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Unlocking Geothermal Potential: Permitting Pathways for Repurposing Abandoned Oil and Gas Infrastructure in Oklahoma

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With growing global energy demands and heightened environmental concerns, renewable energy sources like geothermal energy are gaining increasing attention. However, the oil and gas (O&G) industry faces significant challenges in adopting green energy solutions due to cost, infrastructure limitations, and the complexities of environmental compliance. Additionally, thousands of inactive oil and gas wells require ongoing maintenance and eventual plugging, posing regulatory and financial burdens on operators.

This case study outlines the permitting and regulatory processes involved in converting two inactive O&G wells in Tuttle, Oklahoma, into a direct-use geothermal energy system. The project seeks to extract geothermal heat from the Haskell Formation at a depth of approximately 6,500 feet, where subsurface temperatures reach around 135°F. Energy will provide sustainable heating for local public schools, reducing dependence on conventional, high-emission energy sources.

Key to the project's viability is navigating Oklahoma's regulatory framework, particularly with respect to well repurposing, underground injection control (UIC) permits, and operational safety standards. The Anadarko Basin, characterized by a geothermal gradient of 1.57°F per 100 feet, offers a favorable setting for geothermal development. The project utilizes two existing wells.

This project illustrates a clear permitting pathway for converting end-of-life hydrocarbon assets into clean energy systems, aligning environmental stewardship with energy innovation. It offers a replicable model for similar geothermal repurposing projects nationwide.

Keywords: Geothermal permitting, repurposing, groundwater, O&G (Oil and Gas)

INTRODUCTION

The project will be developed in Tuttle, Grady County, Oklahoma. The project is located in the city of Tuttle, Oklahoma. In Figure 1, a site map of the project is presented. The wells are located inside the blue square.

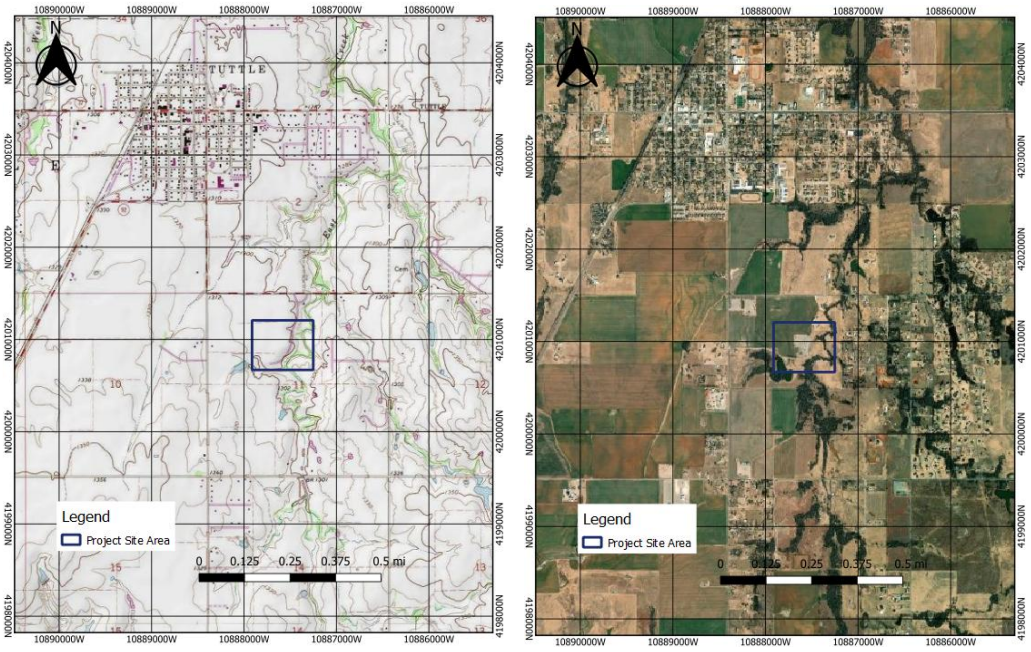


Figure 1: Tuttle project site map. Topographic map [left], and satellite map [right].

The cycling zone is placed in the Anadarko basin, which is a mature oil and gas basin. The typical reservoir rocks for hydrocarbons in the area are related to paleozoic formations. The Skinner, Hunton, Viola, and Mississippian groups are the usual targets for oil and gas production. However, since the project's objective is to access geothermal resources, the Haskell group is the primary target. Sandstones and limestones mostly compound Haskell formation rocks with porosities ranging from 8 to 17%, with permeability values between 0.2 to 100 mD. According to electric logs, water saturation is expected to be above 80%. According to the Oklahoma Geological Survey (OGS, 1984), the geothermal gradient in the study area is 1.57°F/100 ft. The bottom hole temperatures are expected to be in the order of 135°F.

The project's site in Tuttle, Oklahoma, was clearly defined through detailed topographic and satellite imagery, highlighting the well locations within a designated area to facilitate environmental and operational planning. The hydrogeology of the area is dominated by the White Horse Group, El Reno Group, and Hennessey Group. The project is in the El Reno minor aquifer, which is composed of reddish-brown shales, siltstones, and sandstones with thin persistent beds of gypsum and dolomite, as well as thick-bedded evaporite units interbedded with shale. These formations belong to the Permian-age formations.

A critical aspect of the permitting process involved assessing local groundwater resources and recharge zones, ensuring that the project minimized impacts on surrounding aquifers and maintained ecological balance, with close coordination with the Oklahoma Department of Environmental Quality (DEQ) to meet regulatory standards. The injection and monitoring strategy incorporated advanced safety measures, including automated alarms and shut-off systems that activated in response to deviations in pressure or flow rates, with immediate investigations to address any mechanical integrity issues, reflecting commitment to environmental protection and regulatory compliance as overseen by the DEQ.

The abandonment plan outlined a rigorous approach, requiring continuous cement plugs from the deepest point to the surface to prevent the migration of substances or hydrocarbons, with clear identification markings on the wellhead. Operators submitted closure plans well in advance of project cessation, detailing methods for managing contaminated materials, restoring the site to prevent erosion, and ensuring proper disposal of equipment, with completion targeted within a specified timeframe, all in alignment with DEQ requirements.

The project followed a structured approach starting with an introduction that outlined the objectives and geological context, setting the stage for the initiative. The process then progressed to establishing setting criteria, providing a foundation for site-specific planning with a detailed site map of Tuttle, Oklahoma, to define well locations. Subsequent steps included assessing groundwater resources and recharge areas to address environmental impacts, followed by evaluating existing wells and proposing new ones to ensure operational feasibility. The methodology extended to developing injection and monitoring plans, incorporating safety measures and mechanical integrity protocols, while addressing seismic risks and emergency procedures to mitigate potential hazards. The sequence continued with plans for corrective actions for undocumented wells, construction procedures if needed, and a comprehensive plugging and abandonment strategy to ensure long-term site stability. Finally, the process concluded with cost estimates and financial assurances to secure regulatory approval from the DEQ, reflecting a thorough and systematic permitting effort.

The broader impact of this project lay in its potential to revolutionize energy use by utilizing existing infrastructure in Tuttle, Oklahoma, reducing operational costs, and establishing a scalable model for geothermal energy adoption. The sedimentary basin's geothermal characteristics provided a promising foundation for meeting institutional energy needs, with possibilities for expansion to other public facilities. This collaboration between industry and academia not only advanced technological innovation but also offered hands-on learning experiences, bridging research with practical implementation.

1 TIMELINE OF PERMITTING PROCESS

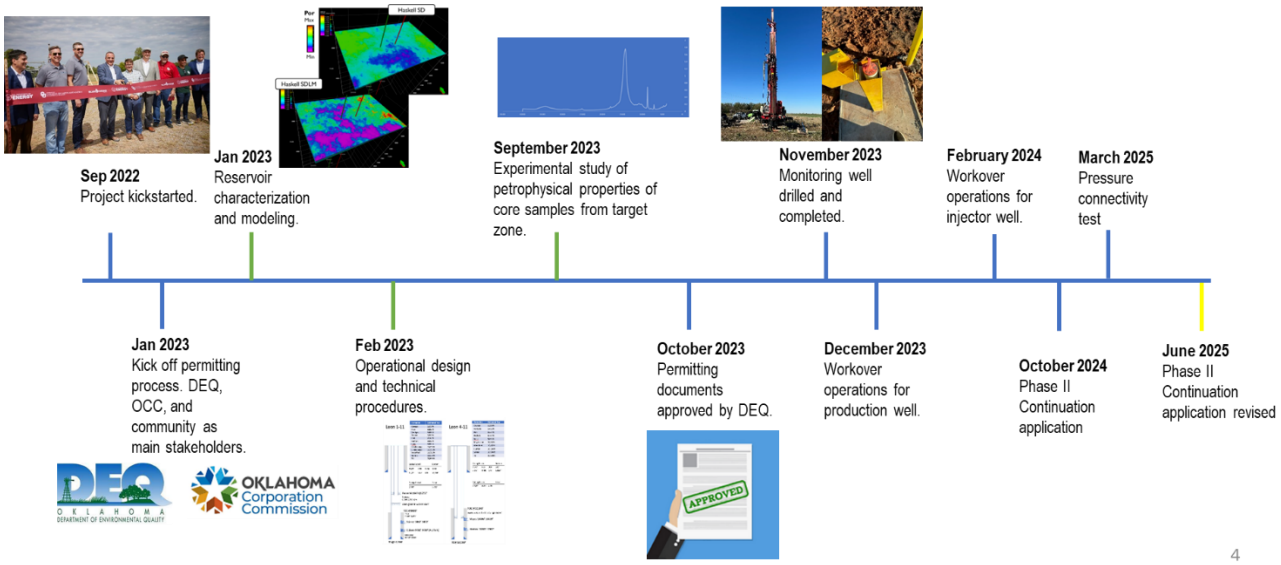


Figure 2: Project timeline and activities toward permitting process

The effort opened with a public-facing launch to establish awareness and invite early feedback from local officials, landowners, and community organizations (Figure 2). This step set expectations about why repurposing legacy oil and gas infrastructure for geothermal service matters, what activities would occur on the ground, and how safety and environmental protections would be handled. Next, the team then focused on building a subsurface picture using available geophysical data and targeted new surveys where gaps existed. Legacy well logs, production history, and public datasets were reconciled with mapping to outline formation tops, faults, and plausible flow paths between candidate wells. Temperature-at-depth proxies, thermal conductivity estimates, and pressure trends were compiled to bound circulation scenarios. Cuttings, cores, and fluids (where available) were analyzed for mineralogy, grain size, porosity/permeability, and thermal transport properties. The team built site-specific geologic and petrophysical framework to quantify the storage and deliverability of heat and fluid. Legacy well files (mud logs, wireline logs, cores/sidewalls, completion histories), production/injection records, and any available seismic attributes were reconciled to map structure, thickness, and connectivity of the target intervals. Data were quality-checked and fused with the geophysical interpretation to refine heat balance and injectivity forecasts. Throughout the technical work, the regulatory track ran in parallel with regular touchpoints. The environmental authority (DEQ) was engaged on matters related to injection and monitoring, while the oil and gas regulator (OCC) addressed production-well status, mechanical integrity, and any required sundry approvals. The Class V geothermal injection permit for the project was issued by the Oklahoma Department of Environmental Quality (Permit No. IW-V-26001-OP).

SUMMARY

In Oklahoma, this project advanced under a dual-track permitting pathway that is typical for repurposing legacy oil and gas wells for geothermal service: the state environmental authority (DEQ) oversees the injection well under the Underground Injection Control program while the oil and gas regulator (OCC) governs activities tied to the production/legacy well. For this site, the team kept continuous coordination with both agencies while completing the core elements of a Class V–style submittal—Area of Review and USDW mapping, updates to operating procedures, siting of groundwater monitoring wells, mechanical-integrity testing plans, injectate characterization, and a contingency/plug-and-abandon plan—paired with a public notice to inform local stakeholders. Early pre-application touchpoints proved essential to align classifications, data sufficiency, and review sequence. By contrast, other states such as Texas provide a helpful example of a more streamlined route: recent statutory and rule changes clarified geothermal ownership and consolidated much of the permitting for closed-loop geothermal wells under a single regulator, producing clearer checklists and faster decisions. Teams planning work in other states should assume greater variability and begin with rigorous due diligence—confirming agency of jurisdiction and UIC primacy, resource ownership, data expectations, public-notice triggers, and ancillary permits—before committing schedule and capital. Finally, projects that repurpose legacy oil and gas wells for geothermal service must foreground risk screening and well integrity before and during operations. A defensible program includes barrier verification (cement bond/ultrasonic imaging across confining units), deviation and caliper surveys, annular-pressure diagnostics for sustained casing pressure. In parallel,

teams should assess induced-seismicity risk from pressure/temperature changes and adopt a robust protocol with baseline microseismic monitoring, conservative initial setpoints, and shut-in thresholds. Hydrocarbon-release risk—from legacy fluids, re-entry work, or surface handling—requires spill prevention and response planning which are the other risks that need to be considered.

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