

Removing Methane in Drinking Water from Domestic Wells located in a Shale Gas Exploration Area

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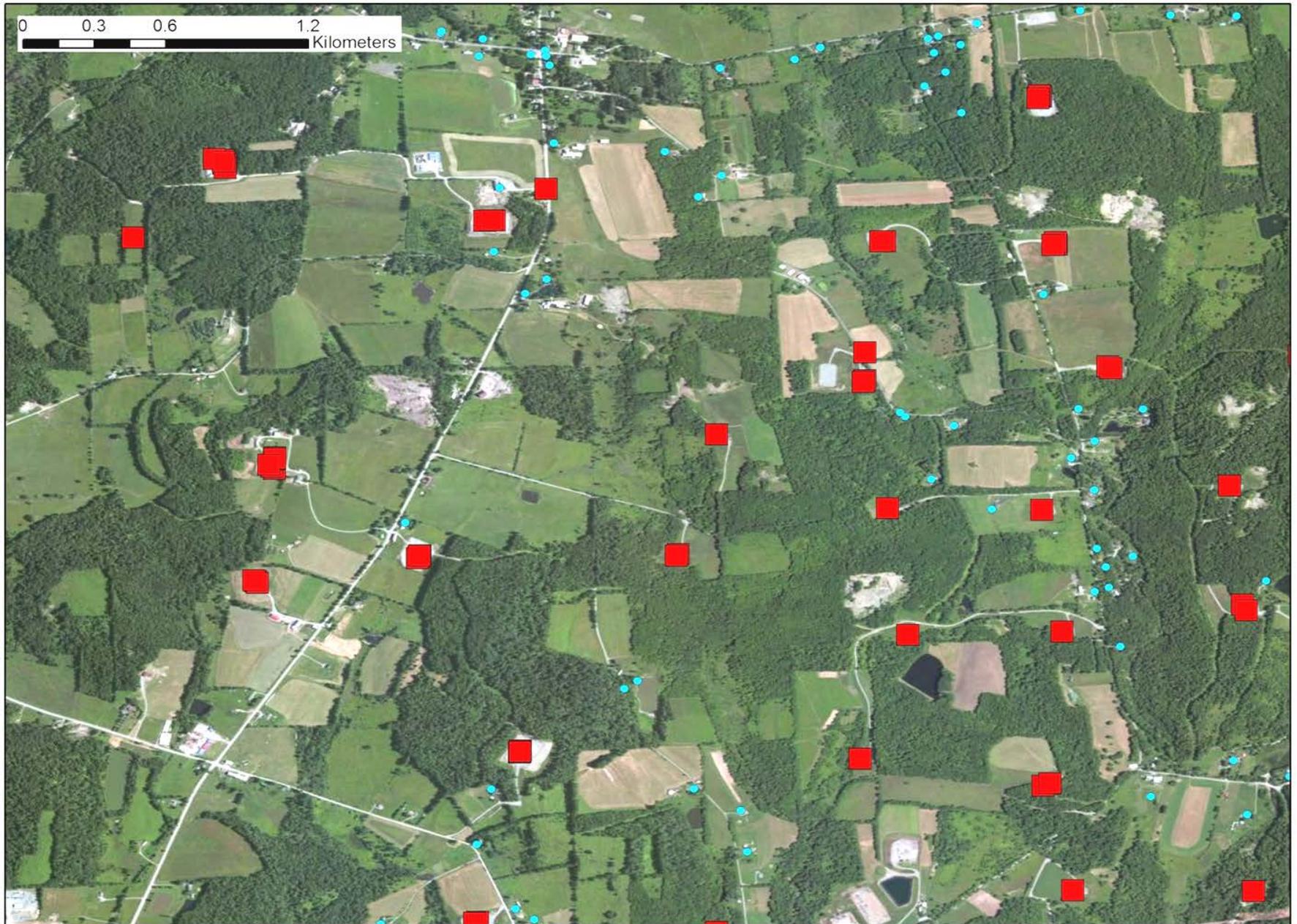
Presentation Overview

- ❑ Shale Gas Exploration in the Marcellus
- ❑ Water Quality Issues
- ❑ Treating Methane Involves more than Treating Methane
- ❑ Treatment System Overview
- ❑ Lessons Learned

Shale Gas Exploration in the Marcellus

- ❑ The Marcellus play is thought to be the second largest natural gas field in the world.
- ❑ By 2020, the Marcellus could produce 25% of America's natural gas (17.5 bcf/day).
- ❑ In 2010, over \$1.6 billion was paid to PA landowners for leases.
- ❑ The process of hydraulic fracturing in an area unfamiliar with gas drilling and near domestic wells has been controversial.





Fracking debate draws Yoko, Lennon and Sarandon to rural battlegrounds

Artists Against Fracking board bus for magical mystery tour of Pennsylvania as New York and New Jersey decisions draw near



Adam Gabbatt in Dimock, Pennsylvania

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guardian.co.uk, Friday 18 January 2013 15.35 EST

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Yoko Ono, Sean Lennon and Susan Sarandon with Dimock resident Ray Kemble.
Photograph: The Guardian

The Methane Problem

- ❑ The Pennsylvania Department of Environmental Protection (PA DEP) focused on methane concentrations found in domestic wells after drilling.
- ❑ Methane is odorless and non toxic, but does pose an obvious flammable hazard.
- ❑ Pre-drill methane data was not collected from domestic wells at the earliest drill sites.

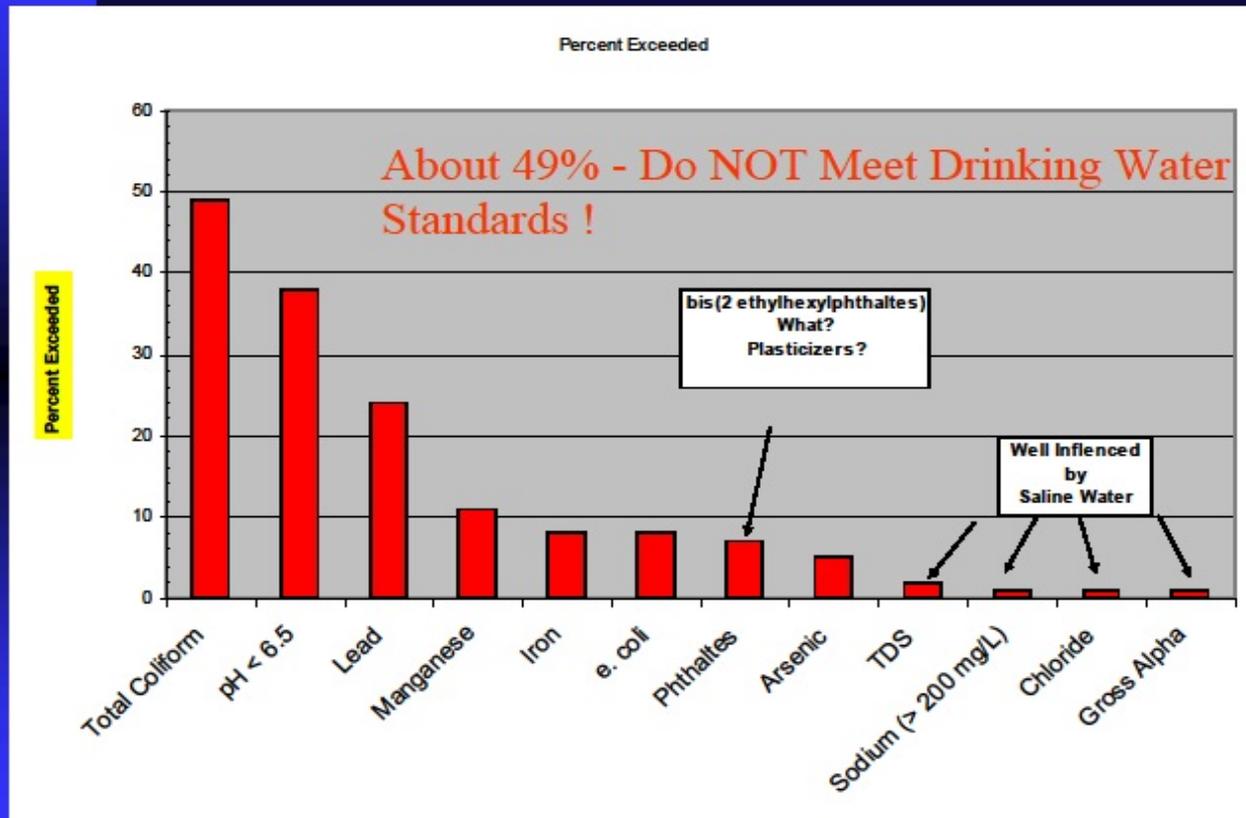
The Methane Problem *(continued)*

- ❑ High natural methane concentrations have been known to exist prior to drilling.
- ❑ Methane in the area was found at concentrations over 50 ppm.
- ❑ 28 ppm is near saturation.
- ❑ 7 to 10 ppm is a concern.
- ❑ Treatment standard is 4 ppm.

Other Water Quality Issues

- ❑ No domestic well drilling standards in PA – no surface seals required on domestic wells.
- ❑ Naturally high concentrations of bacteria, iron, manganese, barium and arsenic are prevalent in the area.

Percent that Exceed a Drinking Water Standard !

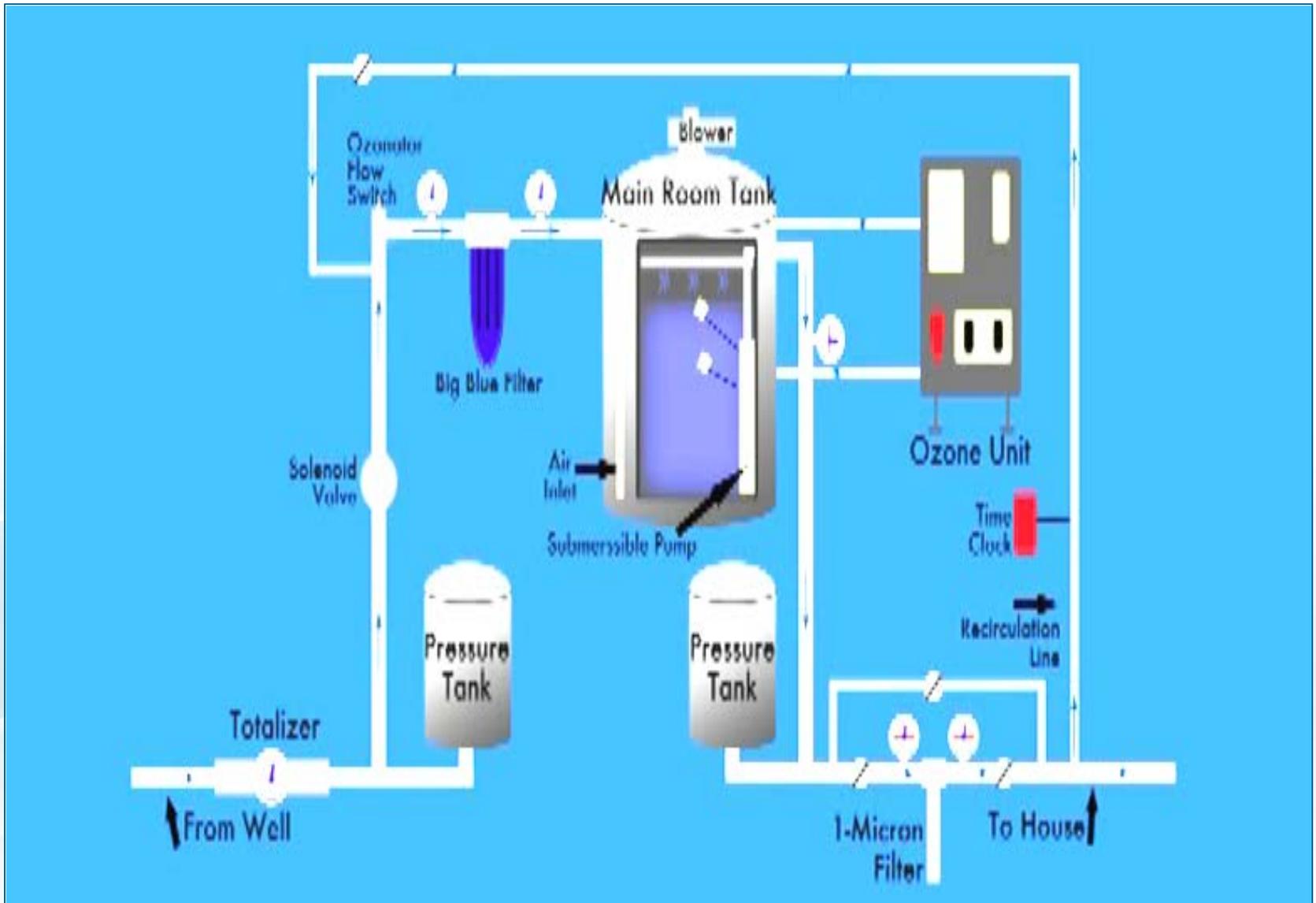


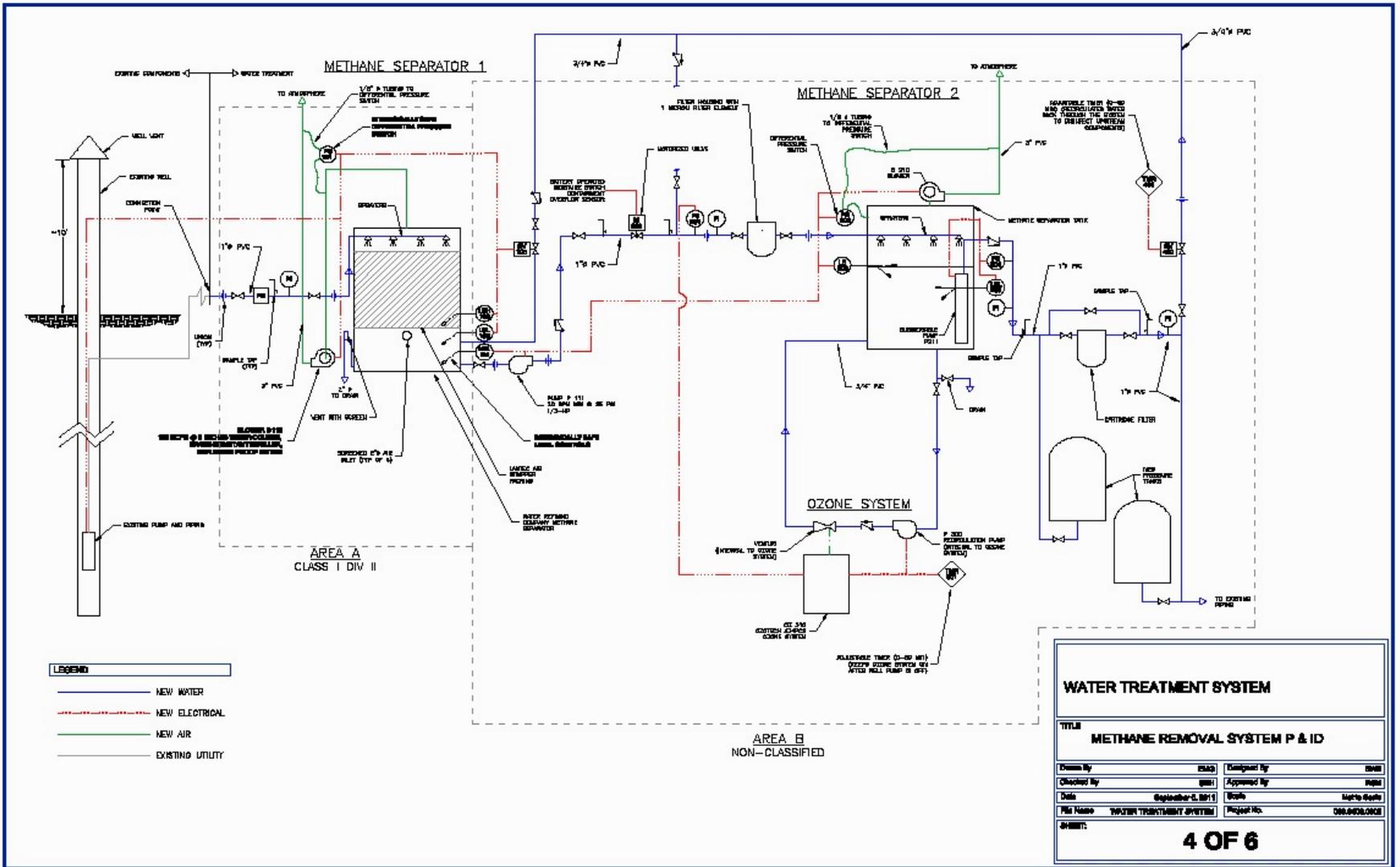
Treating Methane is More Than Treating Methane

- ❑ Methane treatment by aeration is relatively easy and reliable.
- ❑ To ensure adoption of treatment systems by the public, all parameters above standards had to be treated.
- ❑ Fe, Mn, bacteria, and solids removal drive treatment costs.
- ❑ Chemophobia, PR, and litigation issues all had to be addressed.

Treatment System

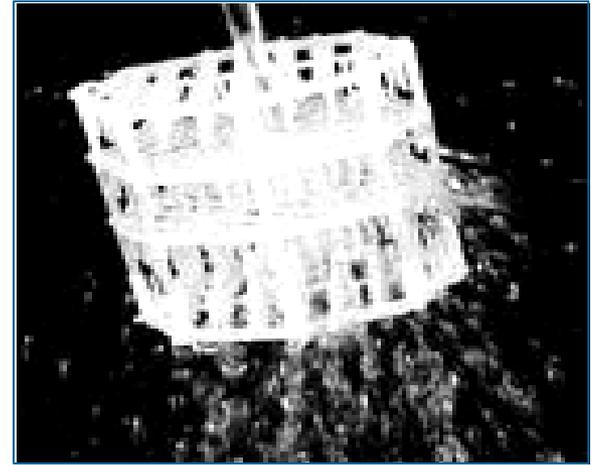
- Three main processes:
 - Two-stage methane stripping
 - Filtration (several different types)
 - Disinfection by ozone

















Water filter with digital control head.

Pool pump mounted on a wooden beam.

CHALLENGER brand pool heater on a wooden platform.

Electrical control panel.

Great Bones dog treats.

System Performance

- ❑ Methane removal is typically greater than 95%, and often above 98%.
- ❑ These high removal rates result in methane concentrations in the treated water that are typically less than one-fifth of the local PA DEP treatment standard of 4 mg/L.
- ❑ Iron and manganese concentrations over 1 mg/L have been successfully treated to below the secondary drinking water standard (0.3 and 0.05 mg/L, respectively).
- ❑ At residences where barium was a concern, reverse osmosis systems have been installed to treat drinking water.

Lessons Learned

- ❑ A robust disinfection system was key in treating coliform and iron bacteria as well as reducing nuisance bacterial growth in aerated water with trace organics.
- ❑ Iron, manganese, and solids (not methane) are key drivers in O&M costs.
- ❑ Public preconceptions and misunderstandings can be as difficult to deal with as the water.

Lessons Learned *(continued)*

- ❑ The EPA conducted testing in the area and concluded that contaminants found during the testing were naturally occurring.
- ❑ No fracking fluid compounds were detected in the EPA study or have been detected by our client in samples from any other domestic well.
- ❑ In the few cases where domestic wells actually do seem to be impacted by drilling, top hole sealing problems seem to be the cause, not fracking.



Questions

