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Delivering Australia's biggest frac: a step change in sand logistics and automated bulk handling systems in the remote Beetaloo Basin

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ABSTRACT

This paper explains the sand logistics and handling innovations that enabled Australia's largest hydraulic fracture stimulation, placing 22.5 million pounds of sand across 67 stages in the remote Beetaloo Basin. The scale nearly doubled the previous national record and required breakthrough supply chain coordination and last-mile handling to sustain 24-h operations at pump rates above 100 barrels per minute. Sand logistics were coordinated across dual supply chains from South Australia and Queensland, with triple-trailer loads travelling up to 2700 km to site. A shift from conventional 2-tonne bags to bulk stockpile management eliminated crane-intensive loading and de-bottlenecked supply, enabling continuous large-scale stimulation. Australia's first automated wet-sand conveyor system was deployed, providing uninterrupted feed from stockpiles to Halliburton's blender systems at rates exceeding 8000 lbs per minute. This supported pumping at designed concentrations and six stages per day, with each stage consuming about 400,000 pounds of sand. Bulk handling reduced manual labour, improved efficiency, eliminated weather-related sand saturation, and freed critical pad space previously filled with thousands of bags. Efficiency gains included removal of crane use, reduced double handling, and lower personnel exposure. The system achieved 98% uptime during the 20-day campaign while safely handling 11,000 tonnes of sand with zero HSE incidents. The paper concludes by discussing how this innovation enables future scalable development in the Beetaloo Basin, with capacity to support 10–12 stages per day in future wells as frac spread uptime improves with zipper fracture stimulations.

Keywords: automation, Beetaloo Basin, bulk handling, conveyor systems, hydraulic fracturing, proppant logistics, shale gas, unconventional resources.

Introduction

The Beetaloo Basin, located in Australia's Northern Territory approximately 600 km southeast of Darwin, represents one of the most significant unconventional gas opportunities in the Asia-Pacific region. With estimated recoverable resources exceeding 200 trillion cubic feet of gas (Northern Territory Government 2018), the basin has the potential to transform Australia's energy landscape and make a meaningful contribution to addressing domestic energy security concerns. However, unlocking this resource requires overcoming substantial operational and logistical challenges unlike any previous Australian petroleum operations.

Australia has developed a strong track record in remote operations across oil and gas and mining sectors. However, the Beetaloo Basin presents unique challenges that significantly impact operational logistics. This basin is even more remote than typical Australian plays, and the required hydraulic fracturing operations are substantially larger than anything previously conducted in the country. The nearest oilfield supply bases are approximately 3 days' truck travel away, and tropical wet seasons flood roads for several months each year, constraining the operational window to the dry season from approximately May to November.

The scale of operations required for economic shale gas development greatly increases demand for fracturing spreads, proppant, chemicals, water, accommodation camps, coiled tubing units, crews, wireline services, fuel, and equipment – far exceeding anything previously attempted in Australia. To put this in context, typical Australian coal seam gas fracturing

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operations use approximately 50,000 pounds of sand per well, while conventional Cooper Basin operations use approximately 200,000 pounds. In contrast, modern Beetaloo horizontal wells require 20–25 million pounds of proppant per well – more than 400 times a typical coal seam gas job. While such operations have become routine in United States shale plays, this scale had not been previously undertaken in Australia.

This paper presents a detailed case study of the Carpentaria-5H (C5H) fracture stimulation campaign, which established a new benchmark as Australia's largest hydraulic fracturing operation. The campaign successfully placed approximately 22 million pounds (11,000 tonnes) of proppant across 67 stages, nearly doubling the previous national record set by the Carpentaria-3H (C3H) well in 2023. Central to this achievement was a step change approach to sand logistics and last-mile handling that transformed operational efficiency. The paper documents the evolution from conventional bag-based sand handling to Australia's first automated wet-sand conveyor system, analyses performance results, presents lessons learned, and discusses implications for future development, including the pathway to zipper fracturing operations.

Background

The Beetaloo Basin

The Beetaloo Basin is characterised by its extreme remoteness, with limited infrastructure and minimal local services. Located approximately 600 km southeast of Darwin in the Northern Territory, the region experiences a tropical climate with distinct wet and dry seasons. The wet season typically impacts operations from December to February, renders many roads impassable and generally halts drilling and completion operations. This seasonal constraint compresses the operational window and places significant pressure on logistics planning and execution.

The target formation is the Middle Velkerri Shale, a Mesoproterozoic organic-rich marine shale comprising the A, B, and C shale members. These formations are accessed at depths of 1500–2000 m true vertical depth, with horizontal laterals extending several kilometres through the target intervals. The Velkerri Shale exhibits favourable characteristics for unconventional development, including high total organic carbon content, thermal maturity in the gas window, and sufficient brittleness for hydraulic fracturing. CSIRO's Strategic Regional Environmental and Baseline Assessment (CSIRO 2021) confirmed minimal risk to water resources from extraction activities, with the Cambrian Limestone aquifer providing adequate water supply for operations while maintaining separation from productive formations.

Operator history and well progression

Empire Energy (now Beetaloo Energy) and InGauge Energy have been at the forefront of Beetaloo Basin development since 2020, systematically advancing both drilling and completion capabilities through a series of increasingly ambitious wells. Each successive operation has built upon lessons learned from previous campaigns, progressively demonstrating the scalability required for commercial development.

The Carpentaria-1 (C1) vertical exploration well was drilled in 2020–2021 and successfully stimulated across four stages with 1.4 million pounds of proppant. This initial well provided crucial formation evaluation data and confirmed the presence of gas in commercial quantities within the Velkerri B Shale interval. The relatively modest stimulation programme was appropriate for a vertical appraisal well and established baseline operational procedures for the remote location.

Carpentaria-2H (C2H), drilled in 2021–2022, represented the operator's first horizontal well in the basin. The well featured a 1345-m lateral section and placed 6.3 million pounds of proppant across 21 stages – the largest fracture stimulation in the Beetaloo at that time. The C2H established that horizontal drilling and multi-stage hydraulic fracturing could be successfully executed in the Beetaloo, achieving gas production rates that supported continued appraisal investment.

The C3H well, completed in 2022–2023, represented a step-change in operational scale. The well was drilled to 4460-m measured depth with a 2632-m horizontal section targeting the Velkerri B Shale. The fracture stimulation campaign successfully placed 12.9 million pounds of proppant across 40 stages at an intensity of 1956 lbs/ft (Empire Energy Group Limited 2023). This operation doubled the size of C2H and established a new Australian record for hydraulic fracturing scale. The campaign achieved two to three stages per day at pump rates up to 80 bbl/min during the 35-day operation, which was conducted on a 12-h operational schedule.

Carpentaria-4 (C4), drilled in 2022, was a vertical appraisal well to approximately 2000 m targeting additional formation evaluation and delineation of the resource extent.

The C5H well, the subject of this paper, was drilled in late 2024 and completed in early 2025. The well reached 5310-m measured depth featuring a 3310-m horizontal section – the longest lateral in Australian shale operations. The fracture stimulation campaign successfully placed approximately 22 million pounds across 67 stages at an intensity of 2295 lbs/ft, establishing a new record as Australia's largest fracture stimulation and nearly doubling the previous C3H record (Beetaloo Energy Ltd 2025). Table 1 summarises the progression of well parameters across the Carpentaria programme.

Sand logistics challenges

Scale of proppant requirements

The C3H campaign used approximately 12.9 million pounds (6300 tonnes) of sand, a volume roughly equivalent to Australia's entire annual frac sand production capacity at that time. This single well consumed more proppant than the cumulative total of all other Australian fracturing operations in the preceding

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Table 1. Carpentaria well programme progression.

Well	Year	MD (m)	Lateral (m)	Stages	Sand (MM lbs)	Intensity (lbs/ft)
C1	2020–21	~2000	Vertical	4	1.4	N/A
C2H	2021–22	~3350	1345	21	6.3	~1430
C3H	2022–23	4460	2632	40	12.9	1956
C4	2022	~2000	Vertical	–	–	–
C5H	2024–25	5310	3310	67	22.0	2295

C4 was a vertical appraisal well without fracture stimulation.
MD, measured depth; MM lbs, million pounds; lbs/ft, pounds per foot.

year. The C5H campaign nearly doubled this volume, requiring approximately 11,000 tonnes of proppant to execute the 67-stage stimulation programme.

The proppant blend for C5H was designed to optimise fracture conductivity across the treatment stages. The blend consisted of a combination of 100-mesh and coarser 40/70-mesh sand. Sand concentrations were increased during each stage to provide near-wellbore conductivity. This blend ratio reflects industry best practices developed in US shale plays and optimised for the Velkerri Shale properties.

Supply chain coordination

For C3H, all sand was sourced from a single supplier in South Australia, requiring transportation over approximately 2700 km of highway and outback roads. While this approach simplified supplier management, it created supply concentration risk and logistical challenges when delivery schedules were disrupted.

For C5H, a dual-source supply chain strategy was implemented to provide redundancy and improve supply security. This included sourcing sand from both South Australia and Queensland. This dual-source approach required additional coordination complexity but provided critical insurance against supply disruptions and enabled a more flexible delivery scheduling.

Transportation requirements

For C3H, triple-trailer road train loads were required to deliver all proppant, accumulating approximately 540,000 km of road travel across the campaign, with round-trip times from South Australian sources averaging 5–6 days including loading, transit, and unloading.

For C5H, the Queensland-sourced sand reduced average haul distances for a portion of the 100-mesh requirement; however, distances from South Australian sources remained at approximately 2700 km. The extended haul distances magnified both cost and safety concerns, requiring careful coordination with Traditional Owners, pastoralists, and community stakeholders along the transport corridors. Despite these challenges, all sand was successfully delivered and utilised without incident, representing a significant logistical achievement (Fig. 1).

Last-mile sand handling

Conventional bag method (C3H)

For C3H, sand was delivered in conventional 2-tonne bulk bags (also known as flexible intermediate bulk containers). This approach represented standard Australian industry practice at the time but created significant operational constraints when applied at the scale required for a 40-stage horizontal shale completion.

Each bag required lifting by crane, positioning over hoppers, and manual cutting to release sand into the blending system. This process required a 24-h crew with constant crane operation throughout pumping operations, and continuing overnight to stock the sand chief storage units, with operators handling thousands of bags over the 35-day campaign. A dedicated sand loading crew worked continuously, creating fatigue management challenges and representing a single point of failure for operations.

Pad space was extensively consumed by rows of stacked bags, also extending onto adjacent leases. The bag storage area required protective covering with tarps to prevent rain saturation during unexpected weather events. Despite these precautions, exposure to wet-season rain meant tarped bags risked saturation and clumping, potentially rendering sand unusable and creating disposal challenges. Most critically, crane cycles could not keep pace with higher pumping schedules, constraining operations to two to three stages per day maximum despite 24-h operations.

Bulk stockpile and conveyor system (C5H)

For C5H, a fundamentally different approach was implemented: bulk sand stockpiles fed by automated conveyor systems. This represented the first successful deployment of an automated wet-proppant conveyor delivery system in Australia and drew on technologies proven in US shale operations but adapted for the unique challenges of the Beetaloo environment.

Sand was stockpiled directly on protective matting in large open piles, eliminating the need for individual bag handling entirely. A purpose-built bunker system with separation walls maintained segregation between 100-mesh and 40/70-mesh sand, preventing cross-contamination while enabling efficient access by front-end loaders and conveyor systems. The bunker walls were designed with sufficient height to contain the stockpiles while allowing loader access for sand transfer to the conveyor system.

The conveyor system fed sand continuously from stockpiles into Halliburton's automated sand delivery system (commonly referred to as a 'sand crane' or 'big box conveyor'), which integrated directly with the fracturing spread's blending system. The system comprised two primary feeder belts providing redundancy, one main sand crane hopper with integrated scales for real-time inventory control, automated belt speed controls, and a backup belt system that was deployed mid-campaign when maintenance was required on a primary belt.

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Fig. 1. Sand supply routes for C5H showing dual-source supply chain from South Australia (~2700 km) and Queensland (~1800 km) to the Beetaloo Basin operational site. Courtesy of GoogleMaps.

Real-time sand tracking was achieved through multiple measurement points. Halliburton's downhole flowmeters produced calculated sand concentrations that were compared against blender tub density readings. These data points, combined with design pump schedules, determined required belt speeds. Front-end loaders equipped with onboard load sensors transferred sand from stockpiles to feeder belts, with operators guided by a large digital displays and a proprietary system developed to communicate weight and indicate loading urgency to ensure sand delivery matched the frac spread requirement (Fig. 2).

Operational benefits of bulk handling

The automated conveyor system delivered sand at rates exceeding 8000 lbs per minute (approximately 3.6 tonnes per minute), removing sand handling as a bottleneck and enabling operations to achieve over five stages per day with peaks of six stages – more than double the rate achieved with bag handling on C3H. This throughput capability provided margin above the actual pump requirements, ensuring sand supply never constrained pumping operations.

Bulk handling dramatically reduced manual labour requirements by eliminating the need for continuous crane operation and bag cutting crews. The system required only front-end loader operators to maintain stockpile-to-conveyor transfer, with the remainder of the process fully automated. This freed personnel for other critical operations and reduced fatigue-related risks.

The wet sand handling approach – already proven in some US basins including the Marcellus and Haynesville – enabled resilient operations in the tropical Beetaloo climate. Unlike bagged sand, which can become saturated and clump when

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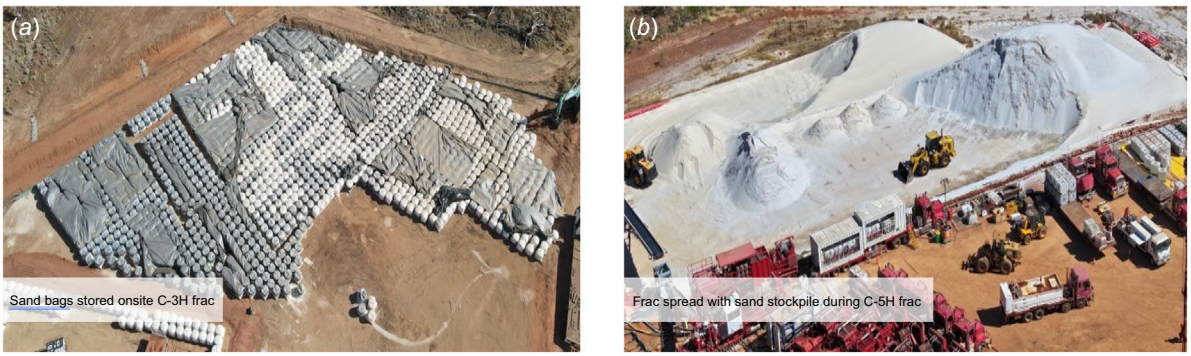


Fig. 2. Comparison of sand handling methods. (*a*) Conventional 1-tonne bag storage during C3H operations showing extensive pad space consumption and crane positioning. (*b*) Bulk stockpile with automated conveyor system during C5H operations showing bunker segregation and integrated feed to blender.

exposed to rain, bulk stockpiles drain naturally and can continue to be used even during or immediately after rain events. This eliminated weather-related sand loss and reduced operational downtime risk.

C5H fracture stimulation campaign

Well design and construction

The C5H well was spudded on 16 November 2024 using Ensign Rig 965. The well was drilled offset west of the existing C2H wellbore, deliberately positioned for future multi-well pad development and potential zipper fracturing operations. This offset distance was selected based on US basin experience with consideration given to stress shadow effects and production interference management.

The well reached total depth of 5310-m measured depth (1518-m true vertical depth) in 34 days from spud to rig release on 27 December 2024. The 8½ in. horizontal section extended 3310 m through the Velkerri B Shale target interval, representing the longest lateral drilled in Australian shale operations to date. Production casing of 5½ in., 23 ppf, P110S grade was run and cemented to 5302.6 m measured depth. Table 2 summarises key well parameters.

Table 2. C5H well data summary.

Parameter	Value
Well type	Horizontal shale gas appraisal well
Permit area	EP187
Spud date	16 November 2024
Rig release date	27 December 2024
Total MD/TVD	5310 m MD/1518 m TVD
Lateral length	3310 m (8½ in. section)
Target formation	Velkerri B Shale
Production casing	5½ in., 23 ppf, P110S to 5302.6 m MD
Bottom hole temperature	~75°C
Offset from C2H	450 m west

MD, measured depth; TVD, true vertical depth; ppf, pounds per foot.

Stimulation design and execution

The C5H stimulation programme targeted approximately 3000 m of horizontal wellbore using plug-and-perf methodology. The campaign was executed over 20 days of continuous 24-h operations – one of the first sustained 24-h fracturing operation in Australia. This represented a significant operational advancement from the 12-h schedule used on C3H, requiring enhanced crew rotations, lighting infrastructure, and safety management protocols for night operations.

Pre-stimulation verification activities included wireline cement bond log confirming satisfactory cement quality behind casing, and casing pressure tests to 8500 and 11,000 psi verifying casing integrity for the planned treatment pressures.

Sixty-seven pump-down plug-and-perf assemblies were run over the campaign. Dissolvable plugs were selected to minimise post-stimulation intervention requirements, with the composite plug used at the heel position where milling was most straightforward.

Cluster configuration was varied across the lateral based on formation properties and completion design optimisation. A variation of six, seven, and eight cluster stages were executed, with some variations to spacing. This variable cluster design reflected learnings from earlier stages and ongoing design optimisation for future campaigns.

Pumping operations achieved sustained rates exceeding 105 bbl/min with Halliburton as the pumping service provider, representing a significant increase from the ~80 bbl/min achieved on C3H. This higher rate capability, combined with the 24-h operational schedule and bulk sand handling, enabled the >5 stages per day performance. Total proppant intensity averaged 2295 lbs/ft, higher than the 1956 lbs/ft achieved on C3H, reflecting continued design optimisation for the Velkerri Shale.

The campaign stimulated 67 stages, with approximately 22 million pounds (10,109 tonnes measured at blender) of

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total proppant placed and total fluid volume of approximately 85 ML, which was a blend of local groundwater borewater and treated produced water (Fig. 3).

Results and performance

Sand handling system performance

The bulk sand handling system achieved exceptional performance throughout the 20-day campaign. The purpose built system of real-time tracking through integrated scales enabled continuous comparison of design volumes, feeder belt measurements, and Halliburton blender and downstream measurements, providing multiple verification points for sand inventory management. Fig. 4 summarises the percentage difference between the sand volumes calculated by Halliburton vs Ingauge, stage by stage.

Overall the reliability of the integrated scale system was verified with the following cumulative delta to Halliburton volume data, providing confidence that the system can accurately feed complex multi-sand grade fracture designs:

i. 0.262% on 100-mesh
ii. 1.061% on 40/70-mesh

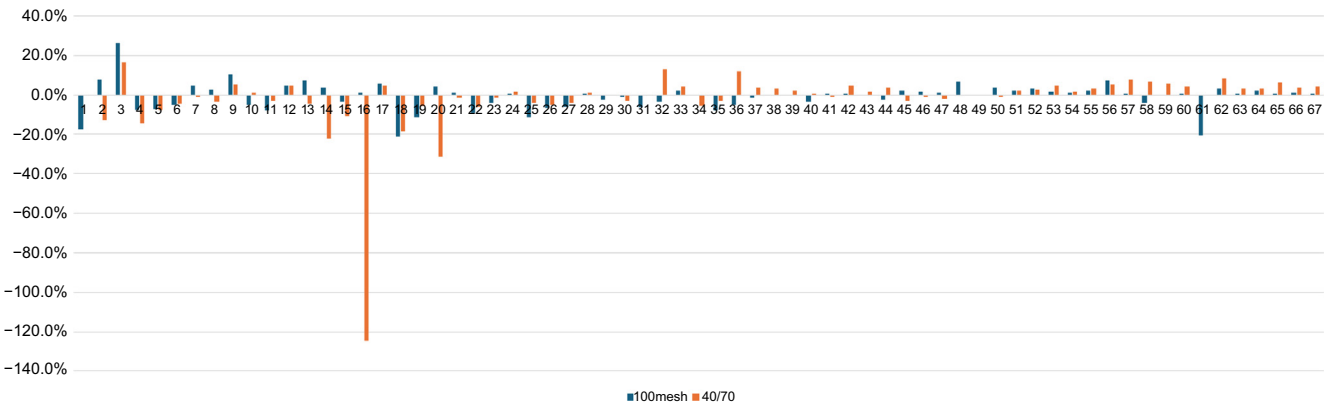


Fig. 3. Comparison of % delta between Halliburton and Ingauge sand utilisation by stage.

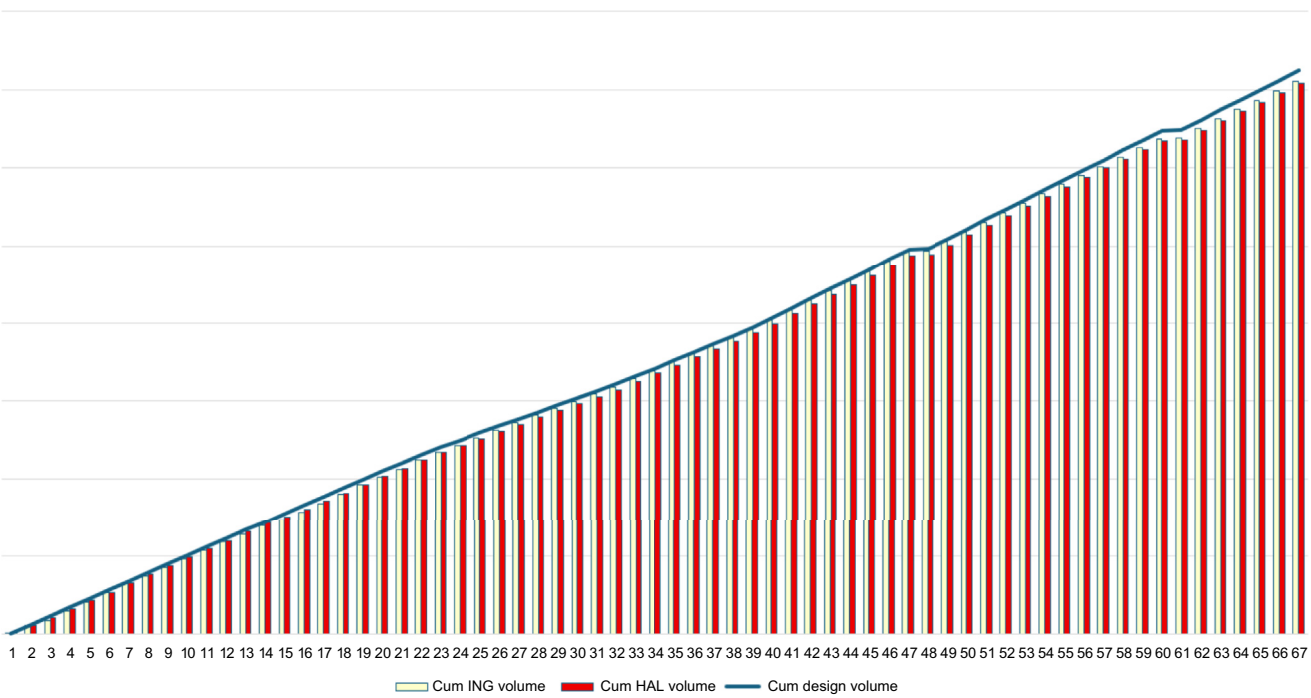


Fig. 4. Cumulative 100-mesh sand tracked (tonnes) over the campaign stages, compared to the job design.

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The higher uncertainty percentage for 40/70-mesh sand is attributed to some software calibration issues for the coarser sand, and some variations in sand moisture content.

The sand bunker was successfully designed for safe unloading of trailers, and containment of two separate sand types. The final estimated losses to the storage system was approximately 2.9%. This includes theoretical losses of 2% for 100-mesh and 5% for 40/70-mesh sand. The 40/70-mesh sand was delivered 6 months prior to the campaign execution date, and exposed to the weather during this time (Fig. 5).

Operational efficiency comparison

Table 3 provides a comprehensive comparison of operational parameters between the C3H and C5H campaigns, highlighting the step-change in performance enabled by the bulk handling system and 24-h operations.

Despite completing 67% more stages and placing 70% more proppant than C3H, the C5H campaign was completed in 20 days compared to 35 days – a 43% reduction in campaign duration. The bulk handling system achieved approximately 98% uptime throughout the campaign, contributing zero hours of sand-handling-related non-productive time. All operations were completed with zero health, safety, and environment recordable incidents, maintaining the strong safety record established across the Carpentaria programme.

Table 3. Comparison of C3H and C5H fracture stimulation campaigns.

Parameter	C3H	C5H
Lateral length (m)	2632	3310
Number of stages	40	67
Total proppant (MM lbs)	12.9	22.0
Proppant intensity (lbs/ft)	1956	2295
Maximum pump rate (bbl/min)	~80	>105
Campaign duration (days)	35	20
Average stages per day	2–3	>5
Peak stages per day	3	6
Operating schedule	12-h	24-h
Sand handling method	1-tonne bags	Bulk/conveyor
Pumping service provider	SLB	Halliburton
HSE incidents	0	0

MM lbs, million pounds; lbs/ft, pounds per foot; bbl/min, barrels per minute; HSE, health, safety, and environment.

Discussion

Lessons learned

The C5H campaign provided numerous insights for future operations. Table 4 summarises key lessons learned and recommended actions for subsequent campaigns.

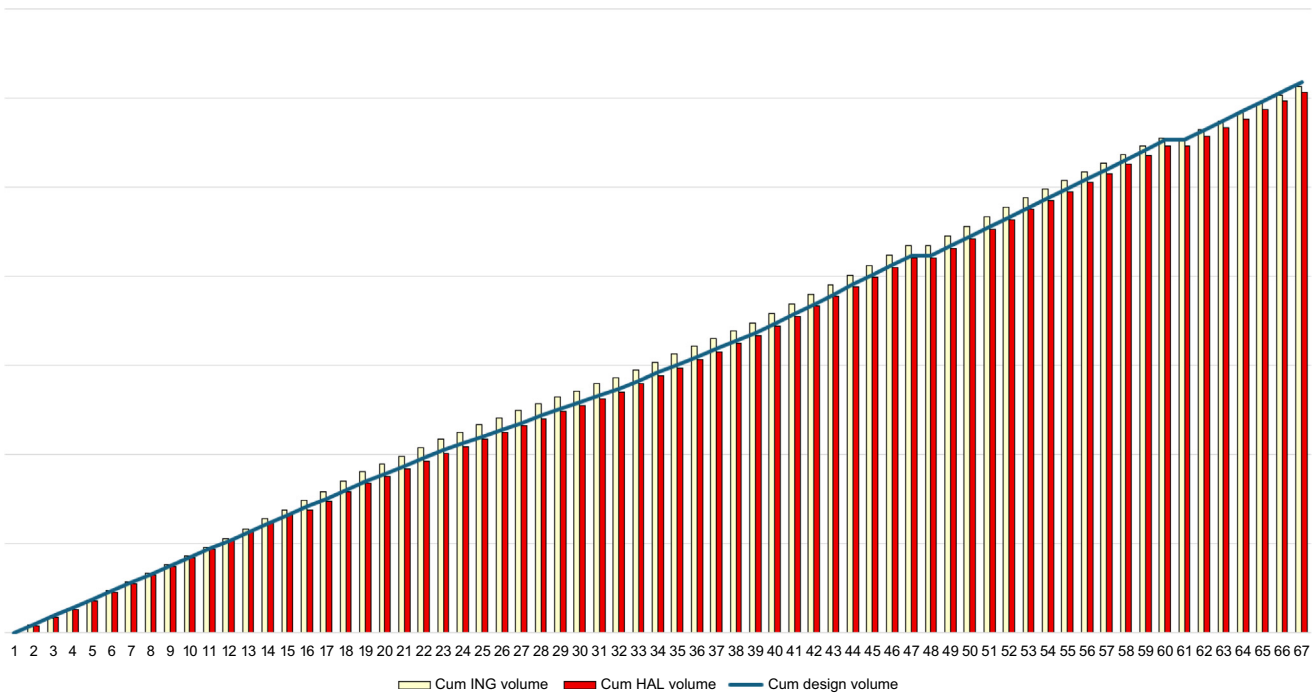


Fig. 5. Cumulative 40/70-mesh sand tracked (tonnes) over the campaign stages, compared to the job design.

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Table 4. Key lessons learned and recommendations.

Element	Observation	Recommendation
Blender calibration	Wet sand density varies by source, mesh size, and position in pile	Separate pre-job calibration for each sand type and regular sand sampling
Hopper capacity	Buffer time limited during high-rate operations	Larger hopper or dual hopper configuration
Feed control	Communication between blender and loader operators	Developed automated feedback loop for belt speed control
Inventory tracking	Stockpile volume estimation challenging with irregular pile shapes	Implement drone/LiDAR for real-time stockpile volume management
Bunker design	Wind-blown fines loss from open stockpiles	Higher separation walls with wind breaks
Belt redundancy	Backup belt required mid-campaign for maintenance	Maintain dual belt capability as standard configuration

Future outlook: zipper fracturing potential

Zipper fracturing – widely adopted in US shale plays over the past decade – involves alternating pumping and wireline operations between two or more wells on the same pad, enabling one well to be stimulated while wireline operations (plug setting and perforating) occur on the adjacent well.

Experience in the Eagle Ford Shale demonstrated that zipper fracturing can increase stage completion rates from 3–4 (single well operations) to 6–8 stages per day (Patel *et al.* 2016). This efficiency gain results from elimination of wireline wait time during pumping operations, with the pumping crew able to maintain nearly continuous operations by alternating between wells. Additional benefits include potential for improved fracture complexity through stress interaction between simultaneously pressurised wells.

More advanced simultaneous fracturing (simul-frac) techniques, where two wells are pumped simultaneously using a single equipment spread, have demonstrated even greater efficiency improvements. Case studies from the Permian Basin by SLB have documented 60% increases in stages per day and 35% increases in sand pumped per day compared to conventional zipper operations, with overall time savings of approximately 30% and cost reductions of 3–6% on multi-well pads.

With the bulk sand handling infrastructure proven on C5H, future multi-well developments in the Beetaloo are positioned to achieve 10–12 stages per day through zipper or simul-frac operations. Key enablers already demonstrated include elimination of sand handling as a rate-limiting step through bulk conveyor systems, demonstrated 24-h operational capability with appropriate crew rotations and safety management, high-volume bulk sand delivery systems capable of sustained >8000 lbs/min throughput, and pad infrastructure designed for multi-well access.

Local sand sourcing opportunities

Local sand sourcing represents potentially the single largest cost reduction opportunity for Beetaloo Basin development. Current haul distances of up to 2700 km from South Australian and Queensland sources create significant cost burdens (transport represents a substantial portion of delivered sand cost), safety exposure through extended road travel, community and stakeholder management challenges along transport corridors, and supply chain vulnerability to weather and road conditions.

Industry participants are actively exploring potential sand sources within the Northern Territory that could dramatically reduce transport distances. Development of local sources would require identification of deposits meeting quality specifications, mining approval processes including environmental assessment and Traditional Owner engagement, processing infrastructure development, and management pathways for off-specification material.

Infrastructure development pathway

Transition from appraisal to development phase will require significant infrastructure investment. Current operations are impacted outside of the dry season (approximately April–November) due to wet-season road conditions. All-weather road infrastructure would enable year-round operations, improving equipment utilisation and accelerating development timelines. Permanent accommodation camps would reduce mobilisation costs and enable maintenance of a trained local workforce. Local supply bases would reduce the current 3-day resupply times from Darwin, and field-wide water pipeline networks would replace current lease-based systems.

The regulatory framework in the Northern Territory requires detailed Environmental Management Plans (EMPs) that specify operational parameters years in advance, creating challenges when completion designs continue to evolve through the appraisal phase. Successful navigation of this framework requires early and sustained engagement with regulators and development of EMP language that provides operational flexibility within clearly defined environmental boundaries.

Summary and conclusions

The C5H fracture stimulation campaign demonstrates that mega-scale hydraulic fracturing operations can be successfully executed in remote, logistically challenging environments through innovation in sand logistics and last-mile handling. The successful placement of approximately 22 million pounds of proppant across 67 stages established a new Australian benchmark, nearly doubling the previous national record set by C3H just two years earlier.

The dual-source supply chain coordinating road train loads over distances up to 2700 km proved that high-volume proppant logistics can be executed reliably even in Australia's most remote operating environment. The innovation in last-mile handling – transitioning from conventional large bags

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to bulk stockpiles fed by Australia's first automated wet-sand conveyor system – transformed operational capability from a constraint to an enabler.

The bulk handling system achieved 98% uptime throughout the 20-day campaign, contributed zero sand-handling-related non-productive time, and enabled sustained operations at over five stages per day with peaks of six – more than double the rates achieved with conventional bag handling on C3H. The system safely handled over 11,000 tonnes of sand with zero health, safety, and environment recordable incidents, while eliminating weather-related sand loss risk and dramatically reducing pad space requirements.

The proven bulk handling infrastructure, combined with multi-well pad positioning and demonstrated 24-h operational capability, allows the platform to achieve 10–12 stages per day through zipper fracturing as development scales. With continued focus on local sand sourcing, infrastructure development, and operational optimisation, the Australian unconventional industry is positioned to transform mega-scale hydraulic fracturing from a record-setting achievement into standard practice, progressively unlocking the Beetaloo Basin's significant gas resources to contribute to Australia's energy security.

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Data availability. The data that support this study were obtained from Beetaloo Energy Ltd and InGauge Energy Pty Ltd. Data can be shared upon reasonable request to the corresponding author with permission from the data custodians.

Conflicts of interest. T Ahmad, K Wuttke, J Bennett, and D Baggio are employees of InGauge Energy Pty Ltd. C. White is an employee of Beetaloo Energy Ltd. InGauge Energy Pty Ltd provided operational and engineering services for the well operations described in this paper.

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Kelvin Wuttke is one of the Directors at inGauge Energy. Kelvin is a Drilling and Completions Engineer with over 30 years of experience in the oil and gas industry, encompassing onshore, offshore, and conventional and CSG operations. With a wealth of leadership roles with Egis, Chevron, Santos, and inGauge his expertise spans drilling and completions design, well integrity, stimulation, workovers, artificial lift, and pipeline operations. Kelvin has successfully managed complex projects including international offshore operations, conventional onshore projects in the Cooper Basin, and unconventional CSG and shale developments in Queensland and the Northern Territory, including combined drilling, completion, and stimulation activities, fracture stimulation, remediation workovers, underbalanced drilling, and abandonments. His ability to integrate technical knowledge with project execution ensures cost-effective and efficient delivery and affirms his status as a trusted advisor to our clients. As a Chartered Professional Engineer, Kelvin holds a Bachelor of Engineering (Mechanical) and a Master of Business Administration.

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Chris White is Chief Operating Officer at Beetaloo Energy Ltd (formerly Empire Energy), overseeing field development programmes in the Beetaloo Basin. He has over 20 years of experience in upstream oil and gas operations across Australia and internationally, with particular expertise in unconventional resource development and remote area operations management.

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