ABRAJ
ENERGY SERVICES

Shallow Water Flow Control

Engineered Lightweight Cement For Aquifer Isolation And Well Integrity



TECHNICAL CASE STUDY

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EXECUTIVE SUMMARY

Uncontrolled water flow from shallow aquifers is one of the most disruptive hazards in top-hole drilling. It is not a subtle problem: in the worst cases the well produces fresh groundwater to surface faster than it can be handled, the ground around the rig substructure loses its bearing strength, and the operation stops. Where the flow cannot be secured, the well is abandoned and the location is lost — a **walk-away event**.

This paper describes how ABRAJ Energy Services controls high-rate shallow water flow using **AbraLITE**, an engineered lightweight cement system with a high solid volume fraction. The system resolves a conflict that defeats conventional cementing in top sections: hydrostatic pressure must be high enough to hold an active aquifer in place, yet low enough not to break down weak formations and be lost to a thief zone deeper in the hole. AbraLITE holds that balance, and because of its high solids content it carries its own bridging capability — sealing losses and isolating the aquifer in a single placement.

Between 2022 and 2025 the system was deployed across 19 wells for OQ Exploration and Production (OQEP), principally in the Bisat field in Block 60. Roughly 40% of those wells presented flow severe enough to be classified as potential walk-away events. Eighteen of the nineteen were secured and drilled to objective.

Key Performance Highlights

Wells treated
19 wells
secured with AbraLITE across Bisat and adjacent fields, 2022–2025

Recovery rate
18/19
wells drilled to objective; a single well abandoned

Walk-away avoidance
40%
of wells presented flow severe enough to justify abandonment

Peak influx controlled
350 m³/hr
water flow exceeding shut off completely

Aquifer protection
100%
no confirmed aquifer contamination event across the campaign was reported

THE CHALLENGE: SHALLOW WATER FLOW IN TOP-HOLE SECTIONS

What happens, and why it matters

In the shallow sections of wells in central Oman, drilling proceeds through freshwater aquifers and unconsolidated formations. The objective is the oil reservoir far below; the aquifer is simply in the way. When the hydrostatic pressure of the fluid column is insufficient to maintain overbalance against the high-pressure aquifer, the aquifer can begin to flow into the wellbore, with the influx rate potentially escalating rapidly.

In the Bisat field, flows starting at 10 m^3/hr have been observed climbing past 200 m^3/hr and then beyond 350 m^3/hr within a single section. At 200 m^3/hr a well is discharging roughly 1,250 barrels of fresh groundwater every hour. The consequences compound across four fronts:

- **Well control.** An uncontrolled influx to surface is a live well-control condition. In Bisat it has been accompanied by hydrogen sulphide, adding a personnel exposure hazard to an already unstable situation.
- **Rig stability.** The rig substructure sits on compacted ground. Saturating that ground with high-volume water flow degrades its bearing capacity and introduces a real risk of the rig settling or tilting.
- **Wellbore integrity.** Continuous flow across an open section washes out the hole, preventing cement bonding in subsequent cementing operations and compromises zonal isolation — problems that persist for the life of the well.
- **Operational continuity.** Drilling cannot safely proceed. Every hour spent attempting to cure the flow is non-productive time carrying the full rig and other services day rates.

The loss–gain trap

The technical difficulty is narrower than it first appears. Raising mud weight is the intuitive response to an influx, and it works — until the additional hydrostatic pressure exceeds the fracture gradient of a weak zone deeper in the hole. At that point the fluid column is lost to the thief zone, the pressure holding the aquifer back reduces, and the water starts flowing. This is the loss–gain scenario: the operation loses returns first, then gains water. Each cycle of mud weight increase and lost-circulation pills widens the problem rather than resolving it.

The workable pressure window between the aquifer's pore pressure and the fracture gradient of the weakest exposed formation is therefore narrow. Any solution must sit inside it.

WHY CONVENTIONAL APPROACHES FALL SHORT

Shallow water flow is a common problem without a common solution. Operators address it differently, and outcomes vary widely with the severity of the flow. At the rates encountered in Bisat, the standard toolkit runs out of options quickly.

Conventional lightweight slurries reduce density by adding water. That lowers hydrostatic pressure as intended, but it also lowers the solids content — leaving a slurry with little capacity to bridge and seal the loss zones that caused the problem. In water-rich sections these slurries are also prone to contamination and poor set, producing exactly the weak, channelled cement sheath the job was meant to prevent. Lost-circulation pills, external casing packers, stage tools and heavy cement squeezes each address one half of the problem; none resolves both at once.

Conventional cementing versus the AbraLITE approach

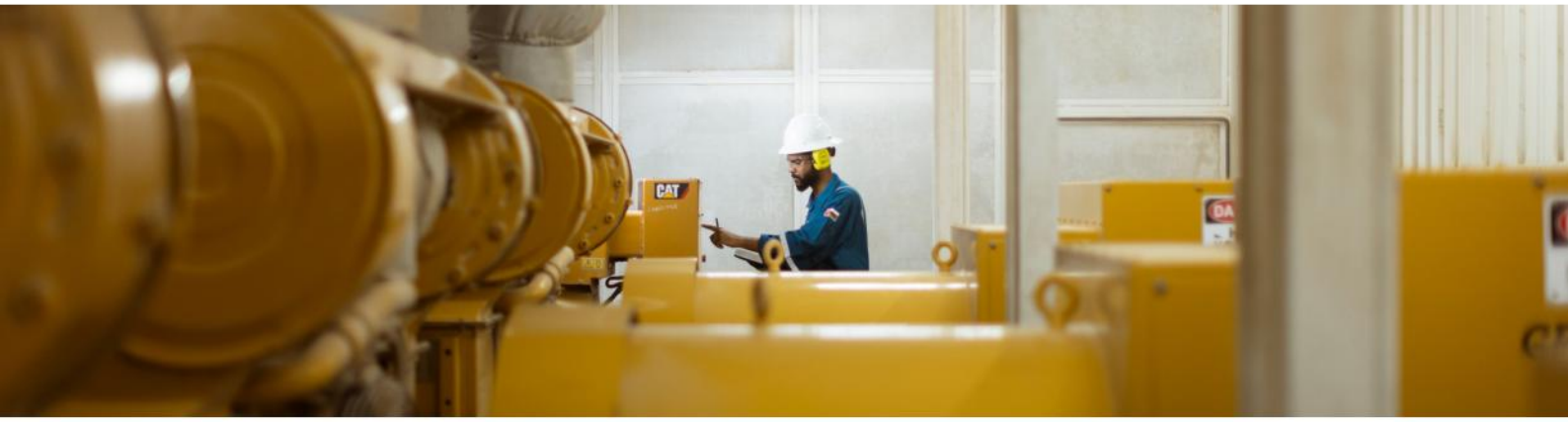
Conventional Approach	AbraLITE Approach
Density reduced by adding water, lowering solids content	Density engineered through particle packing while solids content stays high
Little inherent bridging capability; separate LCM pills required	High solid volume fraction acts as its own lost-circulation material
Loss control and aquifer isolation treated as two operations	Both delivered in a single placement
Hydrostatic either too high, inducing losses, or too low, allowing influx	Hydrostatic tuned to sit inside the fracture-gradient/pore-pressure window
Repeated remedial attempts accumulate NPT and risk	Typically resolved on the first or second placement
Standard formulations may not set properly in water-rich zones	Formulated to set and develop strength against active flow
Fixed density per blend	Flexible density adapted to the specific well design



THE ABRALITE SOLUTION

AbraLITE is a premium high-strength lightweight cement blend developed by ABRAJ for use in challenging cementing applications, including controlling shallow aquifer water flow and mitigating losses in upper-hole sections. Four engineered properties give it its behaviour.

Property	Result
Lightweight, high-SVF	Reduces hydrostatic pressure on weak formations, preventing induced losses, while retaining a high solid volume fraction
Superior particle packing	Bridges and seals both active aquifer intervals and partial or total loss zones
Durable set	Develops the compressive strength needed for long-term zonal isolation and well integrity
Engineered flexible density	Slurry density is adapted to the pressure window of the specific well rather than fixed by the blend



Where the innovation lies

High-solids engineered particle-size cement systems are not new in themselves. They are conventionally deployed deeper in the well, where narrow annuli and depleted zones demand low density without sacrificing compressive strength. The innovation here is one of application: ABRAJ repurposed that technology for shallow, high-rate water flow control, where the combination of low hydrostatic pressure and inherent bridging capability turns out to be precisely what the problem requires.

Put simply, the cement and the lost-circulation material are the same material. That is what allows a single placement to hold the aquifer down and seal the thief zone at the same time — the two objectives that conventional practice is forced to trade against each other.

TECHNICAL PROCESS

AbraLITE deployment follows a structured workflow designed to be repeatable across wells and to preserve the pressure window at every step.

Phase 1: Diagnosis and well assessment

- **Flow characterisation:** Measured influx rate, trend and any associated H_2S, established against depth and section geometry.
- **Pressure window definition:** Aquifer pore pressure and the fracture gradient of the weakest exposed formation are established to bound the achievable slurry density.
- **Wellbore condition review:** Hole geometry, washout extent and any prior remedial attempts are assessed to determine whether placement is achievable through the existing configuration.
- **Decision path:** A structured decision tree determines whether the section can be secured in place or requires mechanical intervention before placement.

Phase 2: Slurry design

- **Density selection:** Slurry density is set inside the pressure window — high enough to overbalance the aquifer, low enough to stay below the fracture gradient.
- **Solids and particle packing:** The blend is engineered to maximise solid volume fraction at the target density, giving the slurry its bridging capability.
- **Placement properties:** Thickening time, fluid loss and rheology are set for the specific placement method and expected contamination risk.

Phase 3: Placement

- **Well preparation:** The well is stabilised and filled, and in extreme cases the casing is cut and recovered to allow a clean placement path.
- **Conveyance:** Work string is run to the target depth to give precise control over plug position.
- **Controlled pumping:** Controlled pump rates are used to position the plug against an active flow.
- **Sequential placement:** Where the first plug does not achieve the design top — a common outcome under losses — a second placement is executed against the revised well condition.



Phase 4: Verification and completion

- **Wait on cement and tag:** The top of cement is tagged to confirm placement depth.
- **Flow check:** The well is monitored to confirm zero flow or level drop before operations resume.
- **Top-up:** A fast-set top-up placement completes the column to surface where required.

FIELD CASE: WELL BST WDW-11

This well is presented because it represents the severe end of the range: an influx that escalated past every conventional mitigation and was resolved only after mechanical intervention and AbraLITE placement. It illustrates both the limits of standard practice and the recovery the system makes possible.

Drilling Phase

Spudded the 16" hole section. Water flow of 10 m³/hr detected; mud weight raised progressively until the well went static. At 425 m the flow surged to 200 m³/hr with H_2S detected. Kill mud at 1.8 SG was pumped but the flow persisted while drilling continued to TD at 730 m, where it exceeded 300 m³/hr. BHA pulled out of hole.

Casing and Cementing

13-3/8" casing run with two external casing packers at 70 m and 49 m and a stage tool at 728 m. Cemented with 100% excess; partial returns observed. Packer inflation attempts failed and flow continued above 350 m³/hr. Heavy cement through the stage tool gave no improvement. Casing retrieval by overpull was unsuccessful. Flow was diverted away from the location.

Well Recovery

Stage tool closed using a closing cone. Assessment confirmed flow above 300 m³/hr with no backflow from the casing, and the decision was taken to cut the casing. Casing cut at 295 m and recovered. With the well under losses it was kept full with 1.55 SG mud, and 3.5" tubing was run to 265 m for plug placement.

AbraLITE Placement

First AbraLITE plug placed; top tagged deeper than planned. Second plug placed with the well flowing at 12 m³/hr, using controlled pumping — successful. Top of cement tagged 2.5 m below the cellar with no flow observed. Fast-set top-up cement placed to the cellar base. Flow stopped completely.

The sequence is worth reading carefully. External casing packers, stage cementing, heavy cement squeezes and casing overpull were all attempted and all failed against a continuous 350 m³/hr influx through a broken-down formation. Conventional cementing had reached its technical limit. What recovered the well was a change of approach rather than a further escalation of the same one: mechanical access to the flowing interval, then a cement system engineered to hold pressure and seal losses simultaneously.



CAMPAIGN RESULTS

Wells secured
18
drilled to objective

Wells abandoned
1
cemented in place

BST WDW-11 is one well in a sustained programme. Between 2022 and 2025 AbraLITE was deployed across 19 wells for OQEP, concentrated in the Bisat field with further applications in adjacent fields.

Parameter	Result
Wells treated	19
Period	2022 to 2025
Operator	OQ Exploration and Production (OQEP)
Primary field	Bisat, Block 60, with further applications in adjacent fields
Potential walk-away events	Approximately 40% of wells presented flow severe enough to justify abandonment
Typical resolution	First or second AbraLITE placement

The walk-away figure is the one that carries the most weight. A walk-away is not a delay; it is the loss of a location and the cost of drilling a replacement well elsewhere. Recovering roughly eight eighteen wells that would otherwise have been abandoned changes the economics of the drilling campaign, not just the cost of a single section.



VALUE DELIVERED TO THE OPERATOR

The value of a shallow water flow solution is measured in three currencies: wells retained, days recovered, and risk removed.

Wells Retained

Losing a well to shallow water flow means abandoning the location, writing off the section already drilled, and drilling a replacement to reach the same reservoir target. This is the single largest exposure in the sequence, and it is binary — either the well is recovered or it is not.

Days Recovered

Industry benchmarks place NPT at 20% to 30% of total drilling time in conventional Middle East drilling operations, and wellbore stability events represent a material cost exposure per well across regional programmes. Each day removed from a water flow remediation cycle is a day of that exposure returned to the operator.

Risk Removed

Eliminating an uncontrolled surface influx removes a well-control condition, removes personnel exposure to H_2S where present, and restores the integrity of the ground the rig is standing on. This is a safety outcome before it is a commercial one.

Indicative campaign value

Parameter	Conventional approach	With ABRAJ premium solution	Savings across 19 wells
Days saved per well	—	—	**~3–4 days per well where water flow is encountered**
NPT exposure	High	Minimal	**25–30% reduction**
HSE risk	Elevated — active flow and handling	Controlled and contained	Improved safety profile

Figures are indicative and derived from ABRAJ operational records. Final publication is subject to operator validation.



ENVIRONMENTAL IMPACT: PROTECTING OMAN'S FRESHWATER

The environmental dimension of this work is not incidental. Groundwater is Oman's primary reliable water resource, and much of what is stored in the country's aquifers was recharged under wetter climatic conditions that no longer prevail — present-day recharge is minimal. Water produced from a shallow aquifer during drilling is not a renewable by-product. It is drawn from a finite store.

Uncontrolled shallow water flow damages that resource in two distinct ways.

Direct loss of the resource

Water produced to surface during an uncontrolled event is contaminated on contact with the drilling environment and disposed of as waste. The volumes are substantial. A well flowing at 200 m^3/hr discharges approximately 4,800 m^3 per day — on the order of 30,000 barrels of fresh groundwater. Sustained across the days a conventional remediation cycle can take, a single event can waste tens of thousands of barrels of potable water. Securing the flow quickly is the difference between a contained event and a significant loss.

Prevention of aquifer contamination

The second mechanism is longer-term and more serious. If a shallow aquifer is not properly isolated, subsequent operations drilling deeper sections through the same wellbore can establish a pathway between hydrocarbon-bearing zones and the aquifer. Contamination of this kind typically manifests as hydrocarbon appearing in water wells near a producing field, and it is effectively irreversible on any human timescale.

Proper isolation at the top-hole stage is the control that prevents this. Across OQEP operations to date there has been no confirmed aquifer contamination event reported.

In a country where groundwater abstraction already exceeds safe yield in several basins and salinity intrusion is a documented consequence, protecting an aquifer during well construction is a direct contribution to national water security — and a measurable sustainability outcome, not a stated intention.



ABRAJ ENERGY SERVICES CAPABILITIES

Cementing and well integrity

ABRAJ Energy Services delivers integrated well services across Oman spanning well construction, stimulation, intervention, integrity and plug and abandonment. The cementing business operates a fleet of integrated cementing units and is supported by a technical organisation that develops and qualifies proprietary blends such as AbraLITE for the specific formations encountered in Oman's fields.

Operational footprint

- Cementing units operating in Block 60 and Block 48, the concessions in which the shallow water flow management programme was executed
- A five-year cementing services contract awarded by OQ Exploration and Production, commencing in the first half of 2026
- Integrated drilling, fluids, casing and tubing running, and cementing delivered as a single well construction service
- A technical organisation combining Omani expertise with engineered blend development and field trial capability



Why the lesson transfers

This solution was developed empirically, well by well, in response to a specific field problem. Its value to the wider industry lies in the transferable principle rather than the blend alone: where shallow water flow is driven by a loss–gain mechanism, the effective intervention is one that addresses both halves at once. ABRAJ's intent is to replicate the approach with other operators in Oman and internationally, and to publish the lesson so that it does not have to be relearned field by field.

REGIONAL CONTEXT: BLOCK 60 AND OMAN'S WATER SECURITY

The Bisat field

Bisat, in Block 60, is among the fastest-growing oil developments in the region. Discovered in 2017, the field moved from around 5,000 barrels per day in 2019 to approximately 60,000 barrels per day by the time of its formal inauguration in early 2023, supported by three processing plants and a well count in the range of 165. Commissioning of the Bisat-C expansion in 2025 raised total oil processing capacity at that facility to 67,000 barrels per day.

That pace of development is precisely what makes top-hole risk material. A field adding wells rapidly encounters the same shallow aquifer repeatedly, and a hazard that occurs at any meaningful frequency becomes a structural constraint on campaign delivery rather than an isolated incident.

Water security

Groundwater is the main reliable water source in Oman, and abstraction has exceeded safe yield in parts of the country, with documented consequences including salinity intrusion and deterioration in water quality. Against that backdrop, an operational practice that keeps thousands of barrels of potable water in the ground per event — and prevents the permanent contamination of a drinking water source — carries weight well beyond the drilling programme it belongs to.

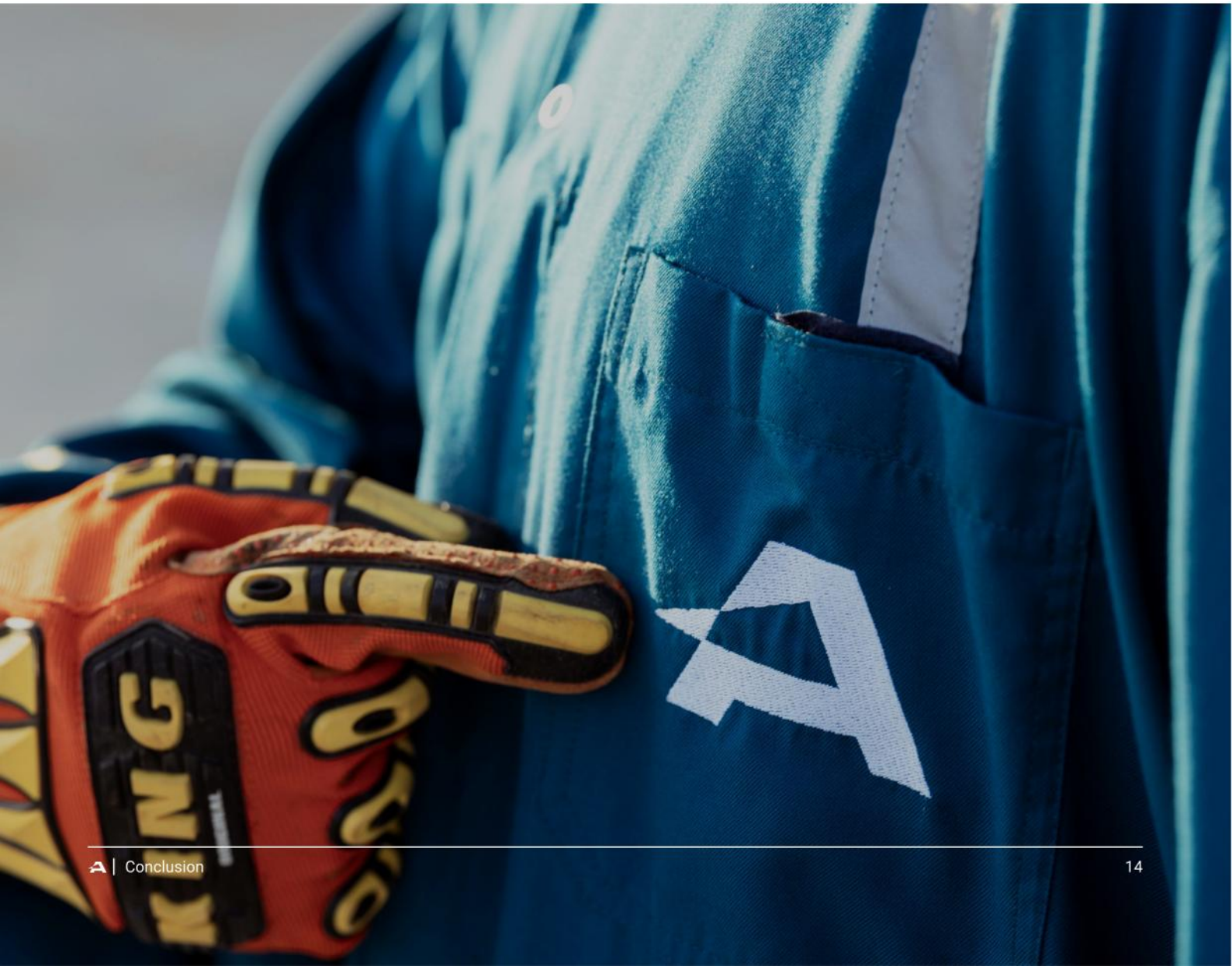


CONCLUSION

Shallow water flow in top-hole sections is a well-control problem, a rig safety problem, a schedule problem and an environmental problem at the same time. What makes it technically stubborn is the narrowness of the pressure window: the intervention must hold an active aquifer down without breaking down the formations around it.

AbraLITE addresses that constraint by combining low hydrostatic pressure with high solids content, so that a single placement both maintains overbalance and seals the loss zones that would otherwise drain it. Applied across 19 wells in Block 60 and adjacent fields between 2022 and 2025, the system secured 18 of them, including wells where every conventional mitigation had already failed and abandonment was the realistic alternative.

For the operator the outcome is measured in retained locations, recovered rig days and removed risk. For the country it is measured in aquifers left intact. As Oman's central fields continue to develop at pace, both measures matter — and the engineering that delivers them is available now, proven in the formations where it will be needed.



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