

PUBLIC WATER SUPPLY ASSISTANCE PROGRAM

Developing and Managing Water Resources

November 9, 2016



Mike Appleby, P.G.
Supervisor, Groundwater



Photo: National Park Service



<http://toilet-guru.com/revolutionUSA.php>



<http://toilet-guru.com/revolutionUSA.php>

“In wine there is wisdom, in beer there is Freedom, in water there is bacteria.” Ben Franklin?

Bacteria: Introduced as scientific word in 1838 by Christian Gottfried Ehrenberg
Source: Online Etymology Dictionary



- Water supplies have come a long way since Franklin's time.
- People like you recognized the need to provide clean, safe, reliable drinking water



Introduction

- People here today represent all (or most) aspects of PWS
 - Board members
 - Managers
 - Operators
 - Regulators
 - Customers

Development and Management of Sources

Developing Sources

- Well Siting
 - Geology
 - Potential yield of formation
 - Fracture trace analysis
 - Development
 - Proximity to system
 - Potential contamination
 - Well head protection area
 - Availability of property
 - Impacts to other users/ Environment
- Time (3-5 years for a new source)
 - Expense (budget)
 - Purpose of source (redundancy/ meet new development)
 - Drilling/ Testing (SWIP, 72-hour testing)
 - Land Acquisition
- Land Acquisition
 - Cost may rise if good supply is found
 - Costly/ timing
- Permits

Managing Sources

- Pumping Schedule
- Contamination/ treatment
- Hydro report
- Routine Monitoring
 - Water levels
 - Daily withdrawals
 - Pump run time
 - Amperage
 - Specific capacity
- Maintenance
 - Pump/ equipment
 - Well rehabilitation
- Leaks
- Rate structure

Time/ Land Acquisition

- Everything takes longer than expected
- Land acquisition can be difficult
 - Drill on Authority property?
 - Watch local market for available properties
- Projects typically require 3-5 years to complete
 - Complex projects take longer
 - Level of testing needed?

Hydro Report

- Testing is done, now what?
- Report should be done to inform you about your sources, not just meet a regulatory requirement
- Provide specific recommendations for operating the well(s)



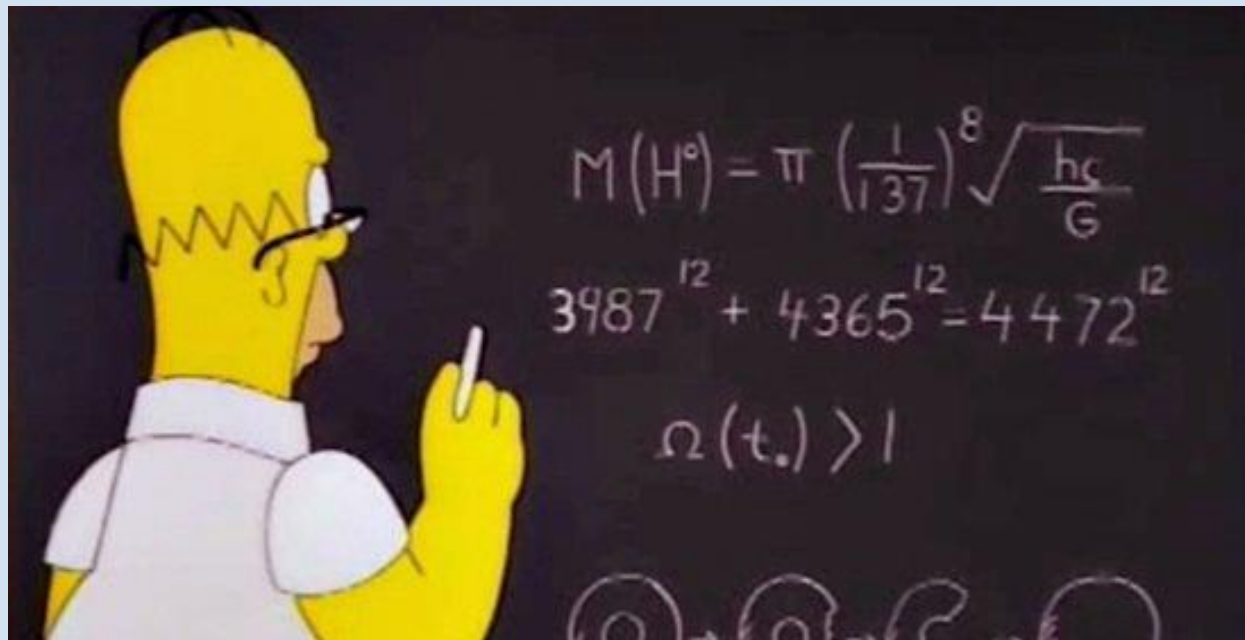
Routine Monitoring

- Water levels
 - Daily?
 - Weekly?
 - Other?
- Withdrawal records
- Pump run time
- Pump amperage

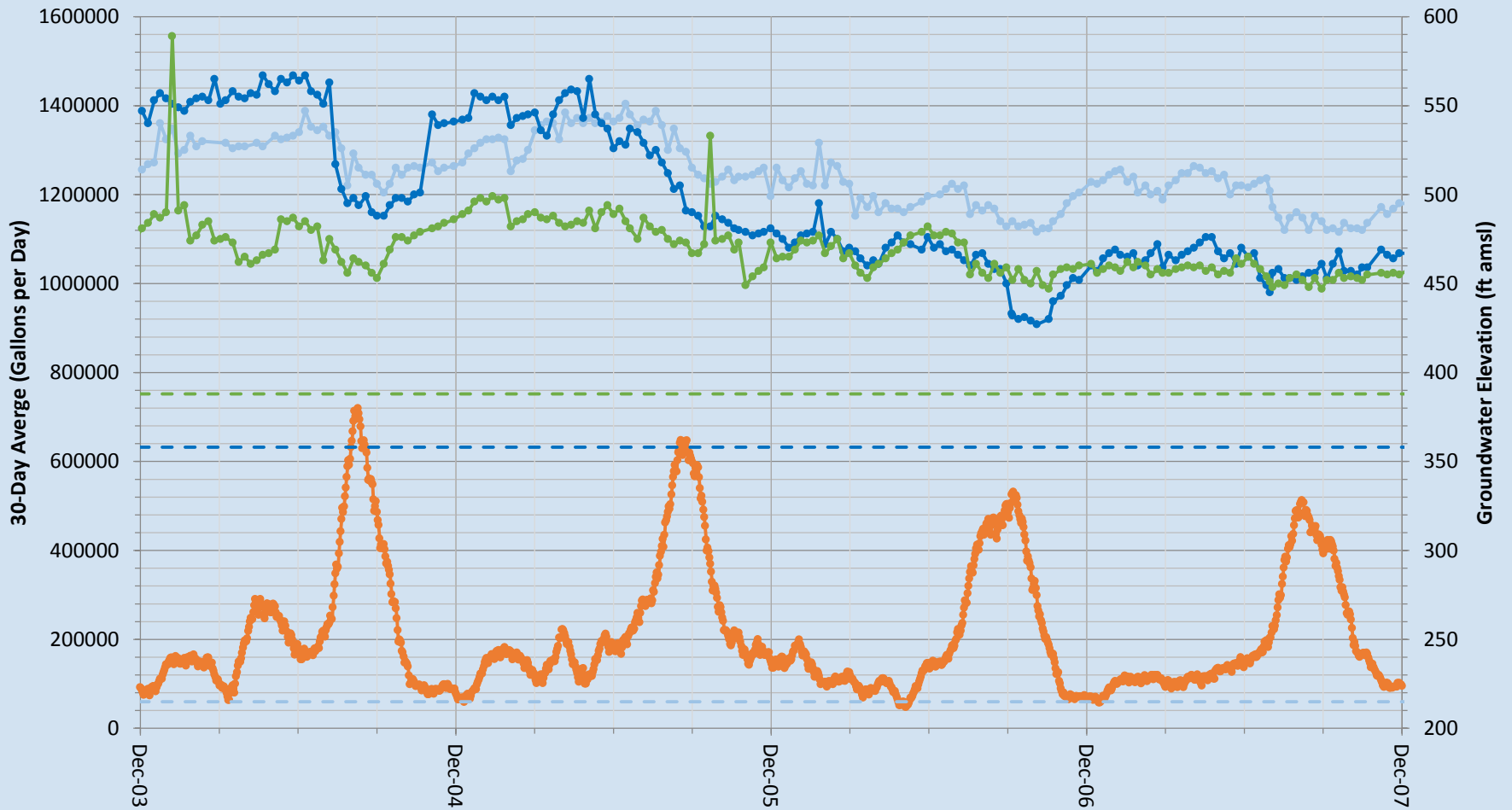


Testing Results and Routine Monitoring

Hydro Report + Monitoring = Maintenance



Consecutive 30-Day Average vs. Groundwater Elevations



—●— 30-Day Average (Wells 1, 4, and 7)

—●— Well 7 Groundwater Elevation

- - - Well 1 Pump Intake

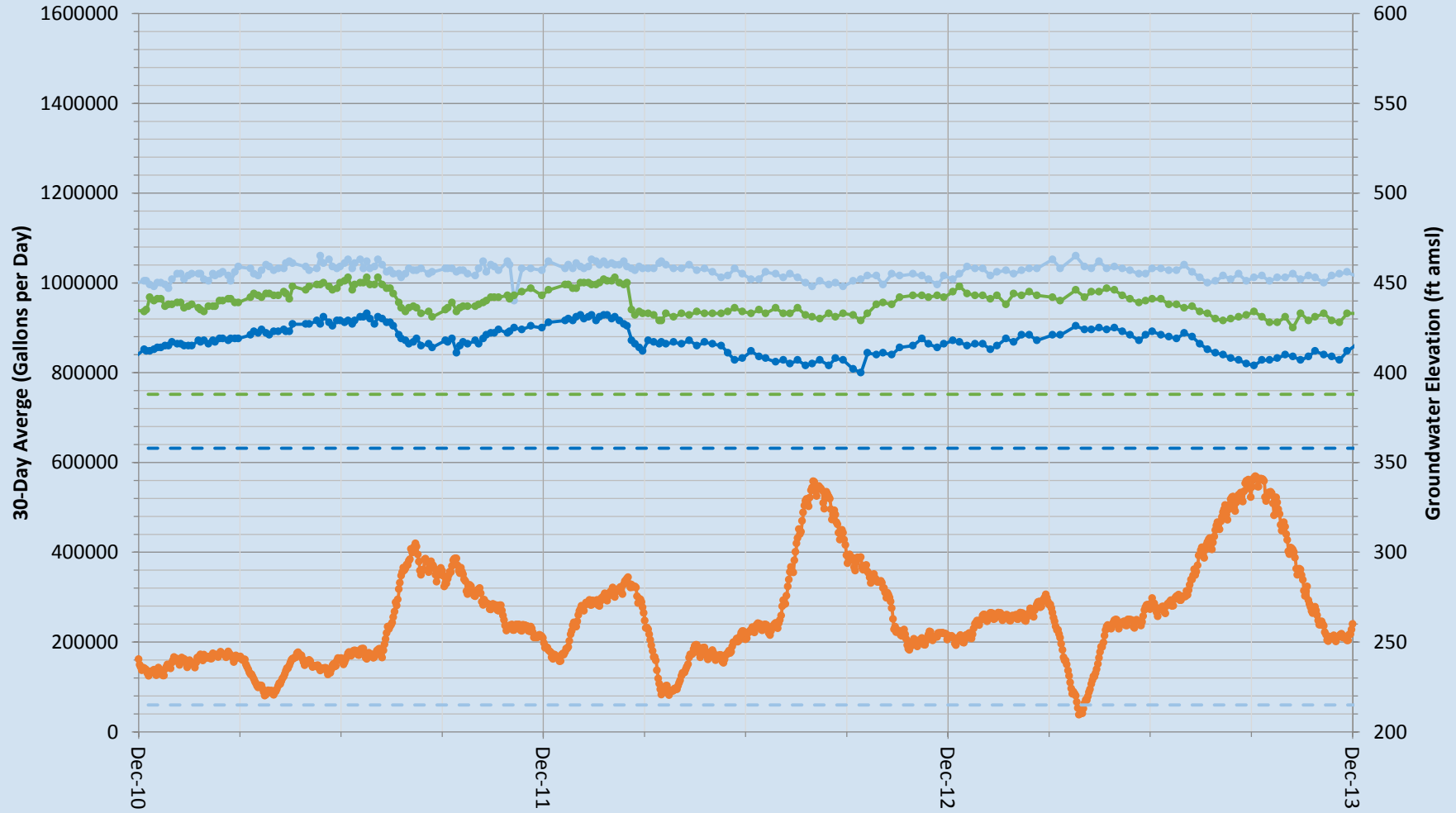
- - - Well 4 Pump Intake

- - - Well 7 Pump Intake

—●— Well 1 Groundwater Elevation

—●— Well 4 Groundwater Elevation

Consecutive 30-Day Average vs. Groundwater Elevations



—●— 30-Day Average (Wells 1, 4, and 7)

—●— Well 7 Groundwater Elevation

--- Well 1 Pump Intake

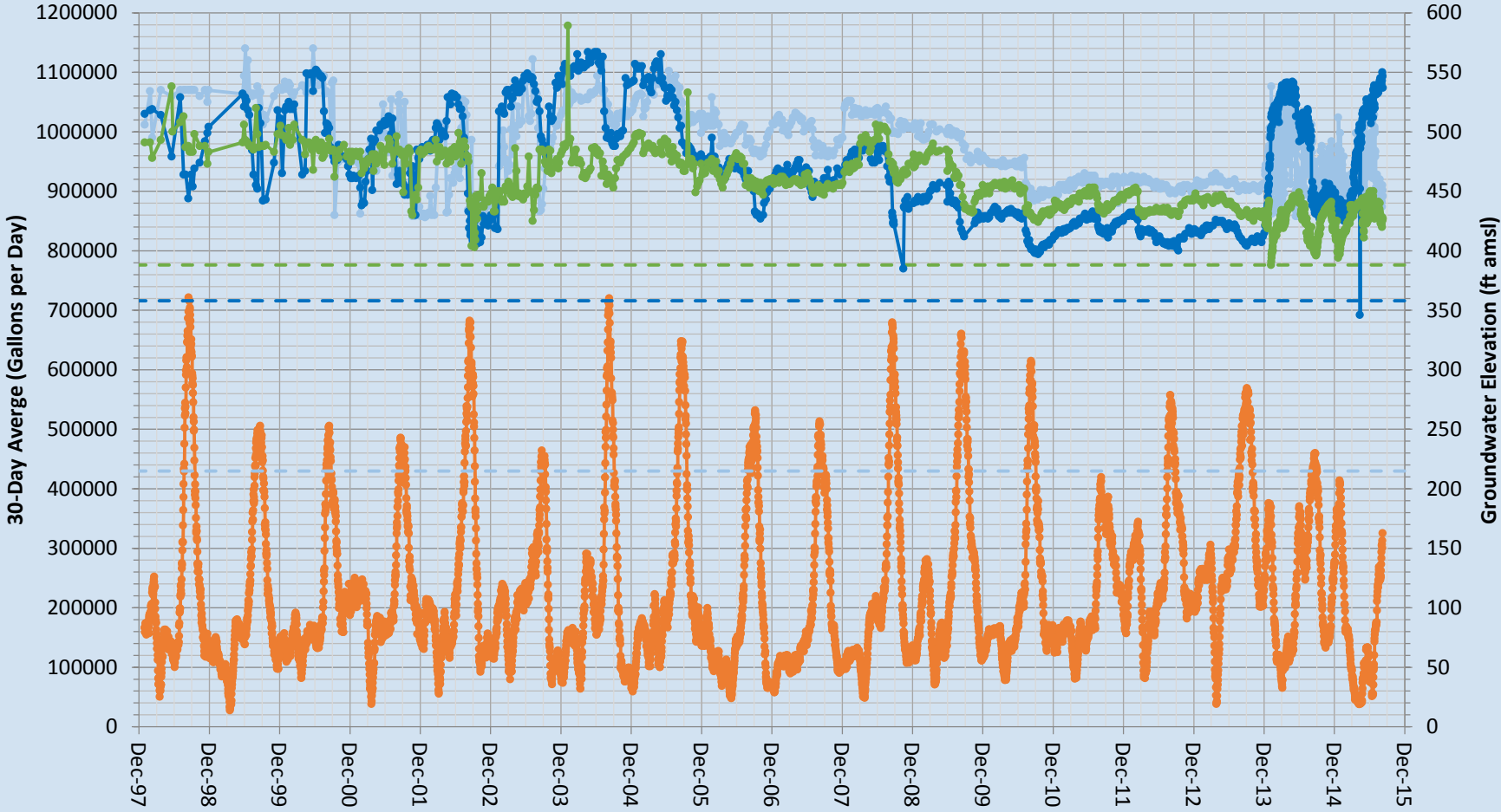
--- Well 4 Pump Intake

--- Well 7 Pump Intake

—●— Well 1 Groundwater Elevation

—●— Well 4 Groundwater Elevation

Consecutive 30-Day Average vs. Groundwater Elevations



30-Day Average (Wells 1, 4, and 7)

Well 7 Groundwater Elevation

Well 1 Pump Intake

Well 4 Pump Intake

Well 7 Pump Intake

Well 1 Groundwater Elevation

Well 4 Groundwater Elevation

Specific Capacity

- Easy method of checking well function
- Complete a step-test (usually done in one day)
- Evaluate daily pumping data periodically to help determine if additional testing is needed.
 - Every day provides a short-term test
 - Compare daily drawdown over a defined period of time to historic pumping records

What Causes Production Loss?

- Mineral incrustation or biofouling
- Plugging of formation by fine particles
- Sand pumping
- Structural collapse
- Pump condition

Driscoll, 1986



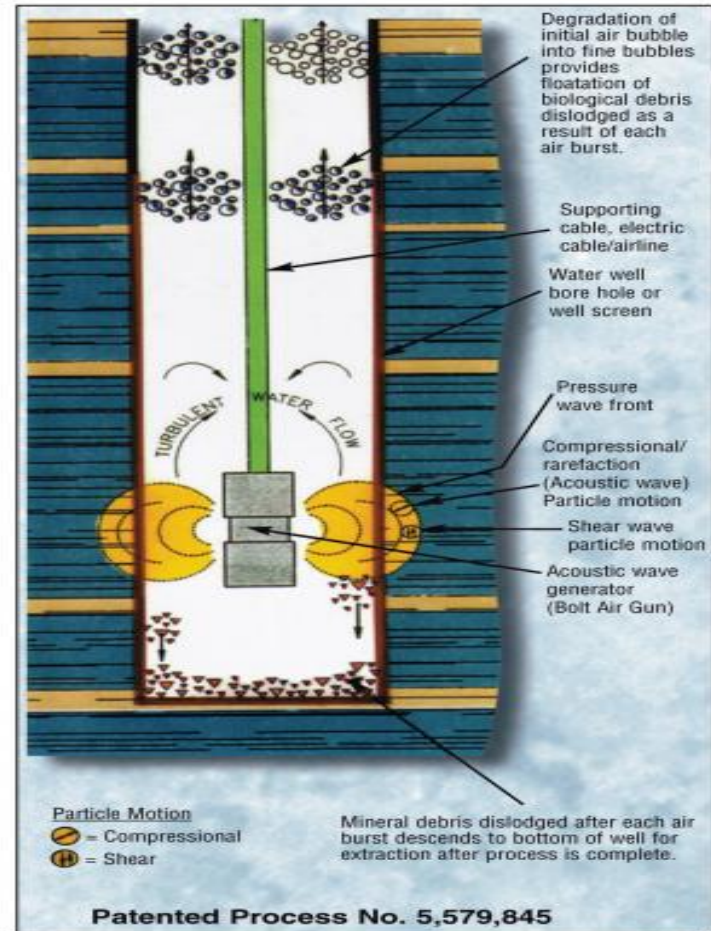
Image 1 of 2 Biofouling is caused when naturally occurring bacteria interact with the components of the well and form a slimy deposit often referred to as iron bacteria. Photo courtesy of Ingram Well and Pump Service

Well Rehabilitation

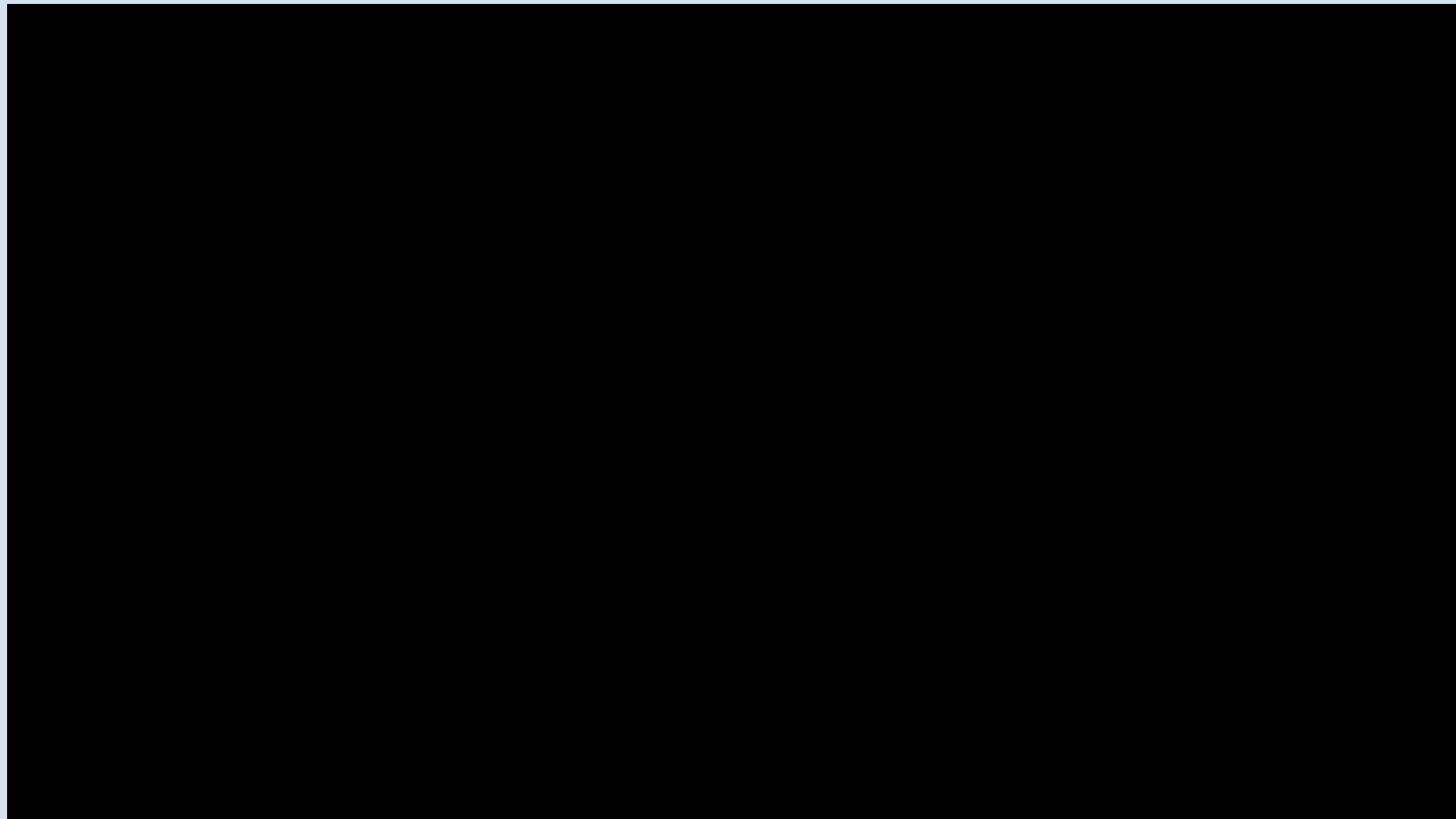
- Physical methods
 - Physical removal of debris
 - May not penetrate far into aquifer
- Chemical methods
 - Chemical removal
 - May require neutralization prior to discharge
 - Penetrates aquifer, but may take time to disperse or may persist longer than desired
- Combination methods

Physical Methods

- Wire brush
- Swabbing
- Surging
- Air impulse generation (Airburst or Airshock)
- Air lifting (re-development)



Picture From: *More Powerful than Dynamite*
NGWA - Water Well Journal, February 2005



Chemical Methods

- Acids
 - Sulfamic acid
 - Hydrochloric acid
 - Hydroxyacetic acid
 - Citric Acid
- Surfactants
- Chlorination
 - Sodium Hypochlorite
 - Calcium Hypochlorite

Combined Methods

- Aqua Freed (injection of liquid carbon dioxide)
 - Agitates well with phase change
 - Injection pressure and expansion of gas
 - Mild carbonic acid development
- Combination of methods
 - Often yields best results to combine physical and chemical methods
- What method is best?
 - Site specific

Did It Work?

- Pre-rehabilitation testing to determine level of impairment
- Post-rehabilitation testing to determine effectiveness of chosen method
- Borehole videos can be helpful

Questions?

