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Assessment of Water and Proppant Quantities Associated with Hydrocarbon Production from the Haynesville Formation Within the Onshore United States and State Waters of the Gulf Coast Basin, 2024

*B*uilding on a geology-based assessment of undiscovered, technically recoverable hydrocarbon resources within the Haynesville Formation, the U.S. Geological Survey estimated the water and proppant necessary for development of the remaining resources associated with the Haynesville Sabine Uplift Continuous Gas Assessment Unit. Additionally, projections have been made on the volume of wastewater expected as a byproduct of possible future development. This fact sheet presents an overview of the methodology, along with the inputs and results of the Haynesville Formation water and proppant assessment.

Introduction

The U.S. Geological Survey (USGS) assessed water and proppant requirements and formation water production associated with the possible future production of undiscovered oil and gas resources in the Jurassic Haynesville Formation in Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, and Florida (fig. 1). This water and proppant assessment is directly linked to the geology-based assessment of the undiscovered, technically recoverable oil and gas resources described by Gardner and others (2025).

The development of hydrocarbon resources in continuous assessment units (AUs) requires water. When drilling in mud, water is the primary component needed to reach the depths at which identified areas containing undiscovered, technically recoverable continuous resources occur within the Haynesville Formation (Gardner and others, 2025). Water is also required in the cementing process that secures casing and seals the wellbore. The greatest volume of water per well is consumed during hydraulic fracturing, which is a process involving high-pressure injection of fluid and proppant to create fractures in rock that enhance gas production from the reservoir.

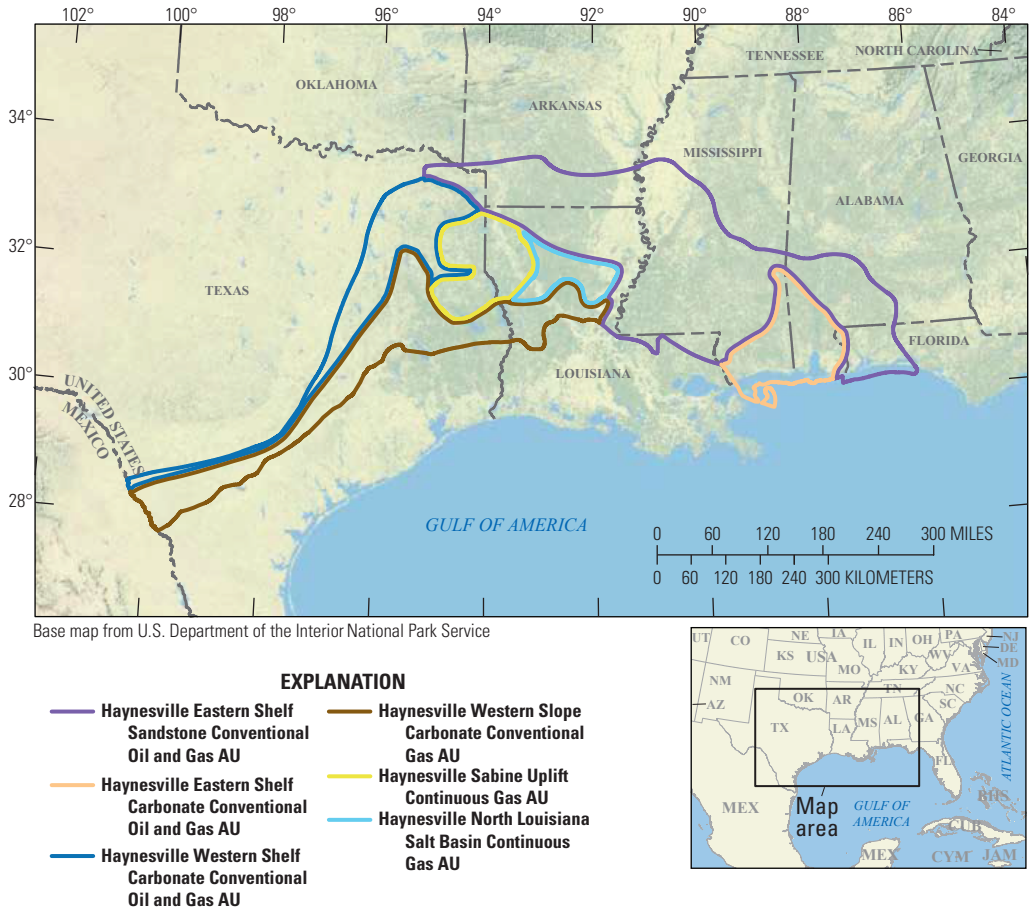

Figure 1. Map showing the location of four conventional and two continuous assessment units (AUs) in the Haynesville Formation (from Gardner and others, 2025). Only the Haynesville Sabine Uplift Continuous Gas AU, outlined in yellow, was suitable for a proppant and water assessment.

Water is also produced as a byproduct of gas production in the Haynesville Formation. This produced water includes flowback water, which returns to the surface after drilling and hydraulic fracturing operations, and formation water that originates from the Haynesville Formation reservoirs. Both types of water are considered wastewater and require treatment before potential reuse or disposal. In this study, we assessed formation water; assessing flowback water is not possible because of the lack of available monthly wastewater production data for the Haynesville Formation.

Assessment Approach and Input Values

The USGS methodology for assessing water and proppant requirements and water production associated with possible future production of oil and gas from continuous accumulations is described by Haines (2015). Input values for well drainage area, percentage of untested resources, well success rates, and estimated ultimate recovery per well are derived from the Haynesville Formation petroleum assessment (Gardner, 2026; Gardner and others, 2025), which followed the methodology of Charpentier and Cook (2010). Additional inputs for the water and proppant assessment include wells that are drilled and completed; water use for drilling, cementing, and hydraulic fracturing; number of fracturing treatments per well; proppant-to-water ratios; and produced water-to-gas ratios. These input values were determined using relations derived from S&P Global Commodity Insights (2024). All inputs are probabilistic distributions intended to capture the uncertainty in the exact values; the ranges for the inputs are shown in table 1 (Gardner, 2026). Probabilistic assessment outputs were generated using a Monte Carlo simulation approach described by Haines (2015). The Haynesville Sabine Uplift Continuous Gas AU is the only AU in the Haynesville Formation that was assessed for water and proppant, because the concepts and methodology apply only to continuous resources. The Haynesville Sabine Uplift Continuous Gas AU is the only AU that had associated water data.

Results of Water and Proppant Assessment

Results from this assessment are detailed in table 2, which presents distributions of estimated water and proppant requirements and total water production associated with developing the rest of the Haynesville Sabine Uplift Continuous Gas AU (Gardner and others, 2025). The assessment outputs are the estimated volumes of water required for drilling, cementing, and hydraulic fracturing, along with the quantity of required proppant and produced formation water presented in this fact sheet as the 95th fractile (F95), 50th fractile (F50), 5th fractile (F5), and the mean value.

Tables 3 and 4 supplement these findings with annual well drilling data from 2019 to 2023 (S&P Global Commodity Insights, 2024) by estimating the associated water and proppant volumes under various drilling scenarios based on mean assessment inputs. Table 5 relates the results with a comparison of water use for other purposes within the Haynesville Sabine Uplift Continuous Gas AU. Table 6 summarizes the mean values for the required water, proppant, and produced formation water to develop the undrilled part of the Haynesville Sabine Uplift Continuous Gas AU.

Table 1. Selected input values for the water and proppant assessment of the Haynesville Sabine Uplift Continuous Gas Assessment Unit.

[AU, assessment unit; %, percent; Mgal, million gallons; lb/gal, pound per gallon; gal/mcf, gallon per thousand cubic feet]

Assessment input values for the Haynesville Sabine Uplift Continuous Gas AU	Minimum	Mode	Maximum	Calculated mean
Unsuccessful wells that are drilled and completed (%)	0.1	1.5	3.0	1.2
Average water per well for drilling and cement (Mgal)	0.155	0.165	0.175	0.165
Average water per treatment for hydraulic fracturing (Mgal)	20	25	30	25
Average number of hydraulic fracturing treatments per well	1.0	1.0	1.01	1.003
Average proppant-to-water ratio for hydraulic fracturing (lb/gal)	0.9	1.05	1.2	1.05
Average produced water-to-gas ratio (gal/mcf)	0.8	1.2	2.0	1.33

Table 2. Assessment results showing resource requirements and formation water associated with production of the Haynesville Sabine Uplift Continuous Gas Assessment Unit.

[F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. AU, assessment unit; Mgal, million gallons]

Haynesville Sabine Uplift Continuous Gas AU result	Estimated total requirement and production			
	Water for drilling (Mgal)			
	F95	F50	F5	Mean
Water for drilling and cement (Mgal)	552	1,750	2,999	1,761
Water for hydraulic fracturing (Mgal)	83,522	265,100	456,493	267,059
Proppant for hydraulic fracturing (1,000 tons)	43,576	138,744	241,474	140,208
Produced formation water (Mgal)	14,926	48,400	92,014	50,282

Table 3. Historical number of wells drilled in the Haynesville Sabine Uplift Continuous Gas Assessment Unit during each year from 2019 to 2023 and quantities of water, proppant, and water coproduced potentially associated with drilling and completing 10 hypothetical wells.

[Mgal, million gallons]

Historical drilling[1] (number of wells drilled each year)					Corequirements and coproduction for several hypothetical annual drilling totals for 10 wells		
2019	2020	2021	2022	2023	Total required water (Mgal)	Total water coproduced (Mgal)	Required proppant (1,000 tons)
413	360	486	684	503	252	47	131

[1]From S&P Global Commodity Insights (2024).

Table 4. Quantities of water, proppant, and water coproduced potentially associated with several hypothetical future annual drilling rates.

[Mgal, million gallons]

Corequirements and coproduction for several hypothetical annual drilling totals								
100 wells			1,000 wells			5,000 wells		
Required water (Mgal)	Total water coproduced (Mgal)	Required proppant (1,000 tons)	Required water (Mgal)	Total water coproduced (Mgal)	Required proppant (1,000 tons)	Required water (Mgal)	Total water coproduced (Mgal)	Required proppant (1,000 tons)
2,517	471	1,313	25,168	4,708	13,127	125,841	23,538	65,634

Table 5. Water quantities produced, withdrawn, and used for various purposes within the area of the Haynesville Sabine Uplift Continuous Gas Assessment Unit.

[Oil and gas total produced water is the mean annual production total from 2019 to 2023 for all producing formations within the assessment unit map area. Surface water withdrawal, groundwater withdrawal, and water use are 2015 annual totals. Mgal, million gallons]

Oil and gas total produced water[1] (Mgal)	Surface water[2] withdrawal	Groundwater[2] withdrawal	Water use[2]			
			Agriculture (Mgal)	Industrial (Mgal)	Municipal (Mgal)	Thermoelectric (Mgal)
9,817	296,526	33,143	13,502	28,875	37,617	249,675

[1]From S&P Global Commodity Insights (2024).

[2]From Dieter and others (2018).

Table 6. Water demand, proppant demand, and water production per unit of undiscovered, technically recoverable gas based on mean values of the assessment outputs in the Haynesville Sabine Uplift Continuous Gas Assessment Unit.

[BCFG, billion cubic feet of gas; Mgal/bcf, million gallons per billion cubic feet; tons/bcf, tons per billion cubic feet]

Total undiscovered gas[1] (BCFG)	Water requirement per unit gas (Mgal/bcf)	Proppant requirement per unit gas (1,000 tons/bcf)	Flowback water production per unit gas (Mgal/bcf)	Total formation water per unit gas (Mgal/bcf)
Mean	Mean	Mean	Mean	Mean
37,643	7.14	3.72	Insufficient data	1.34

[1]From Gardner and others (2025).

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For More Information

Assessment results are also available at the USGS Energy Resources Program website, https://www.usgs.gov/programs/energy-resources-program.

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