CHANGING STATE TECHNOLOGIES

River Intake Pumping for Communities

A Technical White Paper

How MPR™ Stable Vapour Cavity Technology Transforms River Intake Pump Stations

August 2026

Executive Summary

River intake pumping is one of the most operationally critical and technically demanding applications in municipal water supply engineering. Conventional technology — whether vertical turbine pumps housed in deep excavated dry wells or submersible centrifugal pumps installed in flooded sumps — has served the industry for over a century but carries structural vulnerabilities that impose real costs and supply security risks on every community that depends on a river as its water source.

These vulnerabilities were brought into sharp relief in February 2026 when a severe storm destroyed the Te Tahi Water Treatment Plant near Te Awamutu — the primary supply source for the western towns of Waipā District — instantly transforming the backup river intake at the Parallel Road Water Treatment Plant on the Waikato River into the sole supply for tens of thousands of people. The Parallel Road intake, equipped with conventional variable-speed submersible pumps at 4.5 metres depth, performed reliably under normal conditions; but under the elevated suspended sediment loads, screen debris accumulation, and volatile river levels that accompany the same storm events capable of destroying an upstream treatment plant, the submersible configuration faces its greatest risks — mechanical seal wear from silt ingress, loss of prime under reduced suction head from blocked screens, cooling water dependency at low river level, and a crane or barge requirement for any pump maintenance that the confined station geometry prevents otherwise. It is precisely in these conditions that the technology gap is most consequential.

Changing State Technologies' MPR™ (Multi-Phase Rotor) Stable Vapour Cavity technology offers a fundamentally different approach that addresses each of these structural vulnerabilities directly. Rather than avoiding cavitation — the defining constraint of all centrifugal pump design — the MPR™ deliberately passes through the cavitation threshold to reach a stable post-cavitation operating regime, in which a controlled low-pressure vapour cavity is maintained inside the rotor at approximately 2.3 kPa. At this pressure, water boils at ambient temperature 20^{o} C; the vapour core is geometrically stable, self-sustaining, and does not produce the destructive bubble collapse that erodes conventional pump components.

The practical consequences for river intake pumping are transformative: the MPR™ is fully self-priming from an almost dry start — no foot valves, no priming systems, no re-priming after air ingress; it operates with up to 9.5 metres of suction lift from a surface-mounted installation, eliminating the flooded sump, the confined space hazard, the submerged electrical connections, and the crane or barge dependency of conventional submersible design; it handles entrained air, sand, and silt without cavitation or performance loss; it can actively backflush intake screens during debris events without shutting down; and it carries zero inlet seals — removing the primary failure mode that accounts for 39% of all conventional pump failures and is accelerated by the grit-laden conditions of river intake service.

A hypothetical analysis of the Parallel Road station under MPR™ configuration — using the conventional installation as the documented baseline — demonstrates that under the exact conditions created by the February 2026 emergency, the MPR™ would have offered materially higher operational resilience across every critical risk dimension.

The case for MPR™ technology in river intake applications rests not on the vulnerabilities of existing conventional solutions but on the evidence that a superior operating principle is now available — one grounded in well-established fluid dynamics theory and application and protected by a granted US patent (US12398725B2, August 2025).

The recommended pathway — a structured proof-of-concept trial at a low-criticality or non-sole-source intake, operated in parallel with a conventional unit over a full seasonal cycle including at least one significant flood event — is designed to generate precisely that evidence in a commercially and operationally responsible manner.

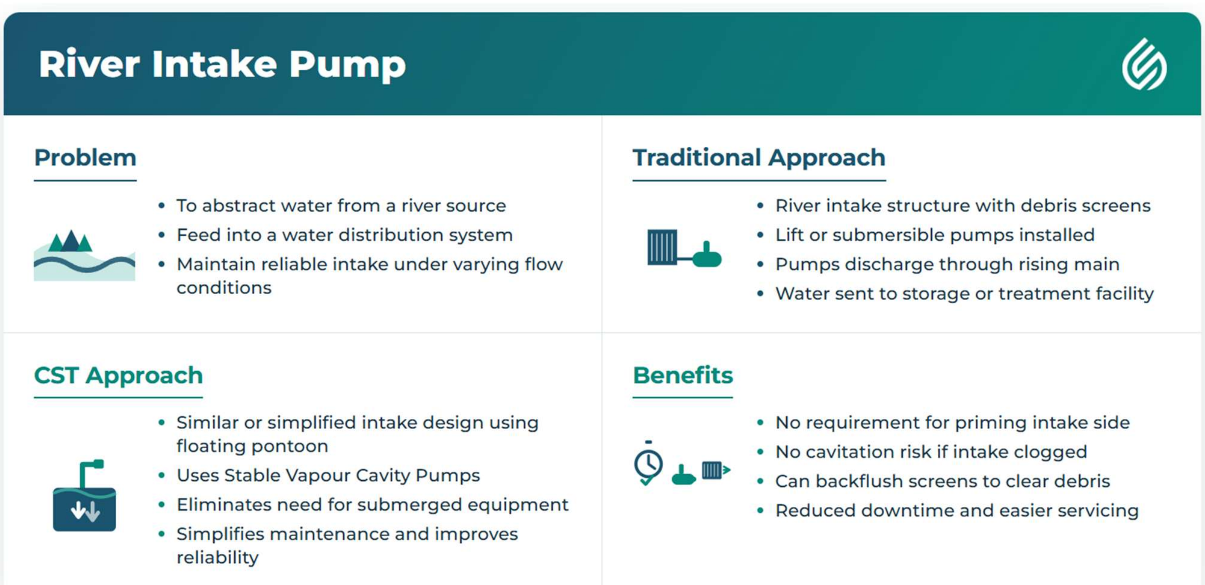
The broader benefit, once field data is established, extends well beyond the Parallel Road station: the same technology applies to small community river intakes throughout New Zealand and internationally, to farm water supply systems where specialist maintenance resources are unavailable, and to rapid-deployment emergency supply configurations where conventional submersible installation timelines are challenging. River intake pumping is fundamentally changed by a pump technology that thrives in the conditions that damage its conventional centrifugal counterpart.

1. Introduction

River intake pumping is one of the most demanding and operationally critical applications in municipal water supply engineering. The requirement to reliably abstract water from a live river — with all the variability in river level, flow velocity, suspended sediment, entrained debris, and biological load that entails — places extreme demands on pump design, installation, and maintenance. Conventional centrifugal pump technology, whether in the form of vertical turbine pumps in deep dry wells or submersible pumps in flooded sumps, has been the industry standard for decades. Both approaches carry significant inherent vulnerabilities that translate directly into capital cost, maintenance burden, and supply reliability risk.

This white paper explores how Changing State Technologies' MPR™ (Multi-Phase Rotor) Stable Vapour Cavity technology offers a fundamentally superior approach to river intake pumping. It does so through a detailed real-world case study: the Parallel Road Water Treatment Plant river intake on the Waikato River, operated by Waipā District Council, currently equipped with variable-speed submersible pumps. A hypothetical analysis is presented — grounded in published technical and commercial data — of how the CST MPR™ technology would have performed in place of the conventional centrifugal pump installation, and what the operational, maintenance, and resilience benefits would have been, particularly in the context of the February 2026 Te Tahi Water Treatment Plant failure that placed the Parallel Road intake under exceptional supply stress.

AUTHOR NOTE	This paper presents a hypothetical comparison. The installation at the Parallel Road pumping station has performed well and is documented as reliable. The CST MPR™ analysis is a forward-looking technical assessment of what could have been achieved with MPR™ technology, not a criticism of the conventional equipment or the decisions made by Waipā District Council engineers. All MPR™ performance claims are based on published CST technology documentation and established physics; commercial CST performance data from equivalent river intake installations is not yet available.



The paper follows the four-quadrant structure illustrated in the infographic above: Problem Statement, Traditional Approach, CST MPR™ Approach, and Benefits and Outcomes.

2. Technology Background — The CST MPR™ Pump

2.1 The Physics of the Stable Vapour Cavity

The fundamental operating principle of the CST MPR™ pump distinguishes it categorically from all centrifugal pump technology. Conventional centrifugal pumps — including the submersible units at the Parallel Road station — are designed to operate well above their Net Positive Suction Head Required (NPSHr). NPSHr defines the minimum pressure that must exist at the pump inlet to prevent cavitation: the formation of vapour bubbles when local liquid pressure falls below the fluid vapour pressure at the operating temperature. Cavitation bubble collapse releases intense localised energy that erodes impeller blades, mechanical seals, and casing surfaces, rapidly degrading pump performance and ultimately causing premature failure.

This cavitation constraint has driven the fundamental architecture of conventional river intake pump installations for over a century: pumps must be installed at or below the river water level, either submerged in the river itself (submersible design) or housed in a deep dry-well or wet-well adjacent to the river bank (vertical turbine or horizontal split-case design). Both approaches add substantial civil cost, create confined space hazards, and impose severe maintenance constraints.

The CST MPR™ takes a fundamentally different path. Rather than avoiding the cavitation threshold, the MPR™ deliberately passes through the damaging inter-cavitation zone — where conventional pumps fail — to reach a stable, third operating regime: the post-cavitation zone. In this regime, a controlled, continuous low-pressure vapour cavity forms at the centre of the rotor at approximately 2.3 kPa. At this pressure, water boils at ambient temperature (20C water @STP). The cavity is geometrically stable, sustained by the inlet restriction and outlet liquid trap that are intrinsic to the rotor design. The destructive, collapsing bubble formation that destroys conventional pump components simply does not occur.

The Key Distinction	In the post-cavitation regime, the MPR™ rotor operates with a stable vapour core rather than an unstable collapsing bubble cloud. The same physics that destroys conventional pumps (cavitation) is transformed into a controlled, stable, useful operating condition. The rotor can be thought of as pumping around a vapour core rather than through a liquid-only flow.

2.2 Consequential Operating Properties for River Intake Applications

The stable vapour cavity produces a set of operating properties that are uniquely well-suited to the demands of river intake pumping:

MPR™ Properties Critical to River Intake Applications

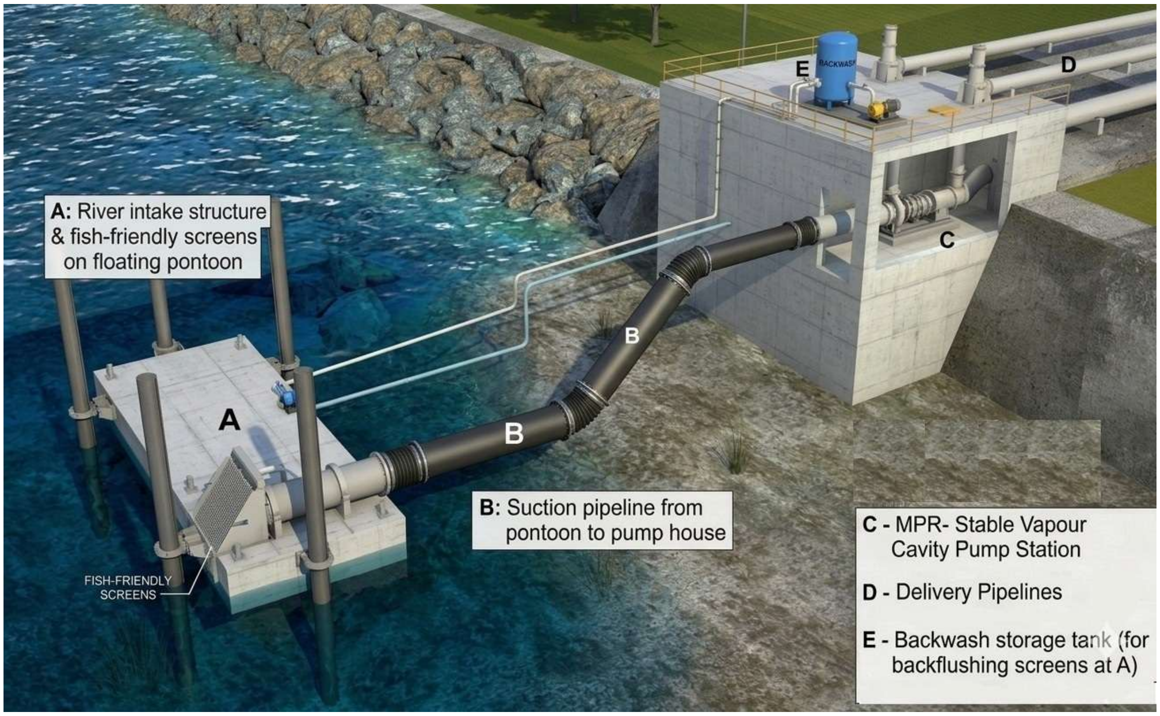
- Self-priming from almost completely dry — operates without foot valves, priming tanks, or vacuum-assist systems; river level variability does not cause loss of prime

- Surface-mounted installation — pump sits at ground level in the pump house, up to 9.5 metres above minimum river level; no deep wet well, no submersible installation
- Air and gas tolerant — handles entrained air in the suction line (common during flood events and screen backflushing) without cavitation, performance loss, or pump trip
- Constant flow independent of backpressure — delivers consistent supply regardless of downstream pressure variation in the rising main or treatment plant
- Zero inlet seals — eliminates the primary failure mode of submersible pumps (seal failure on sand/silt ingress); 39% of all conventional pump failures are seal-related
- Backflush capability — the MPR™ can be plumbed (backflush cycle) to create a reverse flow through the debris screens to clear sediment and biological material without removing the pump from service
- Compact surface footprint — no overhead crane, no confined space, standard tool-kit maintenance at ground level
- Intake and screens can be mounted on a floating pontoon rather than fixed to the riverbank using flexible couplers on the intake pipeline
- Set-and-forget operation — VSD and intake valve control; no pump curve management required

2.3 Schematic Comparison — River Intake Configurations

A conventional river intake using submersible pumps requires: a river intake structure with fish-friendly screens; a suction pipeline running from the river bank to a pump sump; a flooded sump or wet well at or below minimum river level; submersible pump units with watertight motors and electrical cable penetrations; a crane or lifting frame for pump removal; high-voltage underwater electrical connections; a separate dry control room at the surface; and extensive corrosion protection on all submerged components.

Conventional River Intake Schematic. The river intake structure and fish-friendly screens are located at (A); a suction pipeline (B) then runs from the intake to the pump house wet well (C). Lift pumps at (D) discharge into delivery pipelines at (D). Optional chemical dosing at (E).



MPR™ River pump schematic with floating intake pontoon with screens. The MPR™ Stable Vapour Cavity module with VSD and intake valve are surface mounted on the riverbank with standard electrical supply and controls — no underwater electrical connections required.

Factor	Traditional Approach — Submersible Pumps	CST MPR™ Solution
Installation depth	Pump submerged at 4.5m below river level in flooded sump	Surface-mounted at pump house floor level — up to 9.5m above river
Civil works required	Deep excavated wet well, concrete sump, waterproofing	Simple pump house at grade — no excavated sump
Prime management	Foot valve and check valve required; re-priming on air ingress	Self-priming from dry — no foot valve, no re-priming needed
Air entrainment response	Loss of prime, cavitation risk, potential pump damage	Stable operation — air handled within MPR™ rotor
Seal condition	Mechanical seals exposed to river silt and grit — primary failure mode	Zero inlet seals — no seal failure mechanism
Screen backflush	Pump must be shut down; manual screen cleaning or air purge required	Backflush through pump without shutdown — Manual or automated
Crane requirement	Yes — overhead lifting frame or mobile crane for pump pull	No — pump accessible at floor level with standard tools

Confined space	Yes — sump is a confined space requiring gas monitoring and permits	No — all equipment surface-accessible
Flood event operation	Risk of sump flooding above pump; electrical hazard	Surface installation protected from river flood level changes
Maintenance duration	2–3 day shutdown for seal or impeller replacement	4-hour service at ground level by single technician

3. Case Study — Waipā District Council, Parallel Road WTP

3.1 Problem Statement

To fully appreciate the significance of the river intake pump configuration at Parallel Road, it is necessary to understand the supply context created by the February 2026 emergency and the role the Waikato River intake plays in Waipā District's water security.

The Te Tahi Water Treatment Plant Failure — February 2026

The Te Tahi Water Treatment Plant, constructed in 1984 on the lower slopes of Mount Pirongia, had served as the primary water supply source for Te Awamutu, Kihikihi, and Pirongia — the western Waipā towns — for over four decades. The plant drew water from a storage dam and weir intake on the Te Tahi Road headwater catchment, treating it through conventional processes before distribution.

In February 2026, a severe storm event caused catastrophic damage to the Te Tahi plant: the intake weir was destroyed, the storage reservoir was damaged, and the supply pipelines were breached. The plant was taken entirely offline. Because Te Tahi had been supplying approximately half of the total water demand for the western Waipā towns, its sudden loss imposed an immediate and severe supply deficit on the district.

Waipā District Council's response was to implement strict emergency water conservation measures and reroute supply from the Parallel Road Water Treatment Plant — the district's alternative water source — via the Taylors Hill (Te Rua Kotāre) reservoirs. In doing so, the Parallel Road WTP and its river intake from the Waikato River were transformed overnight from a backup supply source into the primary supply for a significant portion of the district's population. Waipā District Council subsequently advised that all new water connections in the affected towns would be paused for up to three years while permanent repairs are made to the Te Tahi plant.

Supply Context	The February 2026 event illustrates precisely the scenario that justifies investment in resilient, reliable river intake pumping technology. When a primary supply source fails catastrophically and without warning, the performance and reliability of the backup river intake become existential for the communities it serves. A pump failure at the Parallel Road station during this period would have left Te Awamutu, Kihikihi, and Pirongia with a significantly reduced potable supply to the population of almost 20,000 people

The River Intake Challenge — Waikato River, Parallel Road

The Waikato River presents a demanding river intake environment. As New Zealand's longest river — draining an extensive volcanic and pastoral catchment from Lake Taupo to the Tasman Sea — it carries substantial suspended sediment loads, particularly during and after flood events. River levels vary significantly between low-flow summer conditions and peak winter/spring flood events. The water contains naturally elevated concentrations of fine volcanic sediment, aluminium, and manganese that require intensive treatment.

The pump station at the Parallel Road WTP is cited in published references as being situated along the Waikato River, tied to the Pukerimu intake point. The primary intake challenge is maintaining reliable water abstraction across the full range of Waikato River conditions — from summer low flows (where river level may be 2–3 metres below the bank) to flood events (where the river carries high concentrations of suspended silt and debris that can clog intake screens).

Problem Statement — River Intake Pumping, Parallel Road WTP

- Abstract water reliably from the Waikato River under all flow and level conditions — from summer low-flow through to high-flood events
- Feed the abstracted raw water at consistent pressure and flow rate into the Parallel Road WTP treatment train (coagulation, flocculation, sedimentation, filtration, disinfection)
- Maintain reliable intake with fish-friendly screens under varying river conditions including periods of high suspended sediment and debris load following storms
- Provide sufficient capacity to supply the western Waipā towns as sole supply source following the Te Tahi WTP failure — peak demand 58 L/s, average 30 L/s
- Ensure pump and intake resilience sufficient to maintain supply through the 2–3 year Te Tahi repair period, including through any further weather events affecting the Waikato River

3.2 Traditional Approach — The Submersible Pump Installation

Historical Context

The Parallel Road WTP has been progressively upgraded over a number of years. The pump station and intake, situated along the Waikato River at or near the Pukerimu intake point, originally featured aging legacy pumps that were supplemented and eventually replaced by advanced submersible pump technology.

The new solution adopted by Waipā District Council involved replacing two aging pumps with a single variable-speed submersible pump powered by a 30 kW motor. The new pump was installed at a depth of 4.5 metres below river level, within the existing river pumping station. Installation circumstances were challenging: the confined geometry of the pumping station made crane access impossible, and the new pump was instead floated on a barge down the Waikato River, anchored below the holding framework, and lowered into position alongside a new screening cage. The pump was flown in from Australia at very short notice to meet the council's urgent timeline.

The new installation was subsequently joined by a second standby submersible pump to provide duty/standby redundancy. The operating performance is well-documented: the station delivers water at 58

L/s during peak demand periods and approximately 30 L/s during average demand, with the variable speed drive enabling demand-matched output.

A representative of Waipā District Council is quoted in a published case study as stating: "The pumping station is working very well. We have had no trouble with it"…and… "is certainly more energy-efficient and reliable than the two it replaced." This is an important baseline: the new installation represents a well-engineered, high-quality conventional solution, and the CST MPR™ comparison must be understood in that context — not as a failing installation being replaced, but as a benchmark of best-in-class conventional technology against which MPR™ is assessed.

Traditional Approach — Equipment and Configuration

Traditional Approach — Submersible River Intake

- River intake structure on the Waikato Riverbank with fish-friendly screens and continuous filtration (state-of-the-art intake screen design per published references)
- Suction pipeline from river to pump sump — pipeline follows river bank gradient to flooded sump at or below minimum river level
- Primary duty: single variable-speed submersible pump, 30 kW motor, installed at 4.5m depth in flooded pump sump
- Standby duty: second submersible pump in duty/standby configuration
- Rising main from pump station to Parallel Road WTP; pump controls set up to feed Taylors Hill (Te Rua Kotāre) reservoir
- Barge-deployed installation due to crane access constraints in the confined pumping station geometry
- Variable speed drive enables demand-matching from 30 L/s average to 58 L/s peak flow

Known Operational Limitations of Submersible River Pump Installations

While the installation at Parallel Road has performed well under normal operating conditions, submersible pump technology in river intake applications carries inherent structural vulnerabilities that are well-understood in the pump engineering community. These are not specific to the Waipa equipment — they are characteristic of the submersible design philosophy and apply to all submersible pumps in river intake service:

- Sand and grit ingress into mechanical seals — river water carries fine suspended particles that enter the seal housing and accelerate mechanical seal wear. In silt-laden rivers like the Waikato during flood events, this can significantly reduce seal life between service intervals.
- Cooling water dependency — submersible motors rely on the flow of river water past the motor casing for cooling. During periods of very low river flow or where the pump is operated near minimum river level, reduced cooling flow can cause motor overheating and thermal trip.
- Electrical penetration integrity — high-voltage power cables and signal cables entering a submersible pump motor through submerged glands are a long-term integrity risk. Cable insulation degradation, gland seal failure, or physical damage during flood events can cause motor failure or electrical safety incidents.

- Screen blockage and pump trip — when river screens become blocked by debris (common during flood events and after freshes), the suction head at the pump inlet is reduced. Centrifugal pumps operating on a reduced suction head approach their cavitation threshold and risk damage. The response is typically to trip the pump — interrupting supply — until screens are manually cleared.
- Crane access constraint — as demonstrated by the barge installation of the river pump, the confined geometry of the pumping station makes conventional crane access for pump removal difficult or impossible. Future pump replacements will face the same constraint, potentially requiring expensive barge operations or significant civil modification.
- Confined space entry — the pump sump is a confined space requiring gas monitoring, rescue standby, and formal permit-to-work procedures for all maintenance entry. This adds cost and time to every maintenance event and creates ongoing safety management obligation.

3.3 CST MPR™ Approach — Hypothetical Analysis

Hypothetical Premise

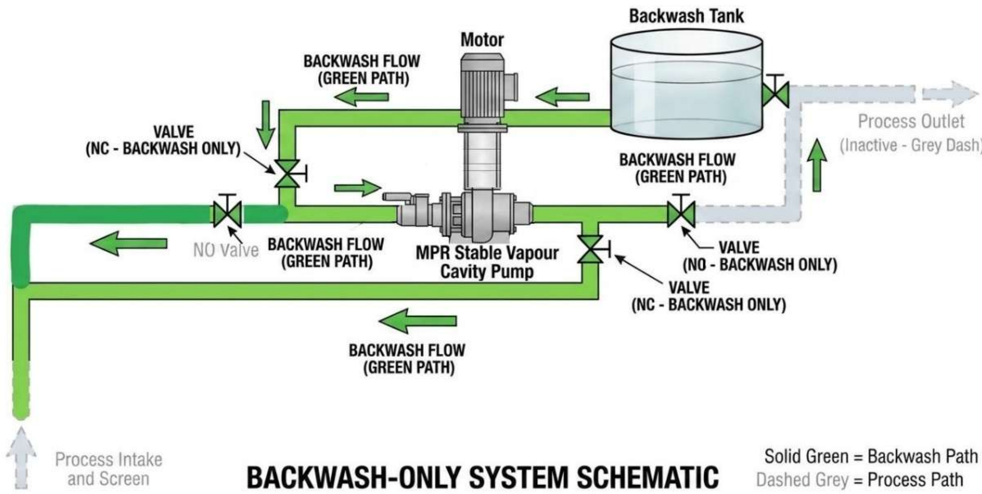
The following analysis considers what the Parallel Road river intake configuration would look like if the CST MPR™ technology had been available and specified in place of the conventional submersible pumps. This is explicitly a hypothetical analysis — the purpose is to quantify the operational advantages and cost differences that would have accrued, based on published MPR™ technology characteristics and the specific operating conditions documented for the Parallel Road station.

Proposed Configuration

CST MPR™ Approach — Parallel Road River Intake (Hypothetical)

- Same or simplified river intake structure— same fish-friendly screens, same intake position on the Waikato Riverbank, or floating pontoon.
- Suction pipeline from river intake to pump house at surface level — no requirement for pipeline to extend to a flooded sump below river level
- Duty and backup CST MPR™ module installed at pump house floor level — surface-mounted, no borehole, no deep excavation
- MPR™ self-priming capability — no foot valve, no priming system required; pump operates from dry start when river level is below suction line
- VSD and intake valve for demand-matched control from 30 L/s average to 58 L/s peak — same performance envelope as the conventional installation
- Standby MPR™ module in parallel configuration for duty/standby redundancy
- Backflush operation available — when river screens accumulate debris during flood events, MPR™ can reverse flow simply by using a PLC and plumbing arrangements through the screen without shutdown
- Rising main and treatment plant connection unchanged — same discharge configuration as conventional installation

Backwash General Arrangement



Installation Advantages — Addressing the Conventional Constraints

The MPR™ configuration eliminates or substantially mitigates every structural constraint identified in the conventional submersible installation:

No confined pump sump required. The MPR™ pumps at surface level, drawing water up through a suction pipe — exactly as a traditional wellpoint or surface centrifugal pump would, but without the NPSH limitations that prevent conventional centrifugal pumps from operating in this configuration. The existing flooded sump is no longer required as a pump installation chamber. This eliminates the confined space safety obligation entirely.

No crane or barge required for installation or maintenance. MPR™ modules at floor level are accessible with standard tools. Future pump replacements — which faced the same barge-deployment constraint as the original installation — become routine workshop-level operations.

No submerged electrical connections. The MPR™ motor and all electrical components are at pump house floor level in a standard IP-rated enclosure. There are no submerged cable glands, no underwater electrical penetrations, and no long-term electrical integrity risks from submersion.

Screen blockage does not cause pump failure. When river screens become blocked during flood events, the reduced suction head at the MPR™ inlet simply increases the air-to-water fraction in the suction flow. The MPR™ handles this air entrainment stably — it does not cavitate, does not trip, and does not require manual screen clearing before supply can resume. Instead, the MPR™ can be used to actively backflush the screen by briefly reversing the intake valve, clearing debris without interrupting the pumping cycle.

The February 2026 Te Tahi Failure — MPR™ Resilience Analysis

The February 2026 emergency demonstrates precisely the conditions under which the structural differences between the conventional and MPR™ configurations would have been most significant. When Te Tahi failed and the Parallel Road intake became the primary supply source for the western Waipā towns, the pump station's resilience was tested across an extended period at elevated demand.

A severe storm of the type that destroyed Te Tahi would also have affected the Waikato River, generating a flood fresh with elevated suspended sediment, debris loads, and volatile river levels. Under these conditions, the conventional submersibles — reliably performing under normal operating conditions — would have faced the following risk profile:

- Elevated suspended sediment load → increased mechanical seal wear rate, reducing remaining seal life between scheduled service intervals
- Debris accumulation on intake screens → reduced suction head → pump operation approaching NPSHr margin → risk of cavitation → pump trip → supply interruption during a period when the station was the sole supply source
- River level volatility → variation in pump submergence → risk of cooling-flow reduction at low river level → motor thermal protection trip
- Extended high-demand operation (58 L/s sustained vs 30 L/s average) → accelerated wear on duty pump → increased probability of unplanned failure during the critical supply period

Under the hypothetical MPR™ configuration, the same storm conditions would have presented a materially different risk profile:

- Elevated suspended sediment → no mechanical seals to wear; sand and silt pass through the MPR™ rotor without critical component damage
- Screen debris accumulation → MPR™ operates stably through reduced suction head without cavitation; backflush operation clears screen without pump shutdown
- River level volatility → MPR™ operates from surface at up to 9.5m above river level; river level changes do not affect pump installation depth or cooling water supply
- Extended high-demand operation → constant-flow characteristic of MPR™ maintains demand-matched output without off-curve energy waste or accelerated cavitation wear

Resilience Assessment	The MPR™ configuration offers materially higher resilience than the conventional submersible installation under exactly the flood-event conditions that followed the Te Tahi failure. The scenarios where the conventional pumps face their highest risk (screen blockage, elevated silt, river level volatility) are the same scenarios where the MPR™'s intrinsic properties provide the greatest advantage.

3.4 Benefits and Outcomes

The following section summarises the full benefit picture of the MPR™ configuration relative to the conventional submersible installation, across four dimensions: operational resilience, maintenance cost and burden, capital and lifecycle cost, and supply security.

Problem Statement	Traditional Approach — Submersible Pumps
• Abstract water reliably from the Waikato River under all conditions • Feed consistent flow to the Parallel Road WTP treatment train • Maintain intake through high suspended sediment and debris events • Provide sole-source supply resilience following Te Tahi WTP failure	• River intake structure with fish-friendly screens • Conventional variable-speed submersible pump at 4.5m depth • Pump installed by barge — no crane access possible • Duty/standby configuration — two submersible units • VSD delivers 30–58 L/s demand-matched supply
CST MPR™ Approach	**Benefits and Outcomes**
• Same or simplified river intake structure and fish-friendly screens • Surface-mounted MPR™ module — no deep sump, no submersible • Self-priming up to 9.5m above river level • Air-tolerant — stable through screen blockage and flood events • Backflush capability — clears screens without pump shutdown	• No requirement for priming — self-primes from dry • No cavitation risk when intake is clogged or partially blocked • Automatic backflush of screens to clear debris and sediment • Reduced downtime and easier servicing at ground level • No confined space entry — eliminates safety risk and compliance cost • Higher resilience during extended sole-source supply periods

Detailed Benefit Analysis

The table below provides a detailed head-to-head comparison of the conventional submersible configuration (as actually installed) against the hypothetical CST MPR™ alternative across all key operational dimensions:

Cost / Risk Item	Submersible (Actual)	CST MPR™ (Hypothetical)
CAPEX — pump unit purchase	Two conventional submersible units, 30kW each; flown from Australia	Two MPR™ modules (indicative — commercial pricing TBC by CST)
CAPEX — pump house civil works	Existing deep pump sump — confined, no crane access	Surface pump house modification only — no sump excavation
CAPEX — installation method	Barge-mounted deployment on Waikato River; specialist operation	Standard floor-level installation — no specialist access required

CAPEX — electrical installation	Submerged cable glands, waterproof connectors, cable management	Standard dry switchboard installation — no submerged electrics
OPEX — seal replacement	Scheduled replacement per manufacturer interval; more frequent on silt-laden river	Not applicable — zero inlet seals
OPEX — maintenance access	Confined space entry procedures; rescue standby; permit-to-work	Ground-level access; 4 hours by single technician; no permit required
OPEX — screen blockage response	Pump trip; manual screen clearing; supply interruption	Backflush through MPR™ without pump shutdown; no supply interruption
OPEX — crane hire (pump removal)	Barge mobilisation or civil modification for crane access	Not required — floor-level pump pull
Resilience — silt/flood events	Elevated seal wear; cavitation risk on reduced suction head	Stable through air/silt entrainment; no cavitation threshold
Resilience — river level variation	Motor cooling dependent on submergence depth	Surface-mounted — river level does not affect pump operation
Supply security — sole-source period	Good under normal conditions; risk elevates under flood event	High — risk profile unchanged under flood event conditions
Safety — confined space obligation	Yes — gas monitoring, rescue standby, formal permit required	Eliminated — no confined space in MPR™ configuration

4. Broader Application — River Intake Pumping Contexts

The Parallel Road case study represents a high-profile, well-documented application of conventional river intake technology against which the MPR™ can be compared. However, the principles established by this comparison apply broadly across the range of river intake pumping applications encountered in New Zealand and internationally.

4.1 Small Community Water Supplies

Many rural and small-town communities in New Zealand rely on river or stream intakes for their water supply, often with pump stations that are smaller, older, and less well-resourced for maintenance than the Parallel Road WTP. In these settings, the advantages of surface-mounted, self-priming, seal-free pump technology are amplified: maintenance resources are limited, crane access is often unavailable, and the operational impact of pump failure falls directly on small communities with no alternative supply. The MPR™'s ground-level accessibility and reduced maintenance frequency are particularly valuable in this context.

4.2 Farm Water Supply Intakes

River intakes for large-scale irrigation and farm water supply present a similar set of challenges to municipal intakes, with the additional complication that farm operators are typically not pump engineers. Pump systems that require specialist maintenance, confined space procedures, or complex prime management are operationally problematic in a farm context. The MPR™'s set-and-forget operating characteristic and simplified maintenance profile are well-suited to the farm water supply market.

4.3 Emergency and Temporary Intake Applications

The February 2026 Te Tahi failure also illustrates the value of rapidly deployable river intake capacity for emergency supply augmentation. A surface-mounted, self-priming MPR™ module requires no deep civil works and can be placed on a standard trailer. This unit can be deployed to a river-bank and operational within hours. Alternatively, the entire system could operate from a barge or floating platform, with the pump mounted on deck and the intake suspended below. Because the MPR™ pump naturally resists vortex generation on intake, it significantly enhances the performance and reliability of this suspended configuration. Either approach provides emergency supply capacity without the crane mobilisation or confined-space infrastructure that conventional submersible installations require. This represents a new product category: a rapid-deployment emergency river intake unit.

5. Pathway to Adoption

The following incremental pathway is recommended for asset owners and engineers considering MPR™ technology for river intake applications:

Phase	Activity	Description
1	**Technology Briefing**	Pump engineers and asset managers receive a structured briefing on the MPR™ operating principle, supported by laboratory demonstration and review of the US patent documentation (US12398725B2)
2	**Laboratory Performance Test**	CST provides head-to-head performance data from controlled testing — flow rate, power consumption, suction lift performance, and air-entrainment response — allowing engineers to validate MPR™ claims against their own specification requirements
3	**Non-Critical Field Trial**	Install a single MPR™ module at a low-criticality river intake (e.g. a farm supply or irrigation intake) with a conventional pump in parallel standby; operate for 6–12 months through seasonal variation including at least one significant flood event; monitor performance continuously
4	**Performance Review**	Analyse trial data against the performance claims in this paper; specifically verify suction lift performance at minimum river level, behaviour during screen blockage events, and maintenance requirements relative to the conventional parallel unit
5	**Municipal Application**	Specify MPR™ module for inclusion in the next planned pump upgrade at a municipal river intake (not as a sole source replacement, but as a duty unit with conventional standby); operate in full monitored commercial service
6	**Full Programme Rollout**	Based on accumulated field data, develop a standard specification for MPR™ river intake stations applicable across the asset owner's portfolio

6. Conclusion

This white paper has set out a detailed case for the application of CST MPR™ Stable Vapour Cavity technology to river intake pumping, using the Parallel Road Water Treatment Plant intake on the Waikato River as the primary case study. The analysis has demonstrated, on a hypothetical but technically grounded basis, that the MPR™ configuration offers substantive advantages over the conventional variable-speed submersible installation actually deployed at that station.

The advantages are not marginal. They address fundamental structural vulnerabilities of submersible pump technology in river environments: the mechanical seal failure mode eliminated; the crane and barge access problem solved; the confined space hazard removed; the screen blockage trip risk converted into an automatic backflush opportunity; the cooling water dependency severed; and the electrical submersion risk eliminated. These are not theoretical improvements to an already-working system — they are the resolution of engineering problems that impose real costs, real safety obligations, and real supply security risks on every operator of a conventional river intake pump station.

The February 2026 Te Tahi WTP failure, which transformed the Parallel Road river intake from backup supply to primary supply for tens of thousands of people across the western Waipā towns, demonstrated with stark clarity the consequences of river intake pump vulnerability under storm-event conditions. The MPR™ configuration would have provided materially higher resilience across exactly the conditions — elevated suspended sediment, screen debris, river level volatility, extended high-demand operation — that the conventional submersibles would have faced during that emergency period.

Final Word	By applying the CST MPR™ technology to river intake structures, the maintenance and operational complexity imposed by conventional centrifugal pumps — which must not be allowed to run dry, must not ingest air, must not operate off their pump curve, and must be maintained in confined spaces by specialist crews — is replaced by a simpler, safer, and more resilient operating philosophy. River intake pumping is fundamentally changed by a pump that thrives in the exact conditions that damage its conventional counterpart.

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