



U.S. Department of the Interior  
Bureau of Land Management

Pinedale Field Office  
April 2021

# Groundwater and Natural Gas Activities Update – Pinedale Anticline Project Area



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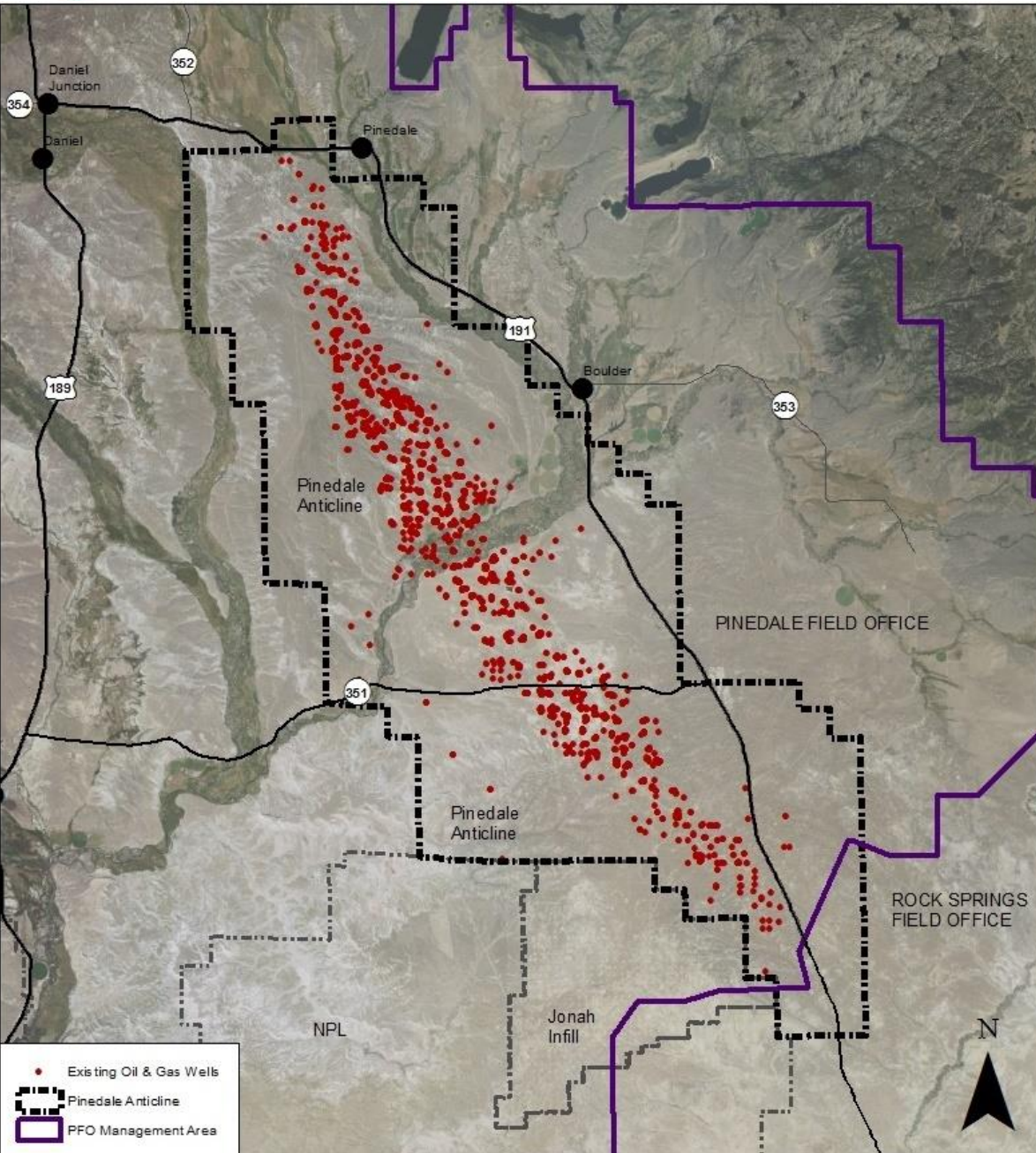
# Existing Oil and Gas Wells

Hydraulic Fracturing  
'Fracking' allowed  
extraction of natural  
gas from tight  
sandstones

1997: < 60

2018: ~ 2,600

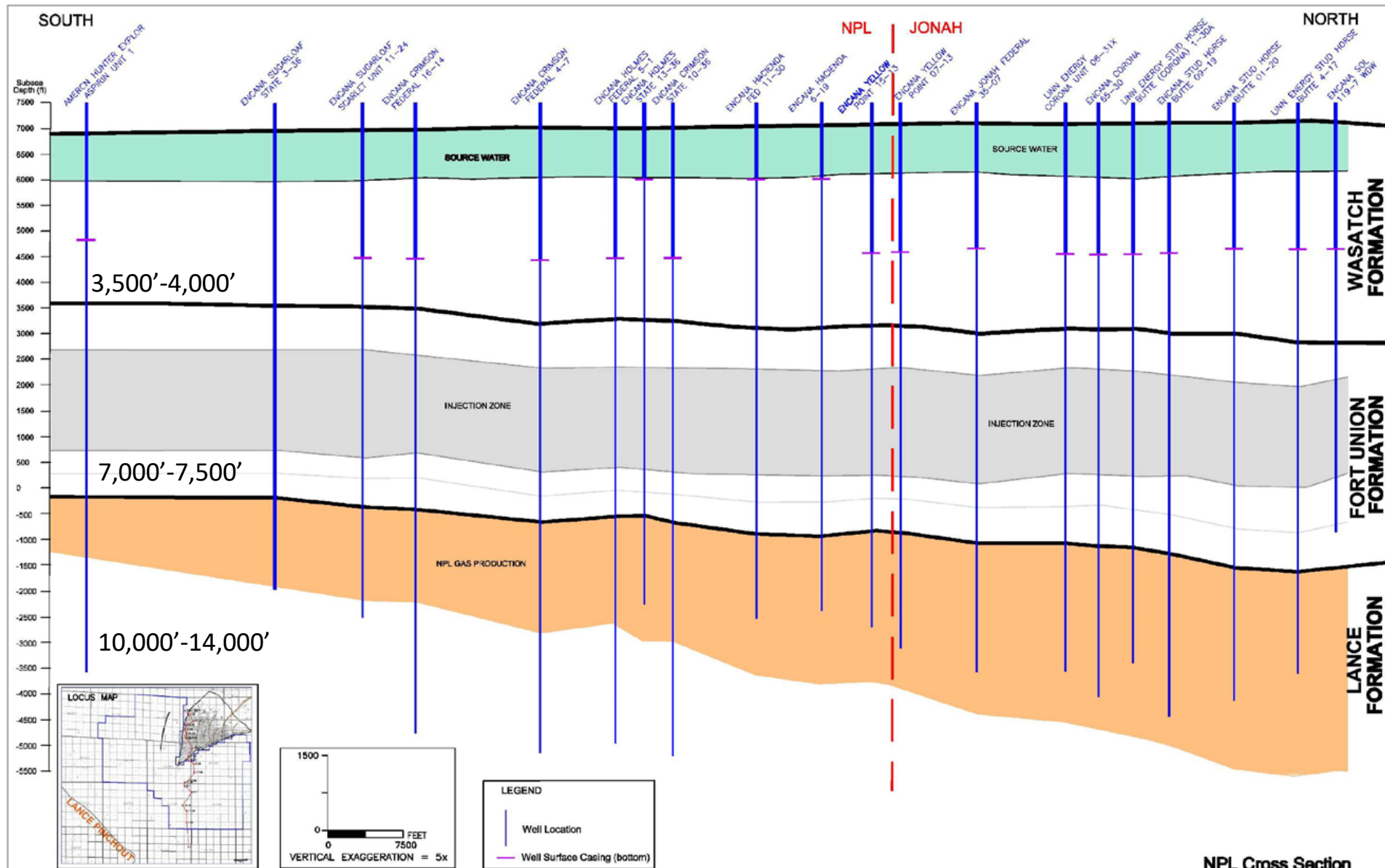
2040: ~ 5,000





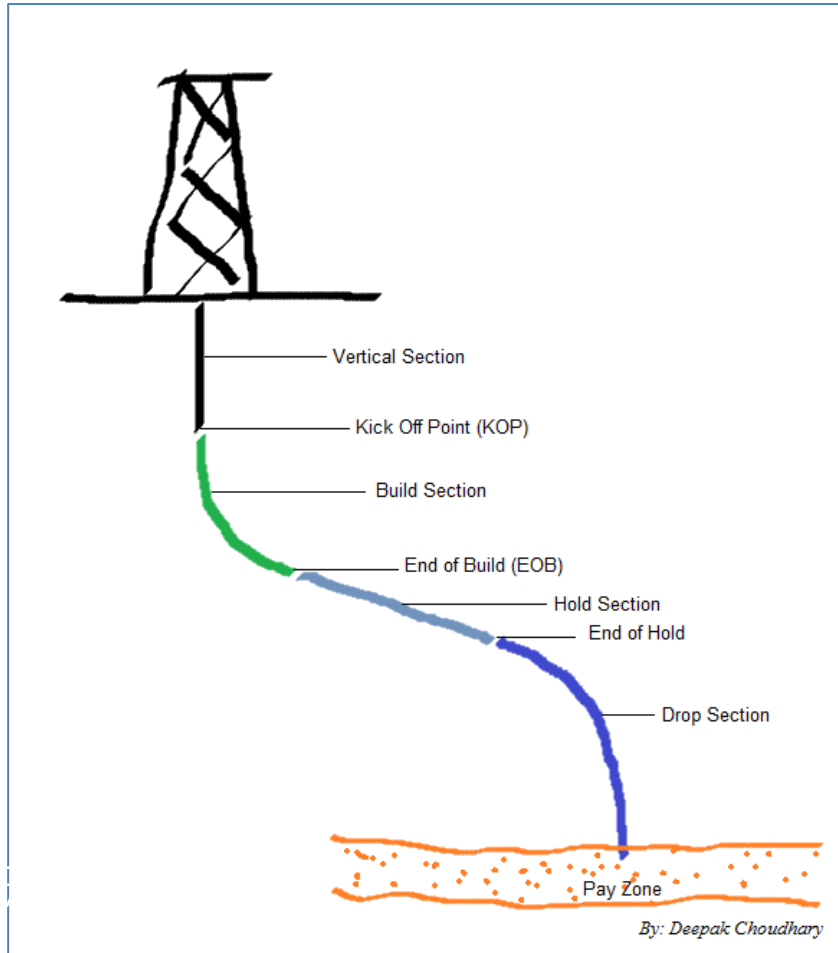


# Formations of Interest in the Pinedale Anticline

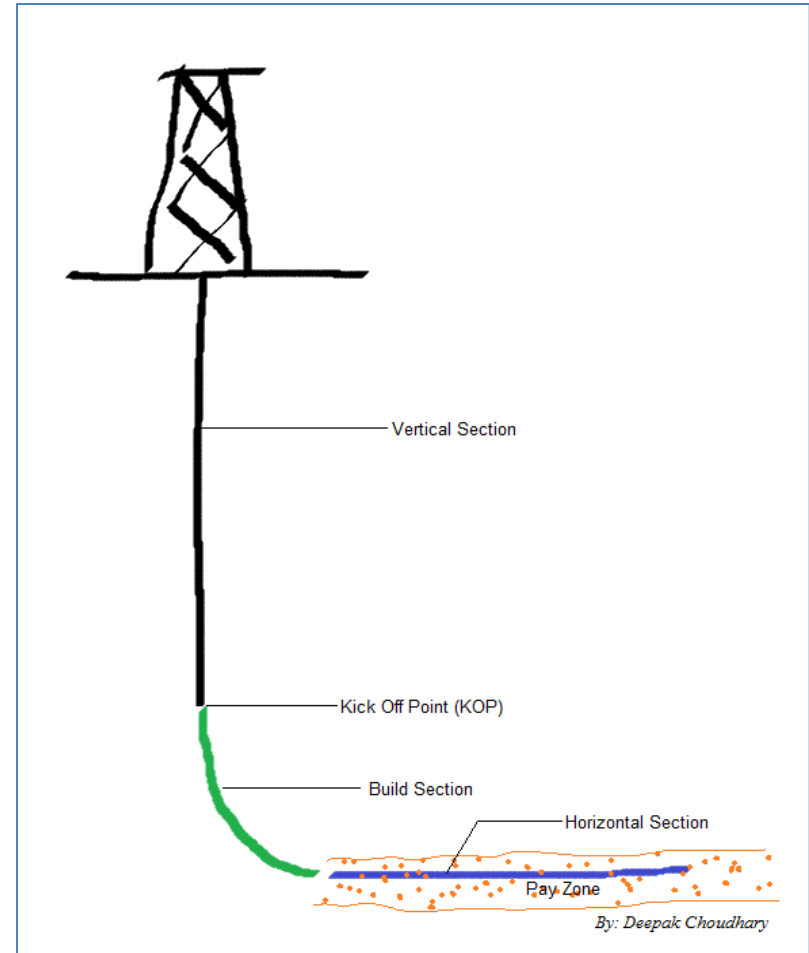




# Directional Wells on Multi-Well Pads



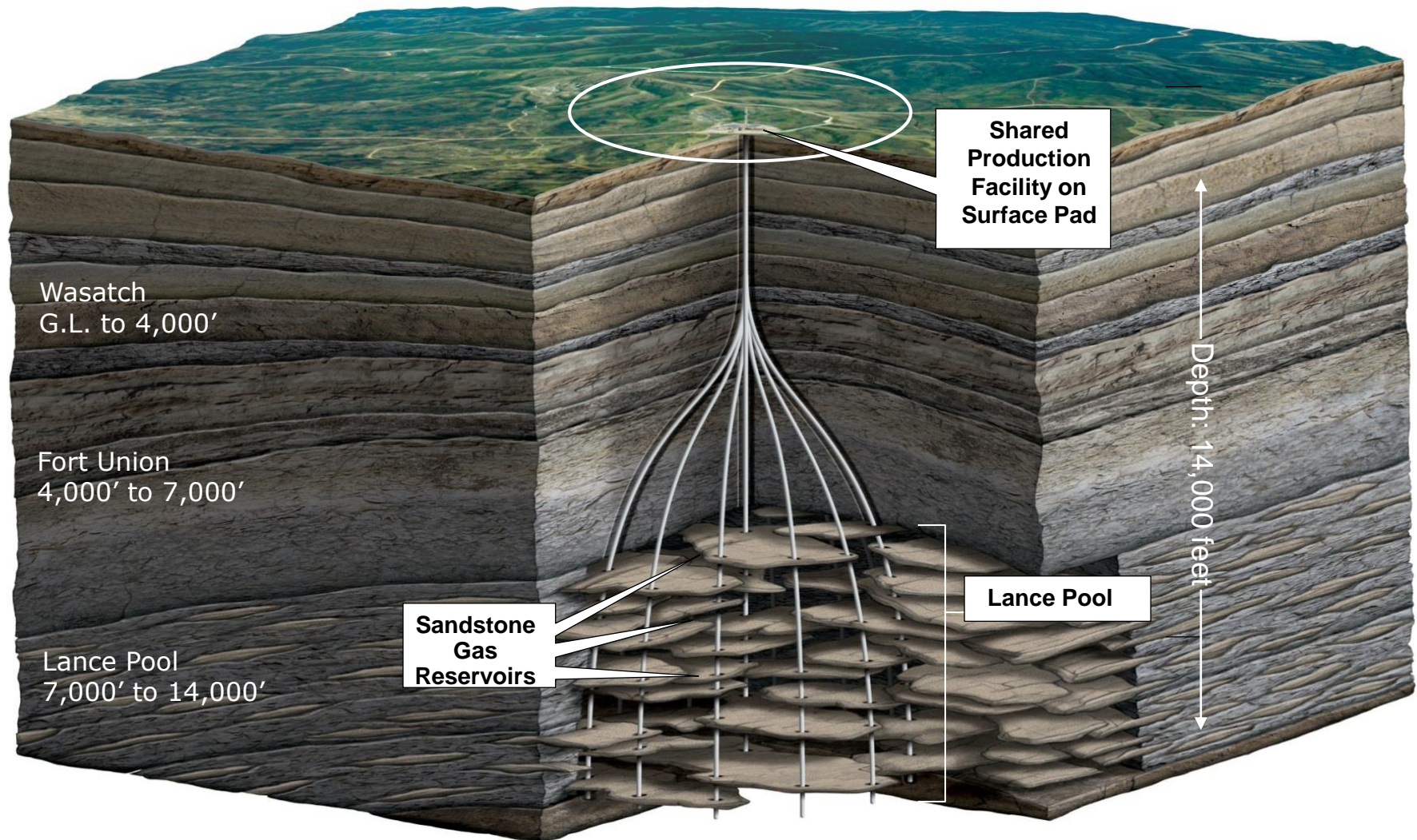
"S" Type



Horizontal



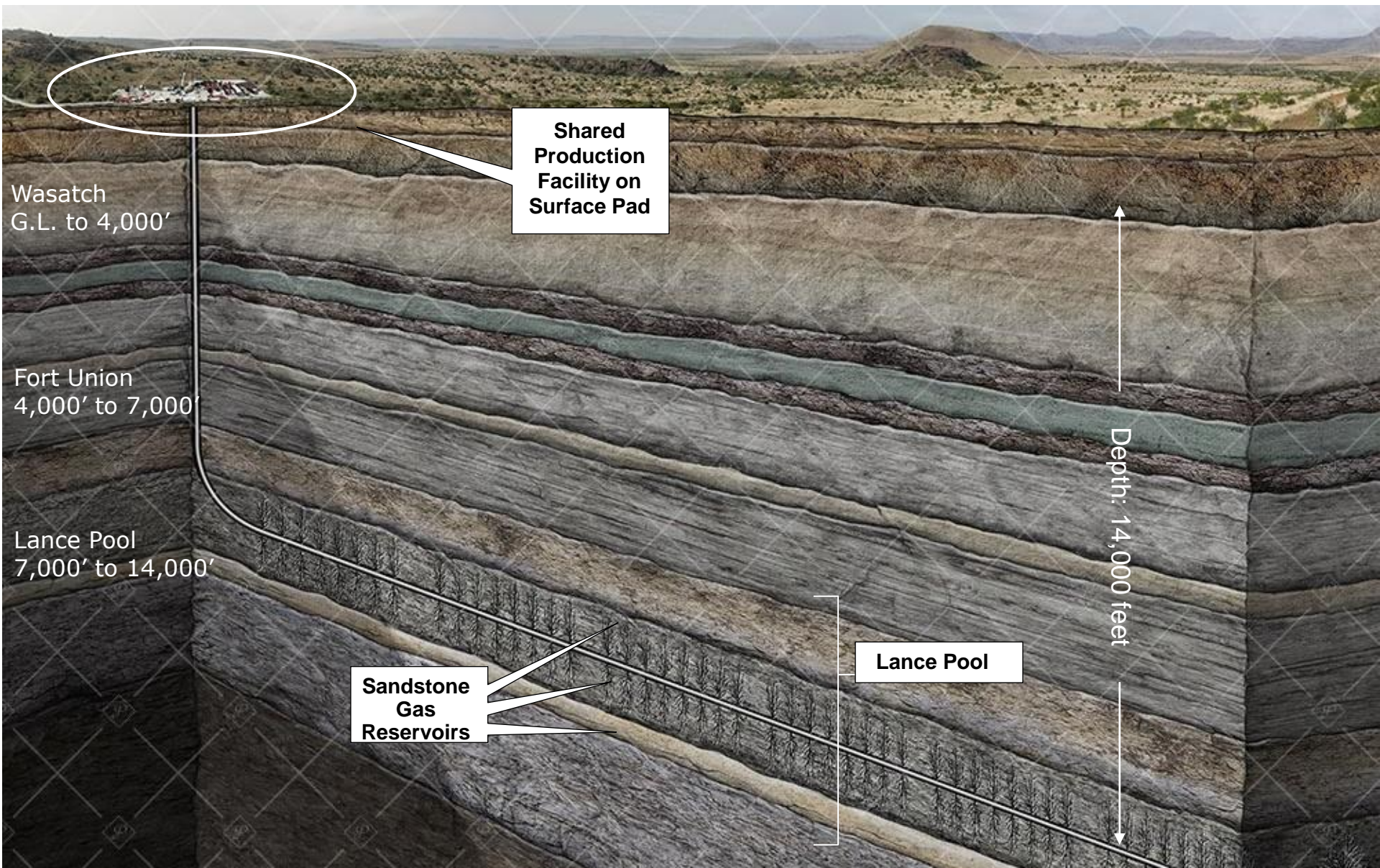
# "S" Type Wells on Multi-Well Pad







# Horizontal Type on Multi-Well Pad





# U.S. Bureau of Land Management Onshore Order #2

## Onshore Oil and Gas Order No. 2 – Drilling Operations on Federal Oil and Gas Leases:

- II. Definitions (Y.). Usable Water are those waters containing up to 10,000 ppm of total dissolved solids
- III. Requirements (B) Casing and Cementing Requirements. Proposed casing and cementing programs shall be conducted as approved to protect and/or isolate all usable water zones, lost circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals





# Wyoming Oil & Gas Conservation Commission Groundwater Baseline Rule

## WOGCC Rules and Regulations, Ch. 3, Sec. 46 (Operational Rules, Drilling Rules):

- Initial baseline water testing on water sources within a ½-mile radius of a planned oil and gas well site not more than 12 months before drilling begins
- Follow-up water quality testing 12 to 18 months after production casing or liner set
- Final water quality testing 36 to 48 months later
- Appendix K: Sampling and analysis procedures which set forth minimum requirements and protocols
- Section 46 I: Provides operators the opportunity to submit a master groundwater baseline sampling, analysis, and monitoring plan





## Potential Sources of Contamination

Oil Based Drilling Mud

Produced Water

Condensate

Flowback Fluid

Pump Installation Materials

Carbonaceous Shale

Natural Gas Production Wells

Light Non-Aqueous Phase Liquid (LNAPL)



	Potential Contaminants
	Methane
	Benzene
	Xylene
	Ethylbenzene
	Toluene
	Naphthalene
	Gasoline Range Organics
	Diesel Range Organics





# PAPA (EIS) Record of Decision (2008)

## 3 Steps to protect groundwater:

1. Compile existing information and develop a preliminary hydrogeological Conceptual Model (EIS 2008)
2. Develop an Interim Groundwater Aquifer Pollution Prevention, Mitigation, and Monitoring Plan (IGW Plan) and initiate groundwater characterization to augment the IGP (Hydrogeologic Data Gaps and Interim GW plan, 2012)
  - a. GW monitoring from 2004-2015
  - b. Low Level Petroleum Hydrocarbon Compound study (2013)
3. Finalize the Groundwater Aquifer Pollution Prevention, Mitigation and Monitoring Plan (GW Plan) and begin Implementation (2016)
  - a. Pollution Prevention Program
  - b. Monitoring Program
  - c. Response Action Program



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## Pinedale Anticline Project Area

# Final Groundwater Pollution Prevention, Monitoring and Response Action Plan



## GW Plan







# Pollution Prevention Program

Goal: Identify Best Management Practices (BMPs) to reduce the potential for groundwater impacts from oil and gas activities – cornerstone of the plan

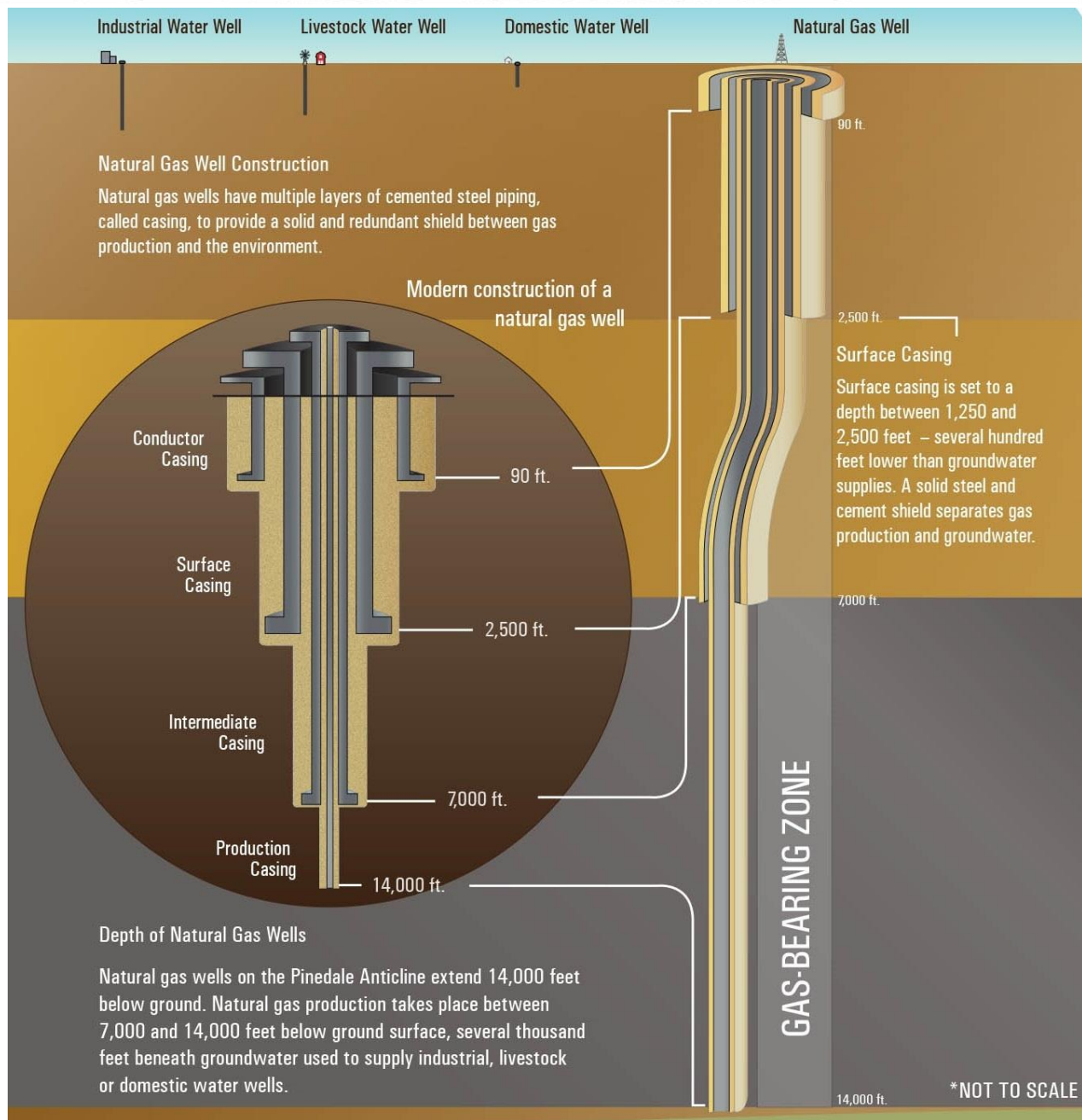
110 regulatory and voluntary BMPs for:

- Planning
- Construction
- Drilling
- Production
- Reclamation





# Typical Natural Gas Well Design







# Monitoring Program

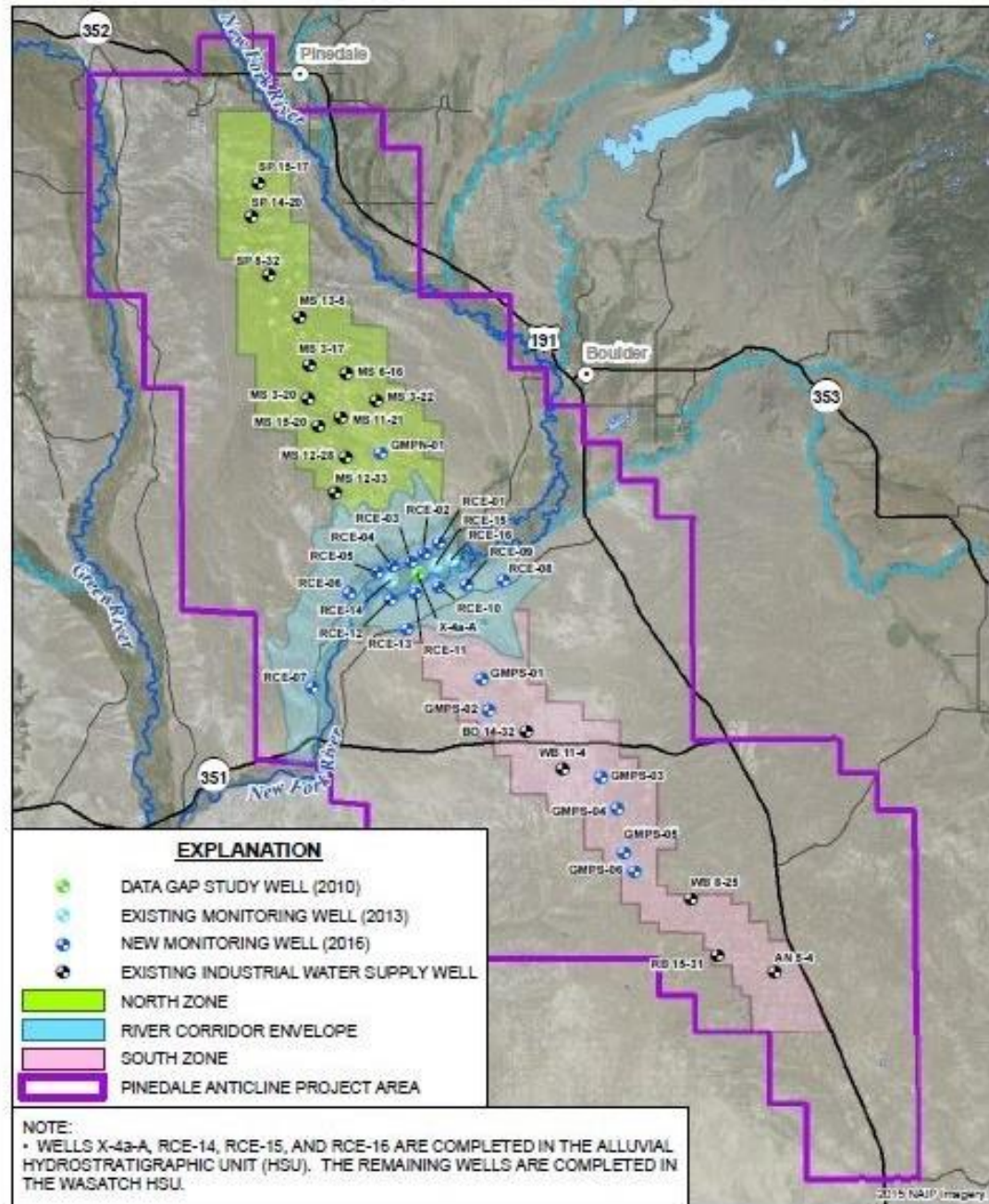
Goal: Monitor groundwater for impacts from oil and gas activities:

- Based on the baseline groundwater characterization
- Appropriate to the level of risk
- Includes constituents that are most:
  - *Indicative of impacts from oil and gas activities;*
  - *Likely to appear first at monitoring sites; and*
  - *Hazardous to public health and the environment*



# 41 Dedicated Monitoring Wells

- North Zone: 13
- River Corridor: 17
- South Zone: 11





# Modifications to 2018 GW Monitoring Program Review Team Meeting (April 2018)

1. Modified SOP-2 (Decontamination)
  - a. Eliminate need for nitric acid and/or methanol rinse
2. Modified SOP-12 (Sampling)
  - a. Allow purging by stabilization of parameters for low flow sampling instead of 2-3 screen volumes
3. Discontinued confirmation of previously confirmed results (e.g., Boron, Manganese, Total Dissolved Solids)
4. Replaced well BR 14-32 with BR 14-32R
5. Repaired pump in well RCE-02





# Modifications to 2019 GW Monitoring Program Review Team Meeting (March 2019)

1. Install sounding tubes in 4 wells to enable direct measurement of water levels using an electric water level probe rather than sonic devices
  - a. SP 15-7, MS 13-5, GMPS-02, and RB 15-31
1. Eliminate field duplicate samples and utilize laboratory duplicate samples to assess precision for very small sample sizes
2. Use closed sampling method (IsoFlasks®) for 5 wells with methane variability ( $\geq 20$  mg/L)
  - a. RCE-11, RCE-13, BR 14-32R, WB 11-4 and GMPS-04



## Modifications to 2020 GW Monitoring Program Review Team Meeting (March 2020)

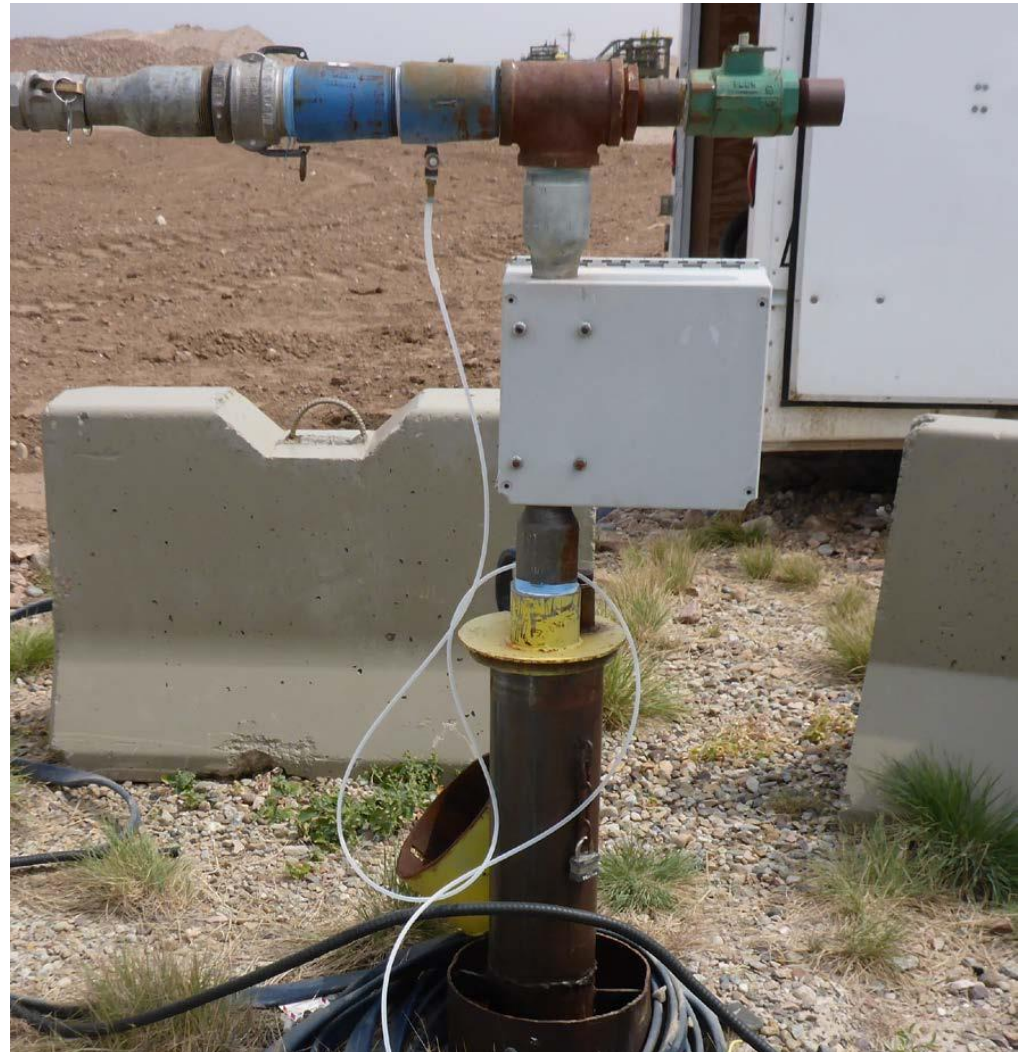
1. Install a new bladder in the pump for well RCE-02 and re-deploy the pumping system.
2. Confirm the accuracy of data recorded by the transducer in well X-4a-A during the January 2020 semiannual monitoring event. If the transducer is not functioning, replace the transducer.
3. Continue to collect samples for methane analysis using IsoFlasks® from the five wells that have had  $\geq 20$  mg/L methane (RCE-11, RCE-13, BR 14-32R, WB 11-4, & GMPS-04).
4. Evaluate benzene results from the January 2020 (semiannual) sample from well RCE-16 relative to the Absolute Value Threshold. If benzene concentrations continue to exceed the AVT, refer the well to the WDEQ Response Action Program



# 2020 Annual Sampling-All 41 wells

NewFields  
completed annual  
sampling August 6  
thru 13, 2020.

All 41 dedicated  
monitoring wells  
were sampled for  
analysis of core or  
core & supplemental  
parameters







# 2020 Semi-Annual Sampling-4 wells

NewFields completed semiannual monitoring on January 25, 2020 of alluvial wells:

- RCE-14
- RCE-15
- RCE-16
- X-4a-A

Samples were analyzed for core & supplemental parameters

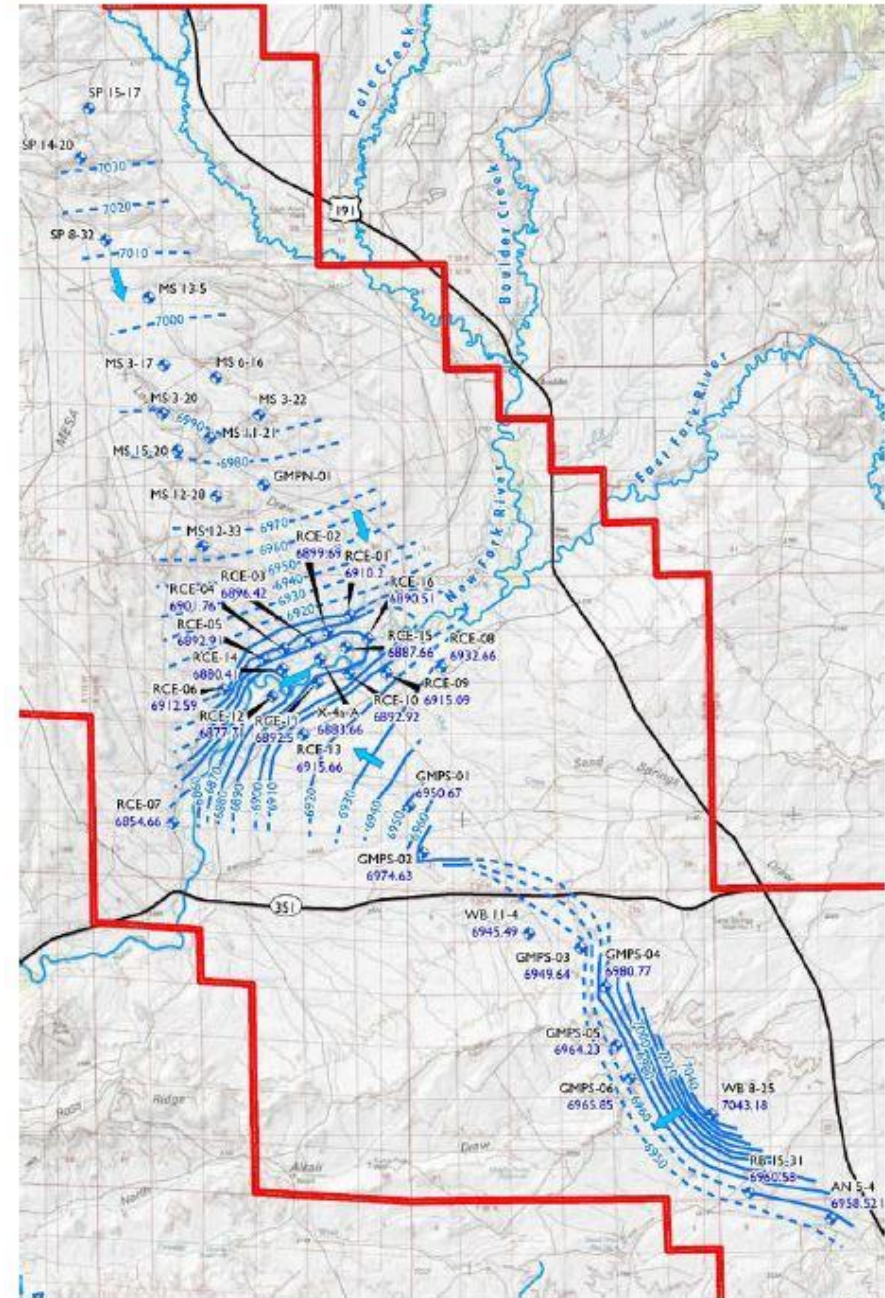




# Groundwater Flow in Wasatch Formation

- North Zone: south towards the New Fork River
- South Zone: northwest towards the New Fork River
- River Corridor: towards New Fork then subparallel to river

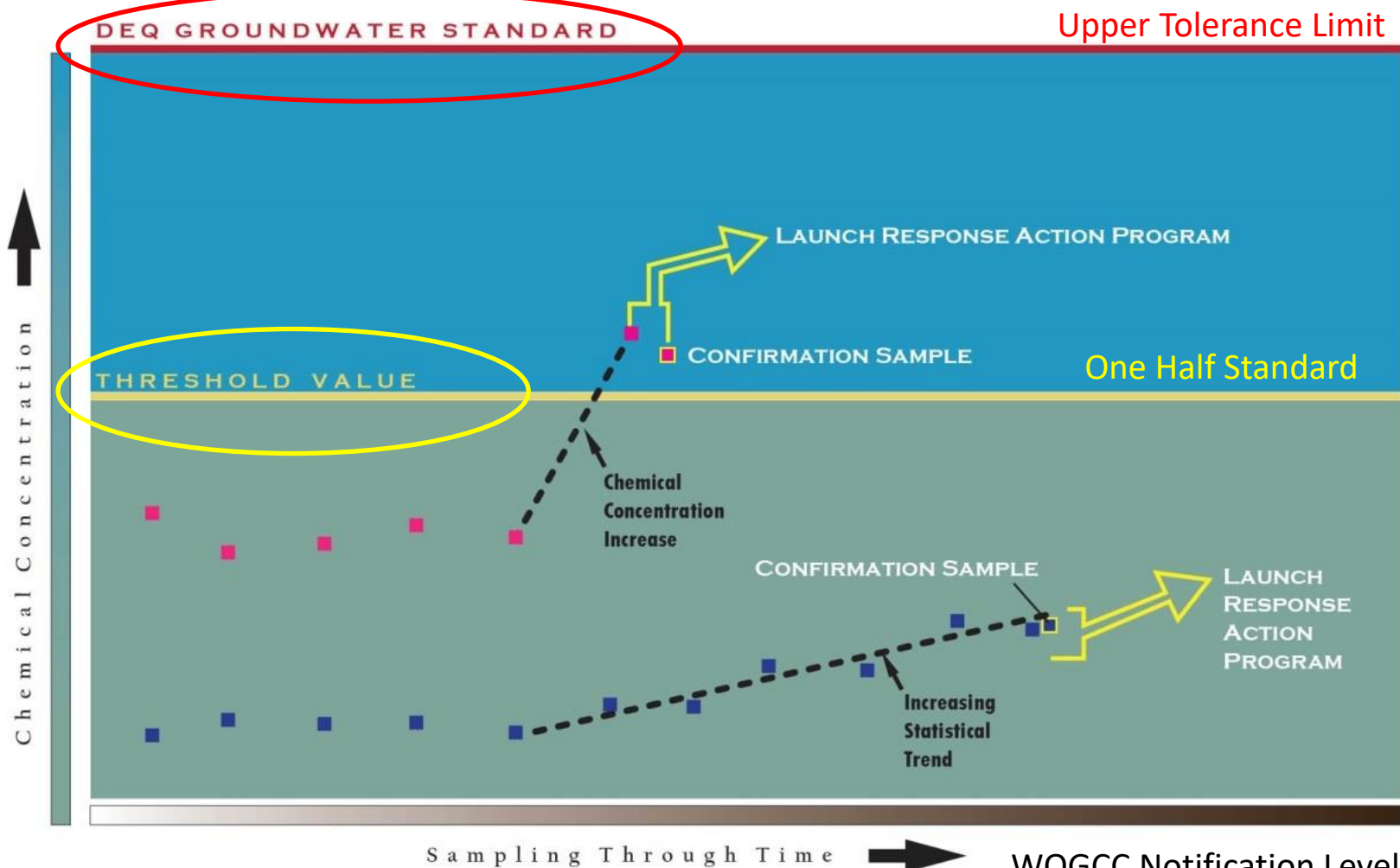
*No significant change (>3 feet) in groundwater elevations in the PAPA during the period of record.*







# Threshold vs Statistical Trends



Note: If Methane Concentration  
Increases by 5 milligrams per liter,

LAUNCH RESPONSE ACTION PROGRAM





# Response Action Program

Goal: Develop a process that specifies responses to exceedences of established thresholds

## Pollution Prevention Program

- Employ BMPs
- BMP Failure
- Annual Review Team Meeting

## Groundwater Monitoring Program

- Monitor Groundwater
- Analyze Data
- Threshold Exceeded
- Annual Review Team Meeting



Assemble  
Working Group  
from Review  
Team

## Response Action Program

- Quarterly Monitoring
- Investigate Cause
- Review Team Determines Next Step

- **Revise Conceptual Model**
- **Revise BMPs**
- **Determine Path Forward**



# Key Findings of 2020 Monitoring

1. Several Wasatch Formation wells exhibited higher groundwater elevations in 2020 relative to 2019, including wells SP 14-20 (+7 feet), RB 15-31 (+~3 feet), GMPN-01 (+~1 feet), and GMPS-03 (+3 feet).
2. Hydrographs and point measurements show an increasing trend in water levels since 2018 in several wells (GMPS-03, WB-11-4, and RB 15-31).
3. Hydrographs in river corridor wells RCE-03, X-4a-A and RCE-10 show variation on a seasonal basis but no obvious overall increasing or decreasing trends between 2018 and 2020.



# Key Findings of 2020 Monitoring

4. 2020 was the first year since the monitoring plan was initiated in 2016 that no confirmation sampling was required. This is based on no Absolute Value Threshold exceedance that required confirmation sampling and because there were no statistically significant increasing trends in the 28 wells with sufficient data for Mann-Kendall tests.
5. Variations in pumping rate or purge volume between 2019 and 2020 appears to affect dissolved methane concentrations (+5 mg/L) in samples from wells BR 14-32R, GMPS-04 and WB 11-4.





# Recommended Changes to the Groundwater Monitoring Plan

No changes are recommended to the groundwater monitoring plan or the existing hydrogeologic conceptual model for the PAPA (AMEC, 2012) based on 2020 monitoring results. Monitoring results do not indicate that there are any failures of, or missing, best management practices for pollution prevention (refer to Section 3 of NewFields, Final GW Plan Report, 2016).



# Recommended Actions for 2021 Sampling

1. Install the new dedicated bladder pump in well RCE-02.
2. Implement the modified GMP sampling frequency as outlined in BLM's letter dated July 27,2020:
  - a. Semi-annual [January] sampling of the four alluvial RCE wells; and
  - b. Annual sampling [August] of all 17 RCE wells.(Note: Bi-annual sampling of the 24 wells in the North and South Zones would occur in 2022).
3. Sample wells BR 14-32R, GMPS-04 and WB 11-4 for dissolved methane using IsoFlasks® during the August 2021 annual event.





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# Questions?

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