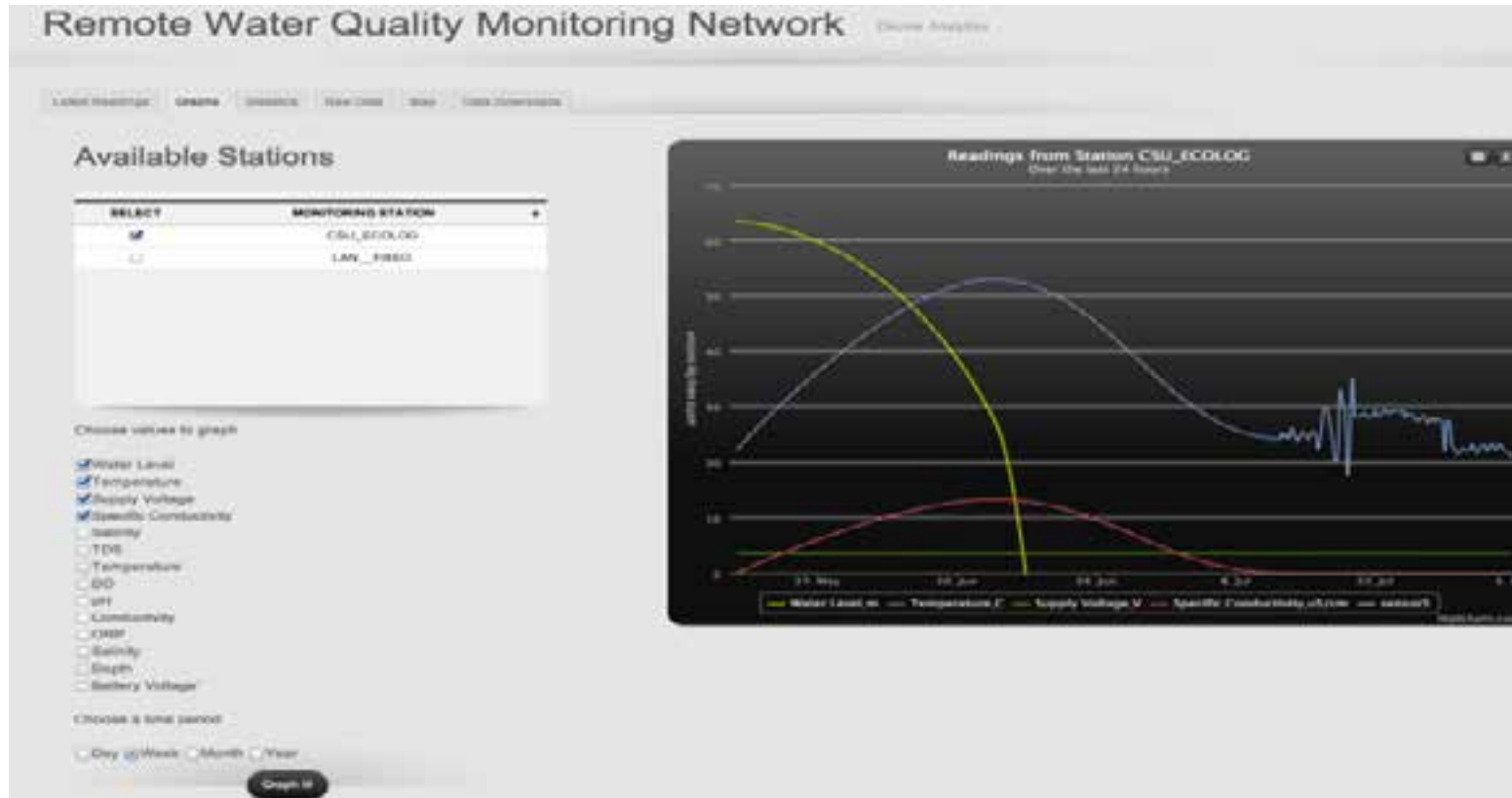
Weld County: Ten new groundwater monitoring wells will serve up real-time (public) data. [More ...](#)

### Featured Links

- Modern Drilling Operations: Hydraulic Fracturing
- EPA - Hydraulic Fracturing
- Hydraulic Fracturing O&A's
- Understanding Fracturing Fluids
- Reducing Surface Footprint with Horizontal Drilling



# DATA MANAGEMENT APPLICATION





# GIS MAPPING APPLICATION

