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An Introduction to Natural Gas Storage in Illinois

Presented by Randy Locke, P.G., ISGS
March 26, 2018

Prepared by the PRI Natural Gas Working Group
with contributions from the IDNR – Office of Oil and Gas Resources Management
for the Mahomet Aquifer Protection Task Force Meeting, Champaign, Illinois

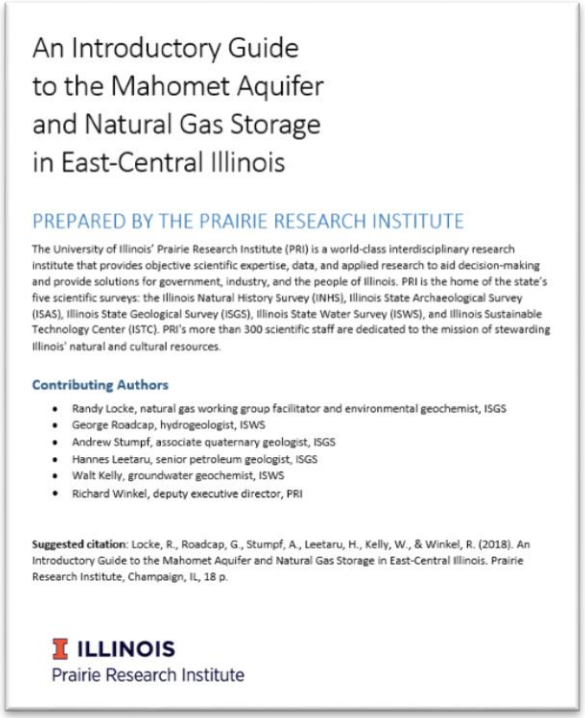
Resources for the Task Force

PRI Natural Gas Working Group (NGWG) goals are to:

1. Assist stakeholders in their responses to address natural gas leakage…
2. Consider natural gas storage activities in Illinois …as they relate to natural resource … protection issues

"Introductory Guide" includes:

- Basic information about the Mahomet aquifer and natural gas storage, and
- A list of potential aquifer protection issues for task force consideration



An Introductory Guide to the Mahomet Aquifer and Natural Gas Storage in East-Central Illinois

PREPARED BY THE PRAIRIE RESEARCH INSTITUTE

The University of Illinois' Prairie Research Institute (PRI) is a world-class interdisciplinary research institute that provides objective scientific expertise, data, and applied research to aid decision-making and provide solutions for government, industry, and the people of Illinois. PRI is the home of the state's five scientific surveys: the Illinois Natural History Survey (INHS), Illinois State Archaeological Survey (ISAS), Illinois State Geological Survey (ISGS), Illinois State Water Survey (ISWS), and Illinois Sustainable Technology Center (ISTC). PRI's more than 300 scientific staff are dedicated to the mission of stewarding Illinois' natural and cultural resources.

Contributing Authors

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Point of Contact:
Trish Barker, tlbarker@illinois.edu; 217-300-2327

For more information, see:
https://prairie.illinois.edu/content/natural-gas-working-group

Natural Gas Quick Facts: Illinois

- No significant natural gas resource in the state
- 80% of homes use natural gas as primary heating fuel (IEA, 2009) and demand varies through time
- Key transportation hub for natural gas: 18 interstate pipelines, 2 market centers
- 24 active underground gas storage sites (1 active site within the Mahomet aquifer boundary)
- Illinois has the greatest amount of natural gas storage capacity *in saline formations* in the nation (~780 billion cubic feet, Bcf)
- US Energy Information - Illinois Profile: www.eia.gov/state/print.php?sid=IL

Natural Gas Quick Facts: Illinois

Current Authority:

- **Office of Oil and Gas Resource Management (IDNR - OOGRM)** is the regulatory authority in Illinois for permitting, drilling, operating, and plugging oil and gas production wells. Authority for intrastate sites.

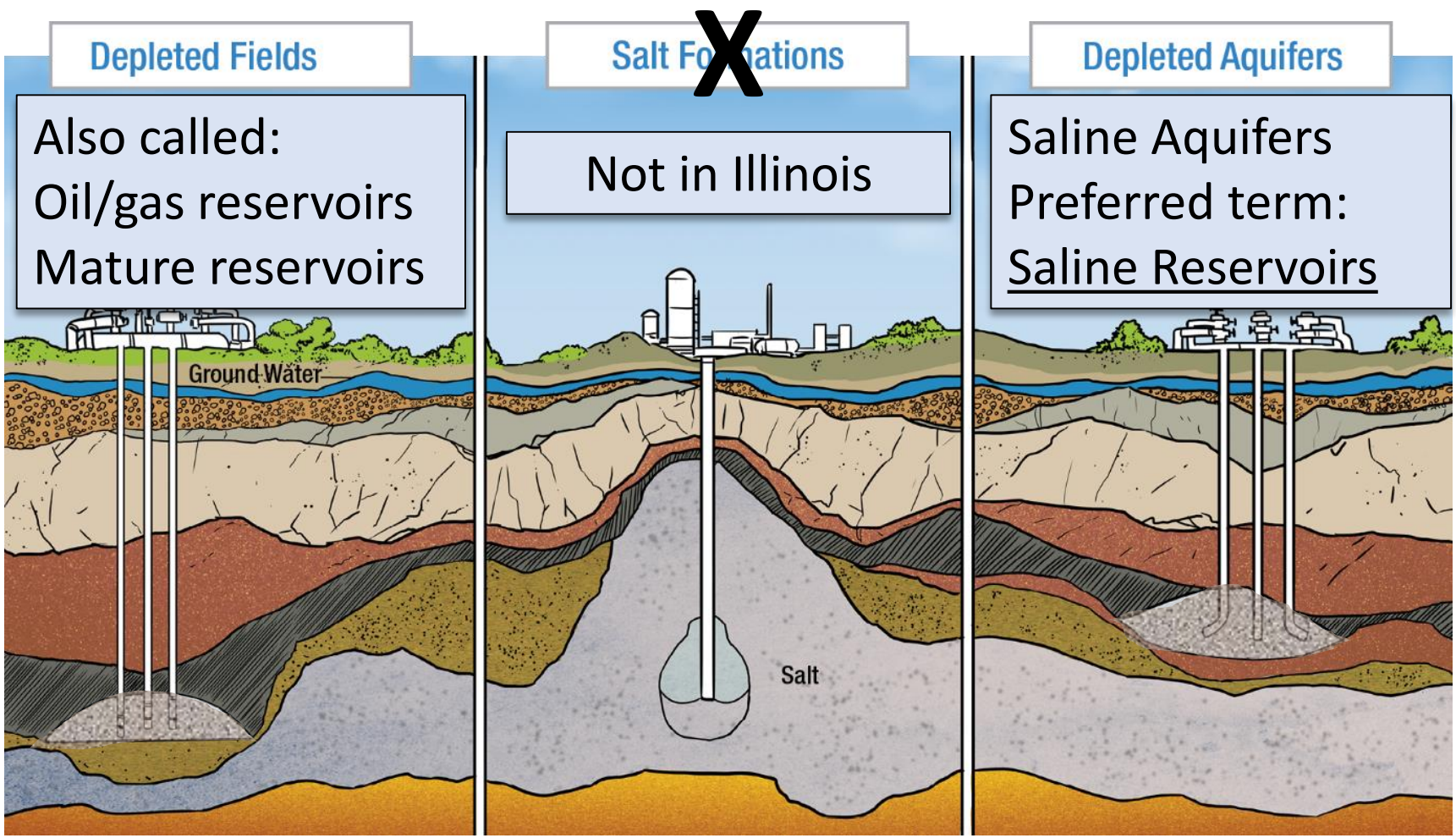
- **Federal Energy Regulatory Commission (FERC)** and **Pipeline and Hazardous Materials Safety Administration (PHMSA)** authority for interstate sites.

In Development:

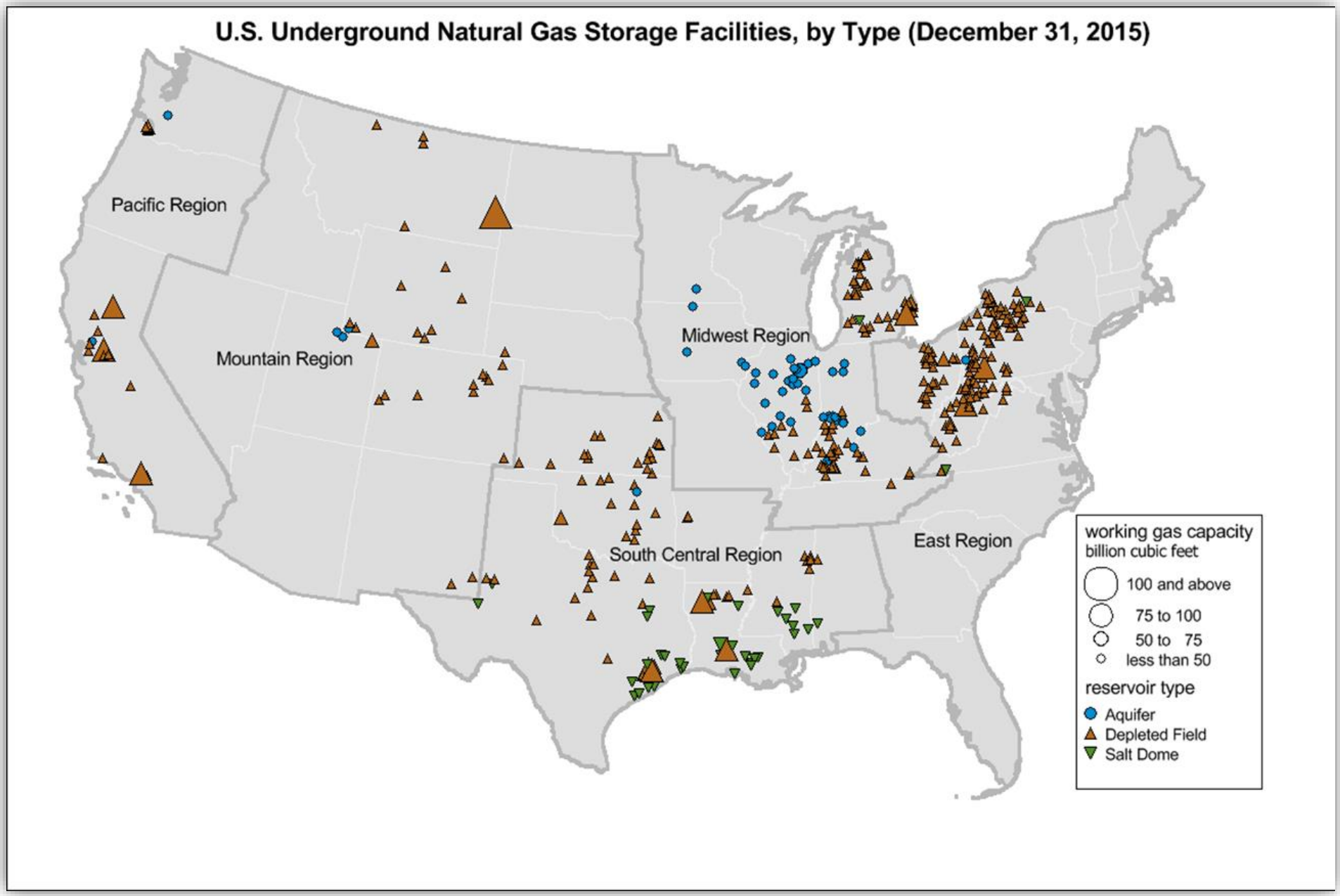
- **Illinois Underground Natural Gas Storage Safety Act** would integrate new federal requirements (PHMSA, Interim Final Rule, 2016) with existing IDNR regulatory program.

- **SB3548 and SB3549** introduced by Sen. Rose to amend the Illinois Oil and Gas Act. Would give IDNR additional ability to respond to releases and conduct annual well inspections at gas storage fields, respectively.

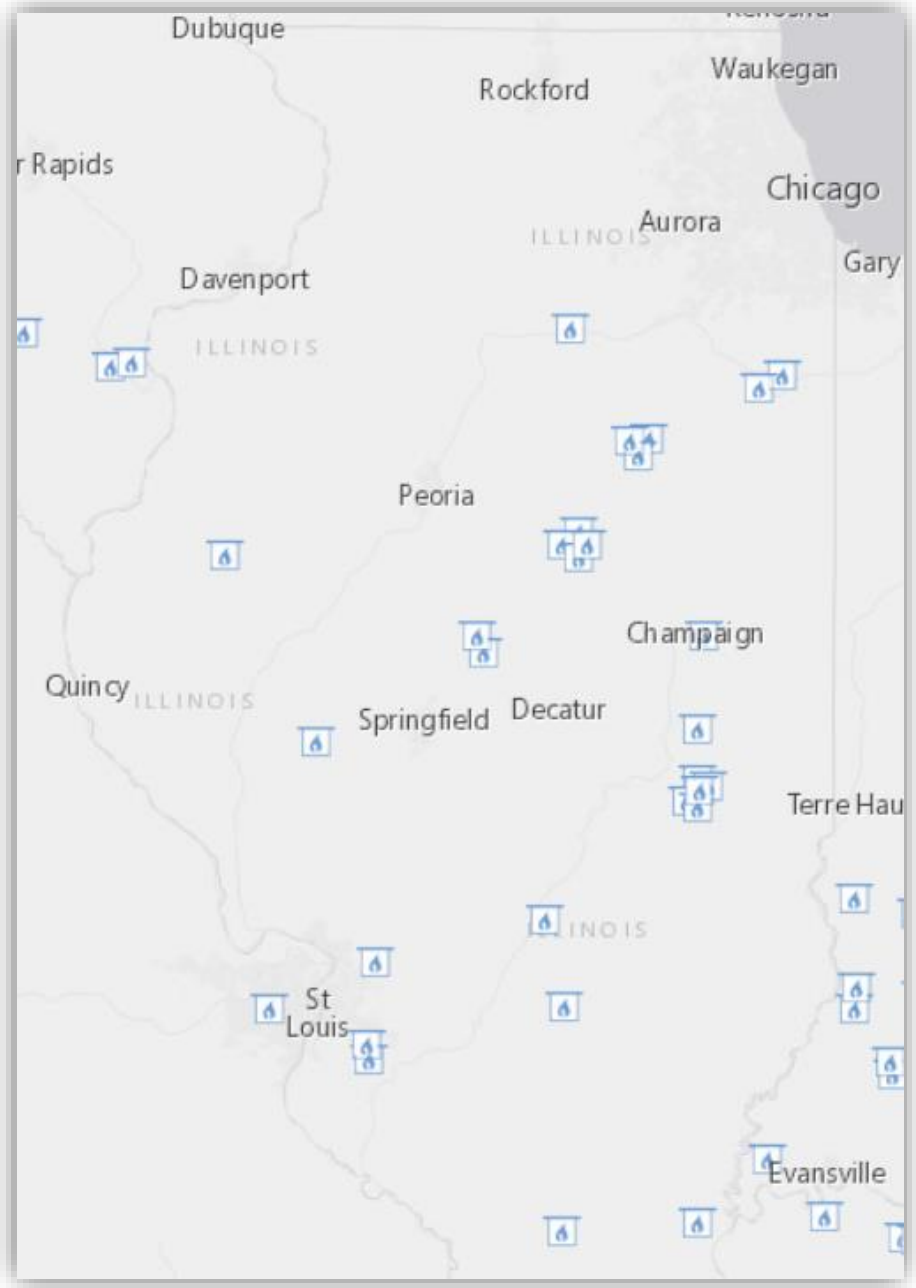
Gas Storage Reservoir Types in U.S.



Modified from, http://www.energyinfrastructure.org/energy-101/natural-gas-storage/



Source: U.S. Energy Information Administration, Map of Storage Facilities, https://www.eia.gov/cfapps/ngqs/images/storage_2015.png

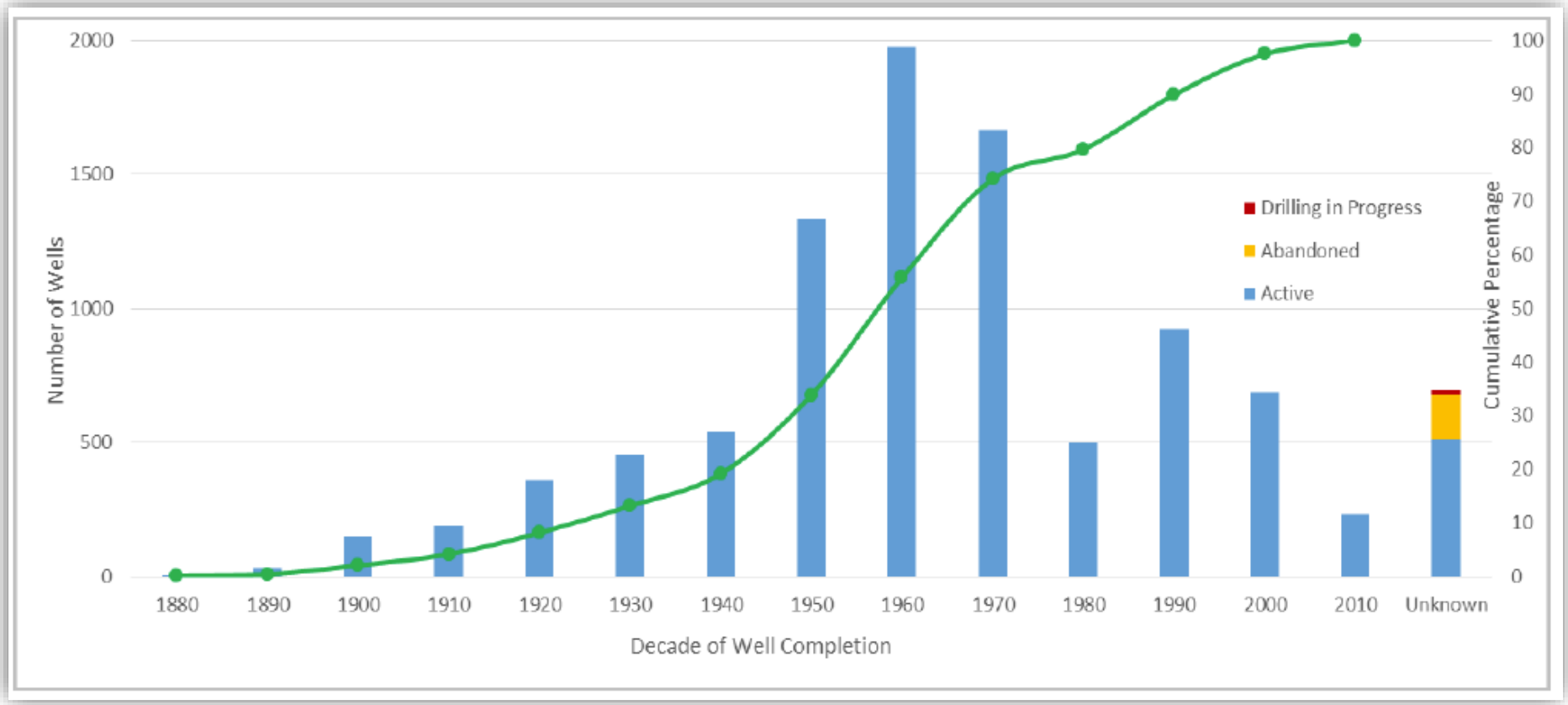


Gas Storage in Illinois

- 24 active sites in 24 counties (+14 inactive/abandoned)
  - 55% (21) saline reservoir
  - 45% (17) depleted field
- 1186 active gas storage wells (+464 plugged)
  - 71% (839) saline reservoir
  - 29% (347) depleted field
- Top 5 counties with the most wells (**green** = in Mahomet aquifer 15-county planning region):
  - Kankakee 14% (162)
  - **Champaign 13% (153)**
  - LaSalle 11% (134)
  - Livingston 10% (119)
  - **McLean 9% (104)**

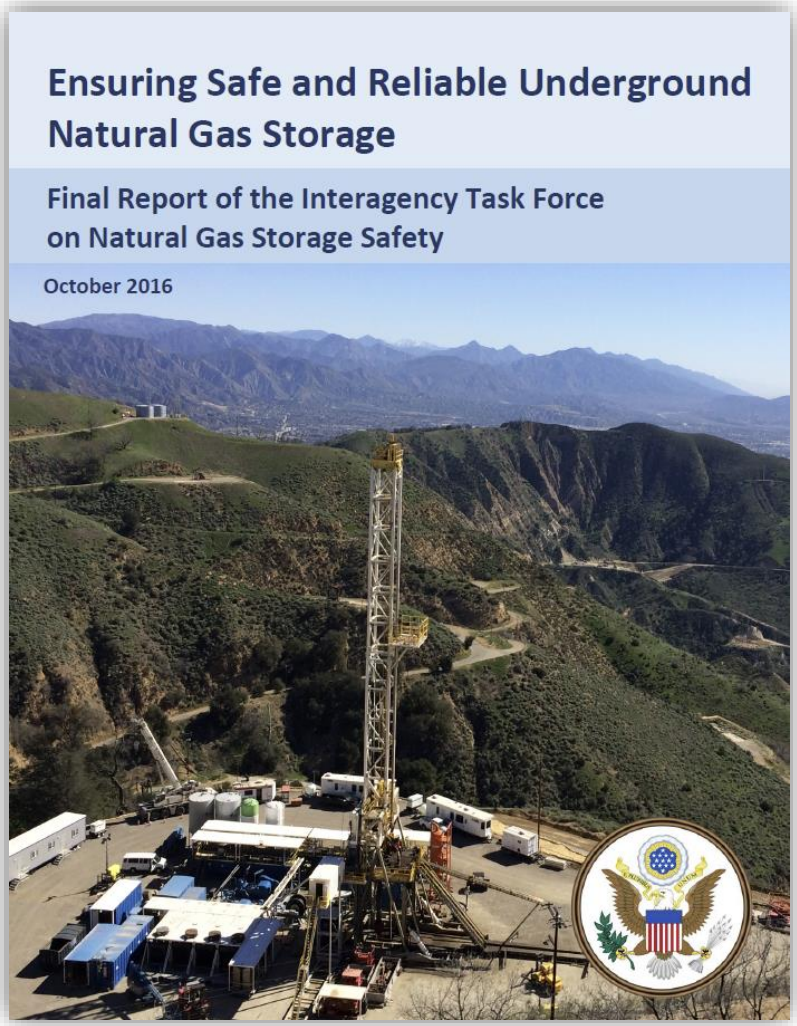
Map from US Energy Mapping System, US EIA, https://www.eia.gov/state/maps.php ; Site and well data from IDNR-OOGRM, Mar 2018

About 75% of natural gas storage wells were constructed in the 1970s or earlier



Source, US Department of Energy, 2016:
https://www.energy.gov/under-secretary-science-and-energy/downloads/report-ensuring-safe-and-reliable-underground-natural

Federal Task Force Recommendations



Task Force convened in response to the Aliso Canyon incident

Two top-level recommendations:

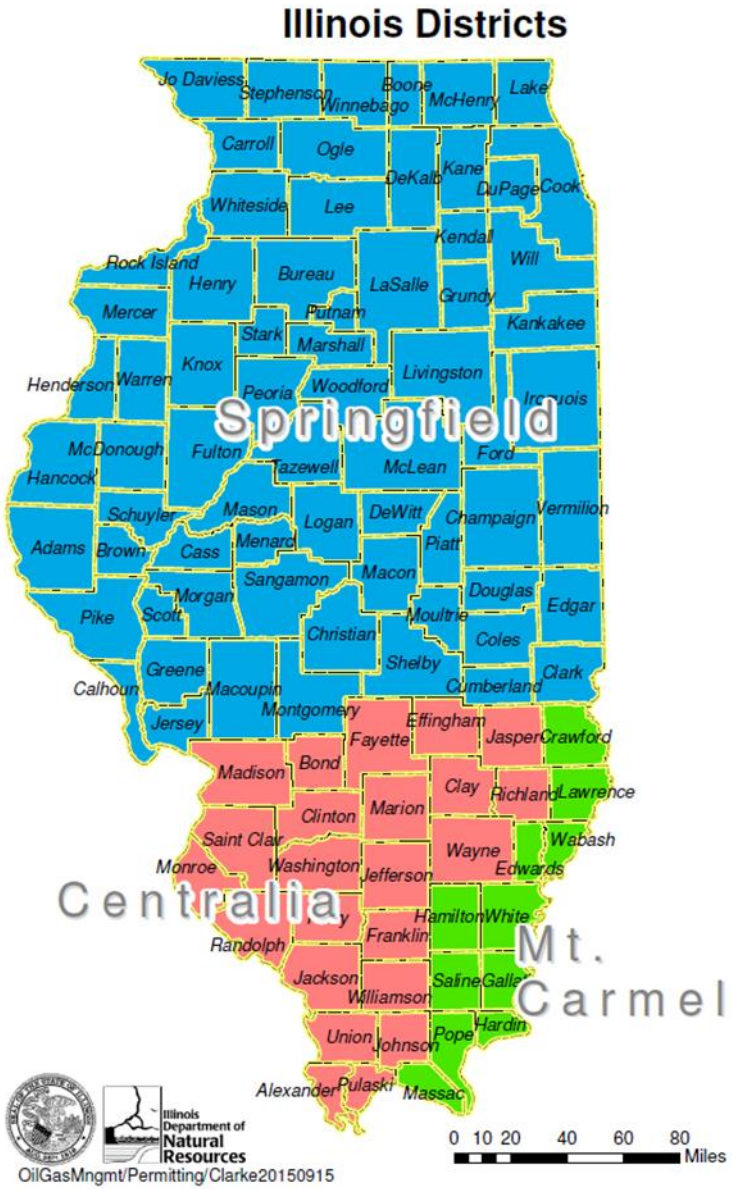
- "Gas storage operators should …**baseline the status of their wells, establish risk management planning and, in most cases, phase-out old wells** with single-point-of-failure designs."
- "**Advance preparation for possible natural gas leaks** and coordinated emergency response in the case of a leak can help manage and mitigate potential health and environmental impacts of leaks when they do occur."

https://www.energy.gov/under-secretary-science-and-energy/downloads/report-ensuring-safe-and-reliable-underground-natural

Summarized Recommendations Chapter 3 – Well Integrity Topic

- **Ensure Integrity**: Phase out old well designs, undertake rigorous well integrity programs, prioritize well integrity tests, and deploy continuous monitoring.
- **Risk Management**: Develop comprehensive risk management plans, develop potential response actions to a leakage event, institute robust record management systems, implement transition plans within 1 year of new federal standards, and account for a broad range of risk factors.
- **Research and Data Gathering**: Study downhole safety valves, well integrity testing tools, well bore simulation tools, address data gaps (e.g., well identification, proximity of facilities to population centers, changes in land use, and collect and provide data for risk assessment.
- **Immediate Regulatory Actions**: PHMSA incorporation American Petroleum Institute recommended practices 1170 and 1171 for well construction. (https://primis.phmsa.dot.gov/ung/index.htm)

DOE, 2016

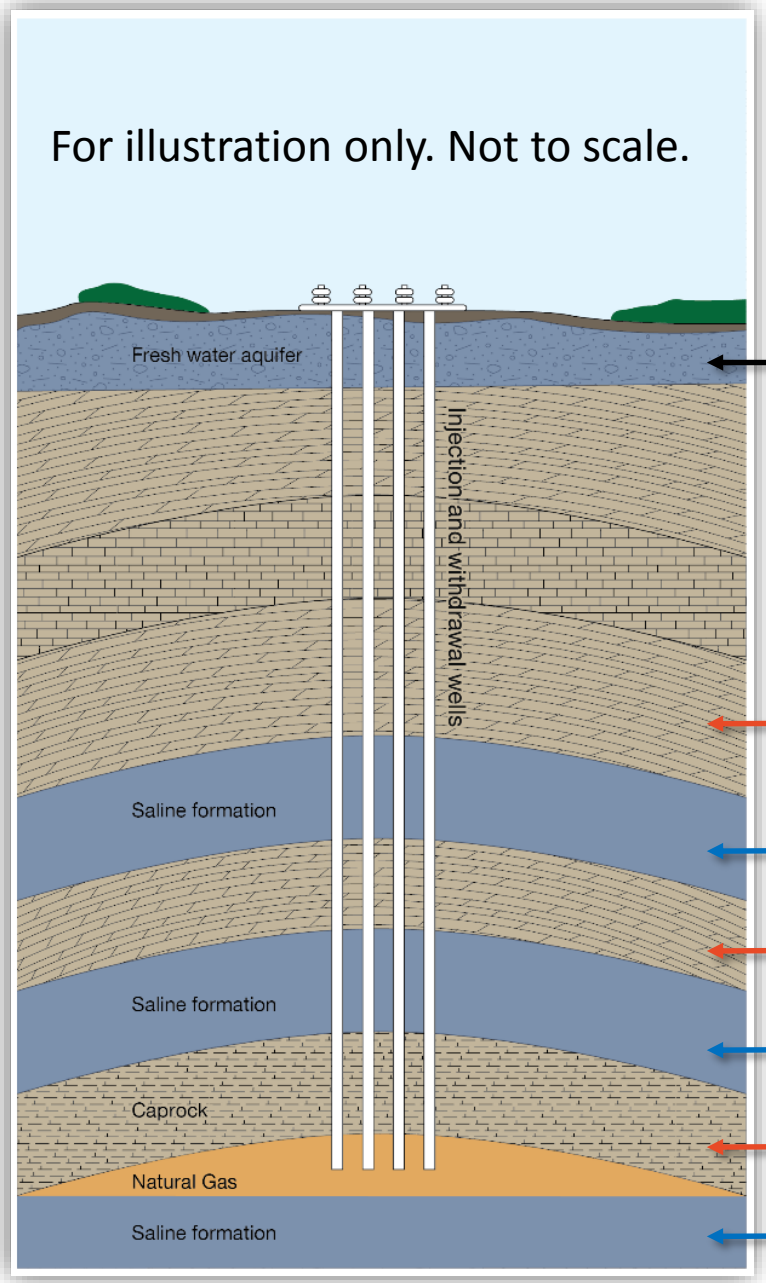


IDNR-OOGRM

- Ensure that oil and gas operators comply with regulations
- Issue violations for non-compliance
- 3 Districts; 12 inspectors
- Conducted 32,000 inspections in 2017

OOGRM page: https://www.dnr.illinois.gov/OilandGas/Pages/default.aspx

Illinois Example: Saline Reservoir Storage



From: University of Illinois, Prairie Research Institute

Freshwater aquifers, including the Mahomet aquifer

Caprock: Maquoketa Formation, New Albany Shale, Galena-Platteville, etc.

Reservoir: St. Peter Sandstone

Caprock

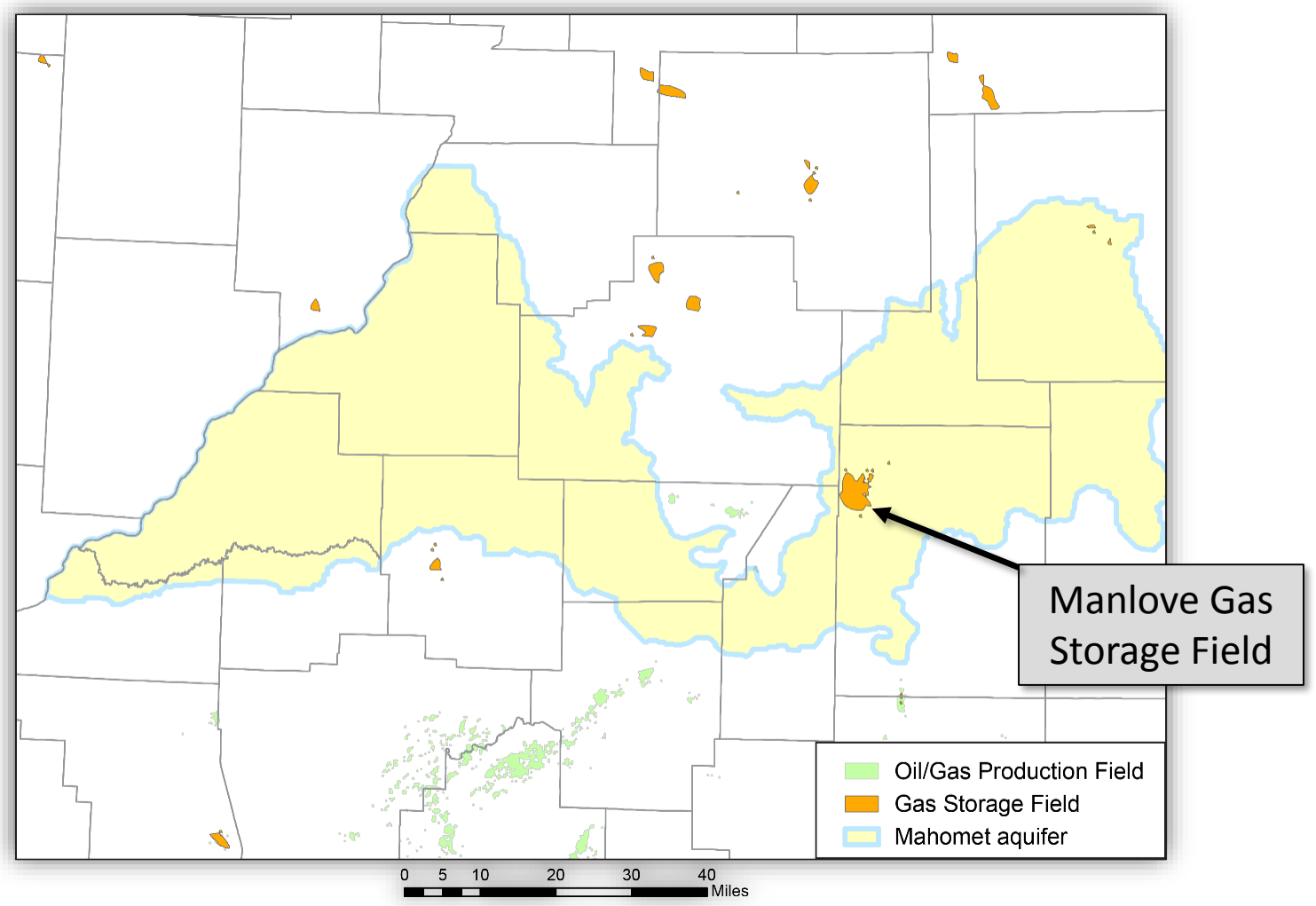
Reservoir: Ironton-Galesville sandstones

Caprock: Eau Claire Formation

Reservoir: Mt. Simon Sandstone

(Blue text = saline reservoirs used in Illinois)

Gas Storage near the Mahomet Aquifer



Map source: Prairie Research Institute (2018)

Manlove Gas Storage Field Leak

- McCord#2 well (about 4,000 feet deep)
- Leak first identified: December 6, 2016
- Leakage through the well casing at about 500 feet below land surface
- Reported to Illinois Emergency Management Agency
- Groundwater sampling subsequently identified private wells with thermogenic methane
- In active litigation with the Illinois Attorney General's Office, Illinois DNR, and Illinois EPA

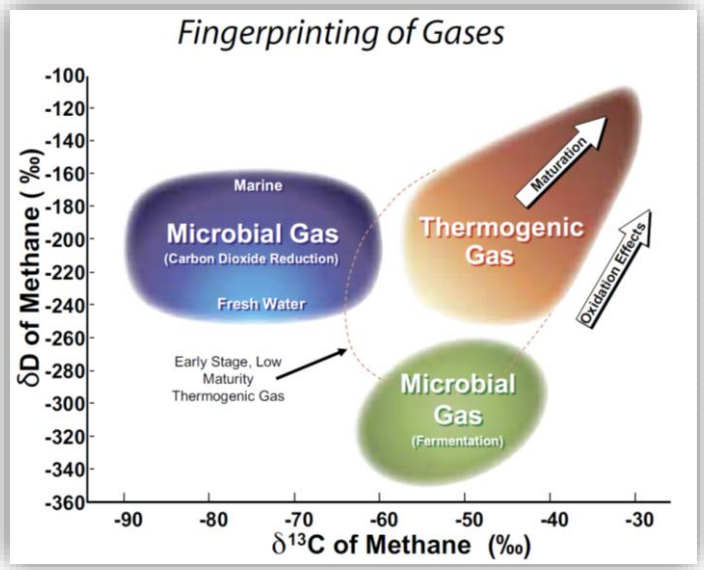


Image source: Isotech

- Thermogenic gas - produced by thermal alteration of buried organic matter.
- Biogenic gas - produced by microbial processes.

Summary

- Illinois relies significantly on natural gas and natural gas storage.
- In response to leakage at sites in the U.S. and in Illinois, modifications to natural gas storage requirements are being developed and implemented at state and federal levels.
- Consolidated list of protection and management issues is important to help the task force to prioritize efforts.
- High-quality, subsurface information is essential for:
  - Understanding movement of fluids in the subsurface
  - Leakage mitigation responses, and
  - Groundwater protection.

Resources for the Task Force

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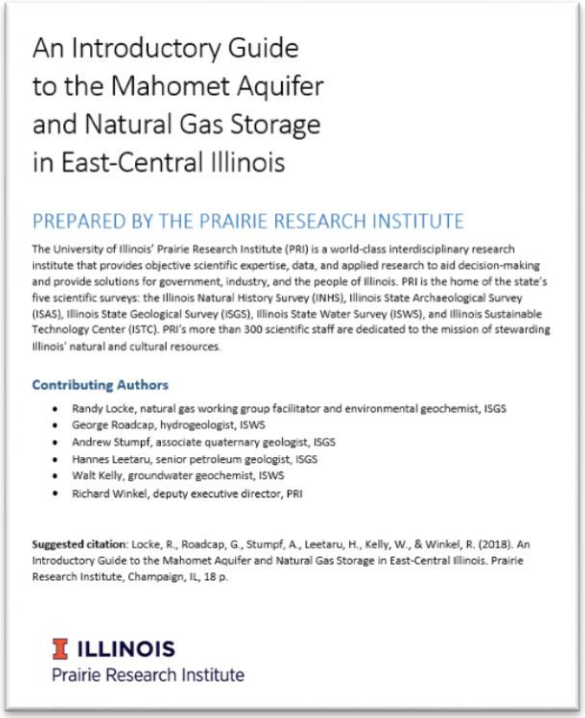

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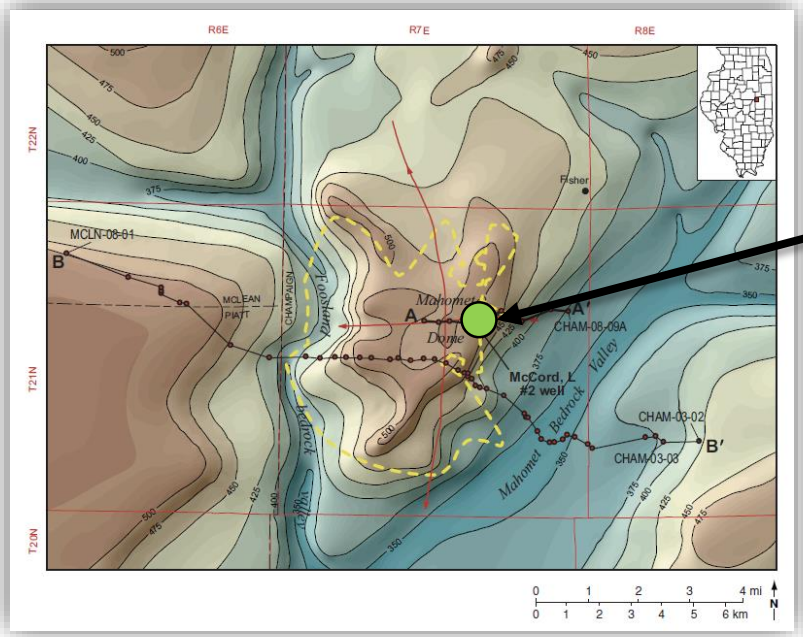
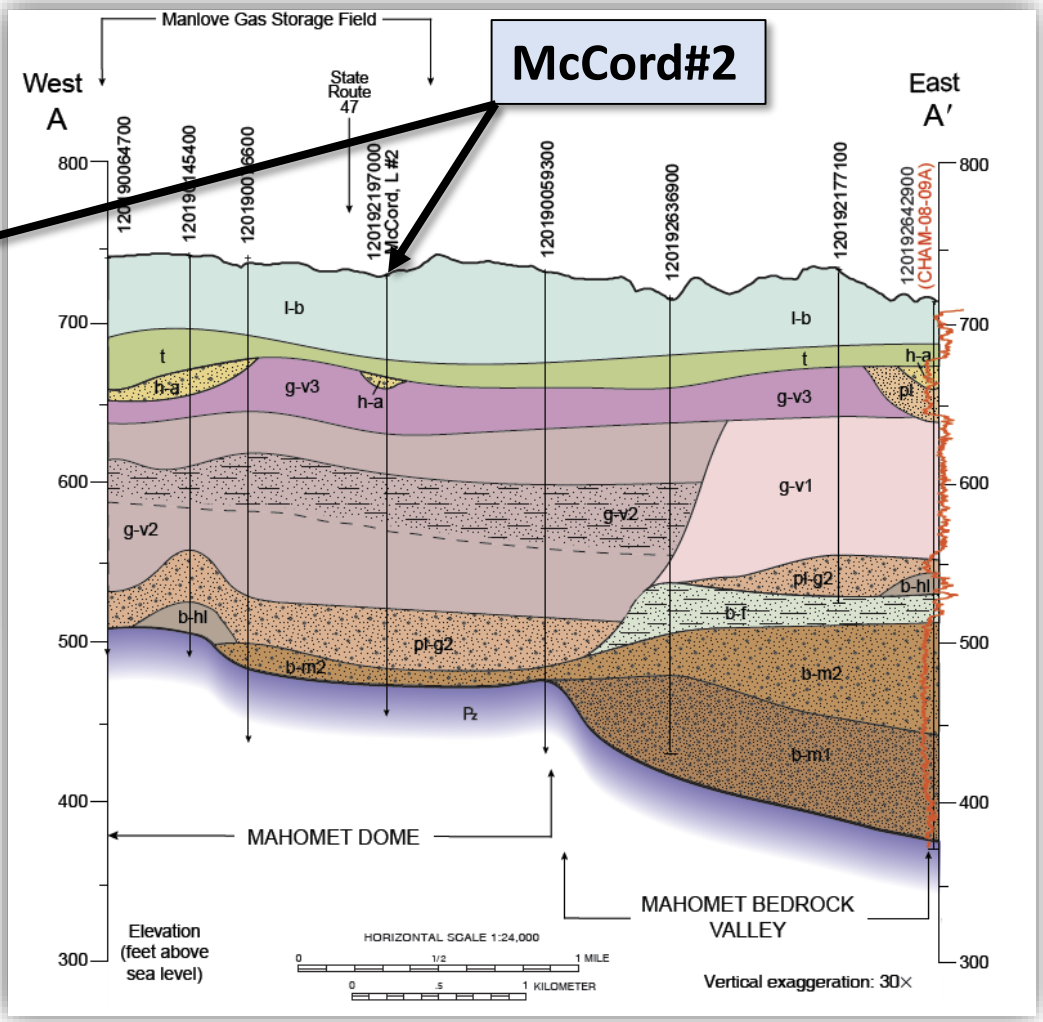
Supplementary Material

Location of McCord#2 and Shallow Geology





- Bedrock topographic surface map (above)
- Cross section A-A’ through shallow glacial deposits (to right)

From: University of Illinois, Prairie Research Institute, ISGS Special Report 6 (A. Stumpf; in final review, March 2018)