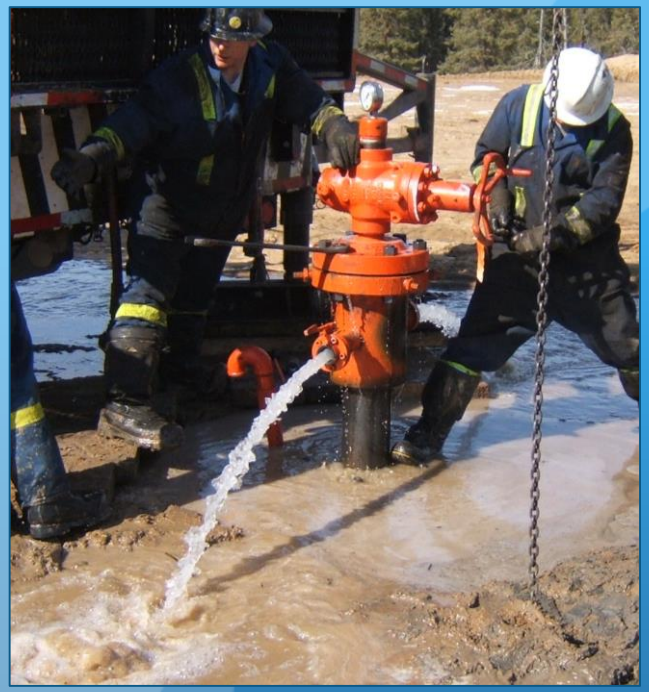


Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

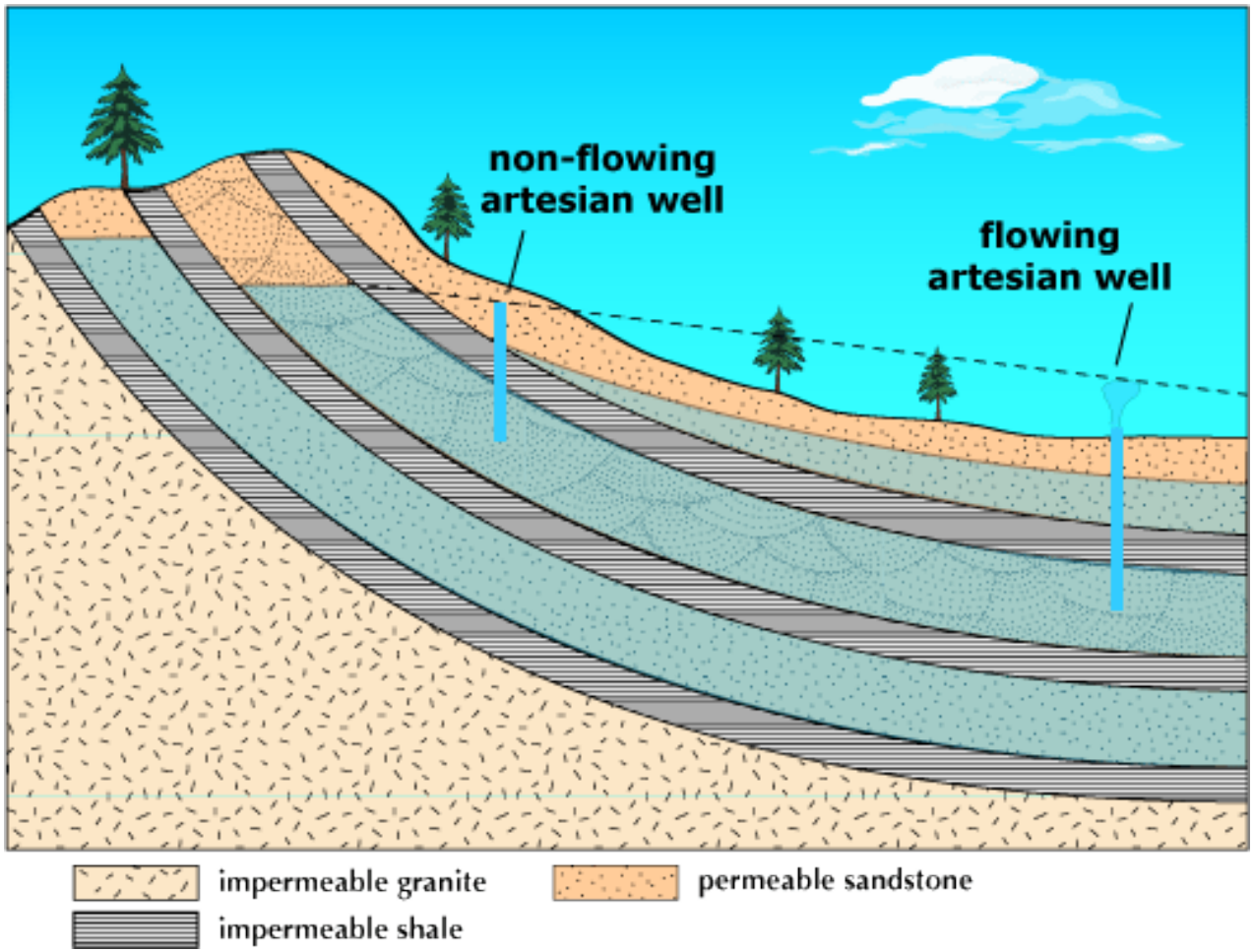
FIELD CONSIDERATIONS FOR ARTESIAN WELLS

Tim Van Dijk

OUTLINE

- Introduction to Artesian Wells
- Risks and Challenges
- Drilling & Well Installation
- Monitoring & Instrumentation
- Aquifer Testing

Artesian (Flowing) Well



Source: University of Wyoming (http://www.gg.uwyo.edu)

Artesian Flow

- Artesian flow depends on:
  - Artesian head
  - Aquifer permeability
  - Aquifer thickness
  - Screen length/type
  - Wellbore/casing diameter

- Risk scale
  - Pressure and flow
  - Higher risk wells need proper planning and approach

Example

- High K aquifer
- Artesian pressure: 5m (7.1 psi)
- Casing diameter affects:
  - Flow
  - Force (P × A)

2”: Area = 3.1 in^2

<u>2” Monitoring Well</u>

- Force = 22 lbs
- Flow = 150 m^3/day

8”: Area = 50 in^2

<u>8” Water Supply Well</u>

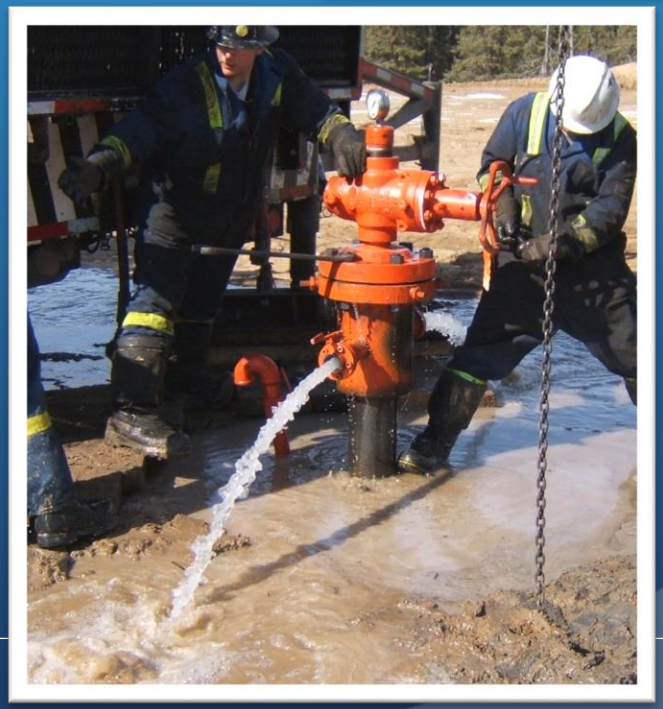
- Force = 360 lbs
- Flow = 600 m^3/day

Well Purposes/Data Requirements

- Water supply/monitoring wells
  - Aquifer parameters/well yield
  - Pumping rates
  - Pressure/water level
  - Water quality

Artesian Well Challenges

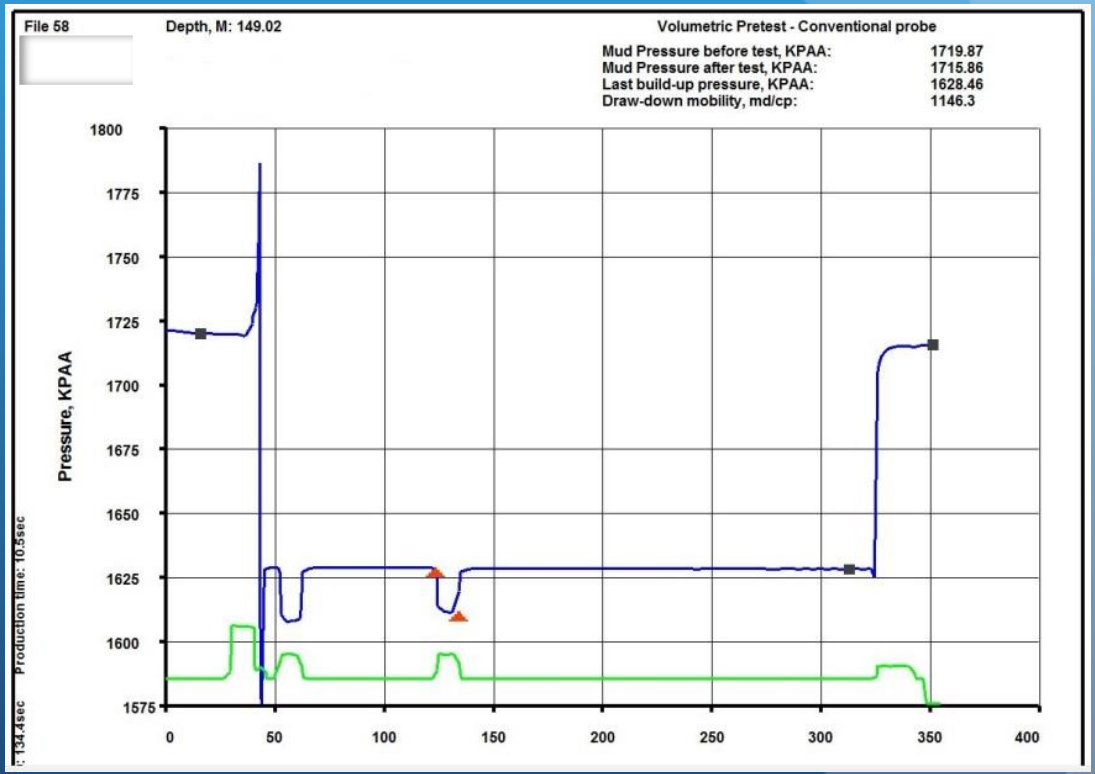
- Drilling & Installation
- Flow control
- Freezing/ice
- Monitoring/Testing



Drilling - Planning

Assess artesian potential

- Drill stem test (DST)
  - Larger zone
  - Packers
  - Expensive
- Repeat formation tester
  - Point measurement
  - Faster, lower cost

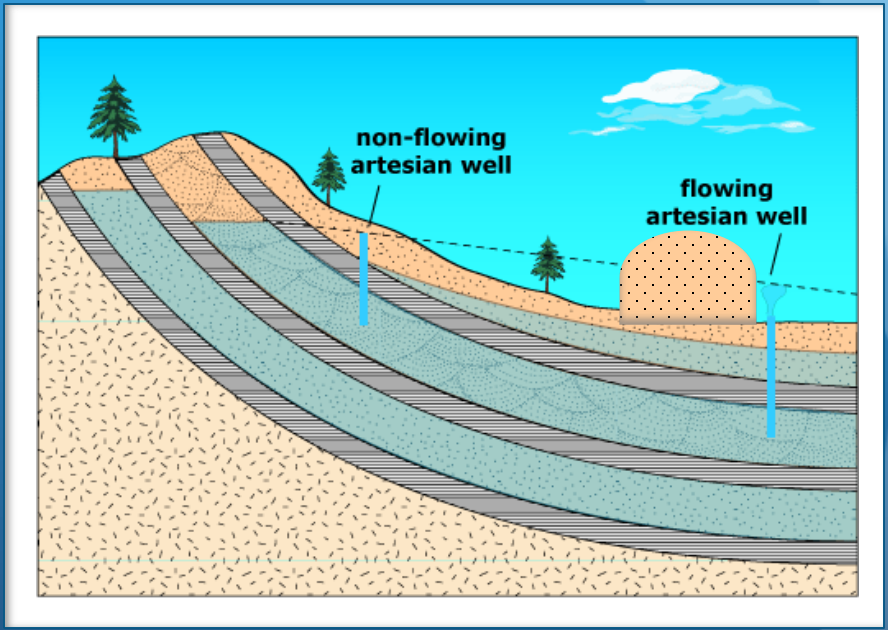


Drilling - Planning

Mapping

- Potentiometric surface
- Topography

Is a flowing well necessary/desirable?



Drilling - Planning

- Controls
  - Surface casing
  - Flow control
  - Water management
- Permitting considerations:
  - AER regulations (> 150 m bgs)
  - TFA (surface discharge)
- Qualified water well driller

Drilling Methods

- Mud Rotary
  - Drilling mud: weight & viscosity
  - More effective with deeper wells
  - Be careful with mud

- Advance Casing Method
  - Dual/air rotary (Barber), sonic, etc
  - Holds back formation, flow
  - Risk of ‘flowing sand’

Flow Control

Simple Methods

- Casing extension
  - Above artesian head

- Shallow Casing Seal
  - J Plug
  - Short packer

Casing extension

J Plug

Margo Plug

Packers

- Inflatable packers
  - Nitrogen, air, water
  - Temporary
- Mechanical packers
  - Lower cost, long-term
- Bridge plugs
  - Larger diameter
  - High cost

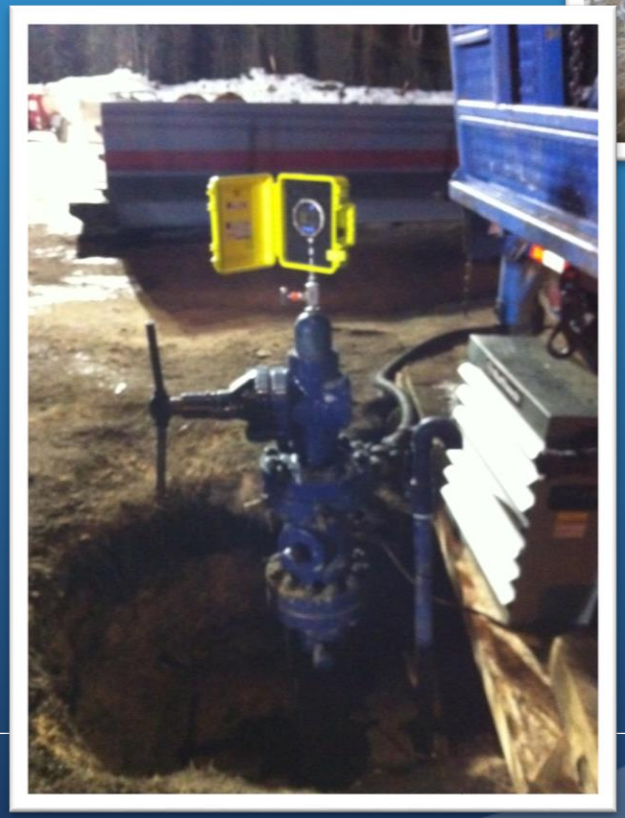
Top Seals

- Well Head/Plug
- Heat source required:
  - Heated Hut
  - Heat trace

Pressure Monitoring

- Well Head Sensors
  - Pressure gauge (non-recording)
  - Pressure logger
  - Accessible

- Limitations
  - Freezing
  - Positive pressure



Pressure Monitoring

Downhole Instruments

- Inside casing
  - Pressure transducer/logger
  - Communication cable
  - Packer
- Outside casing
  - Vibrating wire piezometer
  - Data logger at surface
  - Install during well completion

Aquifer Testing

Pumping Test

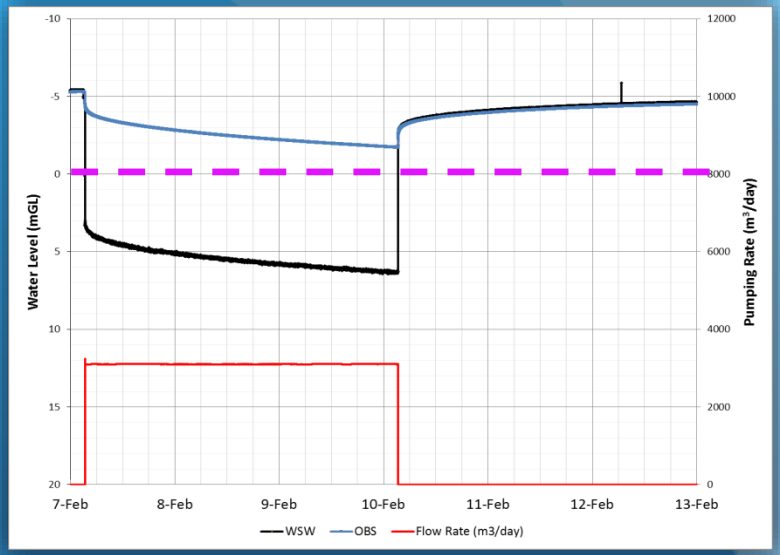
- Using pump
- Flow rate limited by pump depth
- Logistical challenges, higher costs

Flow Test

- Control valve (no pump)
- Flow rate limited by artesian head
- Simple, low cost

Aquifer Testing - Considerations

- Optimize data:
  - Start from static (no flow)
  - Constant flow rate
  - Recovery period (no flow)
  - Pressure/drawdown



- Instrumentation
  - Pressure loggers
  - Flow meter
  - Flow control valve/VFD
  - Sealed wells (packers, etc)

Aquiter Testing

- Water management

Summary

- Artesian wells present additional risks and challenges compared to non-flowing wells
- Additional planning and preparation required for drilling, instrumenting and monitoring of artesian wells
- Monitoring data quality can be achieved and maintained using appropriate methods

Any Questions?

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