WHEN RISK IS REAL

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ABSTRACT

Water and wastewater utilities are increasingly risk-aware but often struggle to translate risk frameworks into tangible asset outcomes. Even with good risk registers, critical work is often deferred, and the result is increased reactive work and investment above what would be expected if the critical work had progressed as planned.

The practical application of credible critical risk - risk scenarios that are operationally grounded, consequence-focused, and clearly owned - is a mechanism to drive improved asset outcomes. A case study on hydrogen sulphide (H_2S) and corrosion in a Sewage Pump Station (SPS) is used to demonstrate how an operational risk assessment can be used to reframe stalled capital projects, escalate critical asset gaps, and prioritise intervention based on consequence rather than condition alone.

A shift from abstract risk statements to shared, credible risk scenarios developed collaboratively with operational teams is highlighted. This approach enables clearer articulation of "right work at the right time," improves alignment between operations and capital delivery, and strengthens escalation of critical water and wastewater risks where system knowledge may be lacking.

Practical examples illustrate how credible risk framing improves decision-making, strengthens investment justification, and supports leadership discussions on risk tolerability. Key lessons and recommendations are provided for utilities seeking to move risk management from compliance to value creation.

1.0 INTRODUCTION

Water and wastewater services operate in high-consequence environments where failure affects service, environment, compliance, personal and public safety, and organisational reputation. While risk registers are often well developed they do not consistently translate into optimised asset lifecycle decisions.

This disconnect is commonly characterised by:

- Weak linkage between risk registers and asset management plans
- Capital programs not aligned to highest consequence risks
- Over-reliance on reactive maintenance

The result is a persistent gap between **known risks and delivered outcomes.**

This paper shows that credible critical risk – clearly defined, consequence-driven, and operationally grounded – provides a practical mechanism to bridge this gap. By linking risk to service expectations and intervention strategies, it enables more effective asset decision-making.

2.0 REFRAMING RISK FOR DECISION-MAKING

Across water and wastewater systems, significant effort is directed toward maintaining assets and delivering projects. However, this activity does not always reduce the most critical risks. Work is often prioritised based on visible defects or reactive issues rather than consequence.

To address this, risk must be reframed in practical terms -*"What can go wrong, what happens if it does, and what are we doing about it?"*

Rather than functioning as a standalone register, risk should guide decisions on:

- What requires immediate action
- What can be deferred
- What type of response is most effective

This creates a clear line of sight: **Risk → Service Expectation → Intervention Strategy → Asset Outcome**

For example:
- Prioritising risks with high safety or environmental consequence
- Selecting operational or non-asset solutions where feasible before capital investment (eg, wet well pump/level control strategy to minimise hydrogen sulfide generation and subsequent corrosion)
- Addressing root causes at the system level

To keep decisions practical and consistent, responses should be grouped into three simple questions based on a simplified hierarchy of control:

Question	Control Type
Can we **remove** the problem?	Eliminate
Can we **stop** it happening as often?	Prevent
Can we **reduce the impact** when it happens?	Mitigate

Table 1: Simplified hierarchy of control for critical risk management

This aligns with the principle of *so far as is reasonably practicable* (SFAIRP) (R2A Due Diligence Engineers, 2025), while remaining practical for day-to-day use. It ensures decisions are driven by **risk reduction effectiveness**, rather than condition alone or available budget (IAM, 2016).

2.1 Making Decisions When the Data Isn't Perfect

Water and wastewater systems rarely have complete or reliable deterioration data. Waiting for perfect data can result in delayed intervention and increased risk exposure. Waiting for perfect data before acting can lead to delayed intervention and increased risk exposure.

Instead, credible risk integrates:
- Observable system behaviour (failures, corrosion, odour, complaints)
- Operational experience
- System dynamics
- Consequence of failure

The key decision question becomes: "*Is this a real problem with real consequences - and do we need to act?"*

This gives teams confidence to make decisions earlier, even when the data isn't complete. In practice, this allows:
- Earlier intervention before failure escalation
- Greater confidence in operational and maintenance solutions
- Targeted capital investment where consequences justify it

Importantly, this approach supports better decisions while data maturity improves, rather than replacing the need for improved data.

3.0 CASE STUDY: H2S AND CORROSION IN SEWAGE PUMP STATIONS (SPS)

Hydrogen sulphide generation and corrosion in sewage pump stations is a well-recognised issue across wastewater networks. However, it is often addressed at the asset level rather than as a system-driven risk.

At GRC, there is consistent operational evidence of deterioration, including:
- Accelerated corrosion linked to H_2S and septicity
- Corrosion rates exceeding original design assumptions
- Increasing occurrences of odour, asset degradation, and service risk

While these conditions are well recognised operationally, they have not historically been structured in a way that supports consistent asset intervention. Reliability data remains incomplete, and deterioration is variable across sites, making predictive modelling difficult.

In this context, the issue is not the absence of risk, but the absence of a **clear, shared articulation of that risk linked to consequence and action**. Credible risk provides the mechanism to bridge this gap - translating observable system behaviour into a structured basis for decision-making.

3.1 Credible Risk Scenario

- **Cause:** Septicity and H_2S generation across the network
- **Event:** Toxic gas and accelerated corrosion of SPS wet wells and associated infrastructure
- **Impact:** Worker exposure, environmental harm, premature asset failure, and increased lifecycle cost

3.2 Defining the System Using SIPOC

A key step in progressing the SPS corrosion and H_2S issue was shifting from an asset-level view to a system-level understanding of the problem.

A simplified SIPOC (Suppliers–Inputs–Process–Outputs–Customers) framework (Six Sigma Institute, 2026) was used to map how H_2S is generated, transported, and realised as risk across the network. This helped articulate that the issue was not isolated to individual assets but driven by upstream conditions and system behaviour.

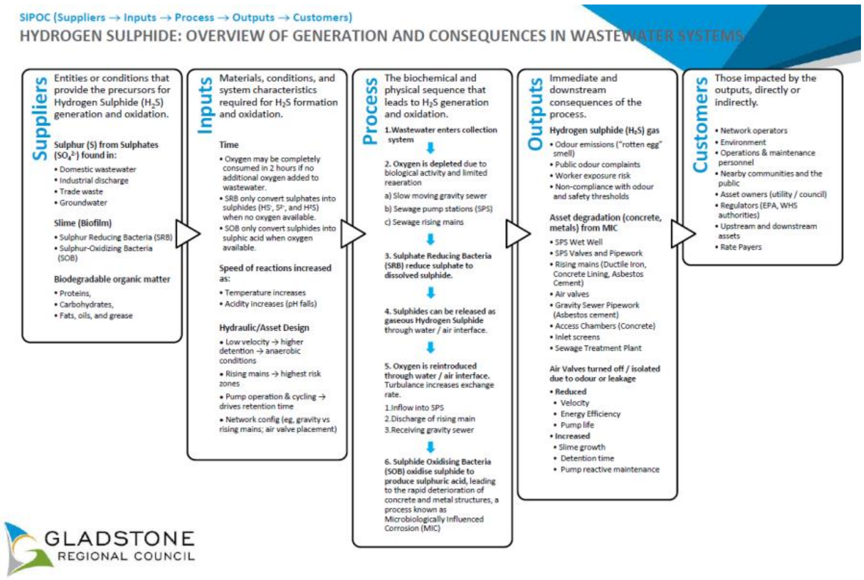

Figure 1 - SIPOC for H2S Generation & Consequences in Wastewater Systems

3.2.1 Suppliers - *Entities or conditions that provide the precursors for Hydrogen Sulphide (H2S) generation and oxidation.*

Sulphur (S) from Sulphates (SO42-) found in:

- Domestic wastewater
- Industrial discharge
- Groundwater

Slime (Biofilm)

- Sulphur Reducing Bacteria (SRB)
- Sulphur-Oxidizing Bacteria (SOB)

Biodegradable organic matter

- Proteins

- Carbohydrates
- Fats, oils, and grease

3.2.2 Inputs - Materials, conditions, and system characteristics required for H_2S formation and *oxidation.*

Time

- Oxygen may be completely consumed in 2 hours if no additional oxygen added to wastewater.
- SRB only convert sulphates into sulphides (HS-, S2-, and H2S) when no oxygen available.
- SOB only convert sulphides into sulphuric acid when oxygen available.

Speed of reactions increased as:

- Temperature increases
- Acidity increases (pH falls)

Hydraulic/Asset Design

- Low velocity → higher detention → anaerobic conditions
- Rising mains → highest risk zones
- Pump operation & cycling → drives retention time
- Network configuration (eg, gravity vs rising mains; air valve placement)

3.2.3 Process - *The biochemical and physical sequence that leads to H_2S generation and oxidation.*

1. Wastewater enters collection system
2. Oxygen is depleted due to biological activity and limited reaeration
   a) Slow moving gravity sewer
   b) Sewage pump stations (SPS)
   c) Sewage rising mains
3. Sulphate Reducing Bacteria (SRB) reduce sulphate to dissolved sulphide.
4. Sulphides can be released as gaseous Hydrogen Sulphide through water / air interface.
5. Oxygen is reintroduced through water / air interface. Turbulence increases exchange rate.
   d) Inflow into SPS
   e) Discharge of rising main
   f) Receiving gravity sewer
6. Sulphide Oxidising Bacteria (SOB) oxidise sulphide to produce sulphuric acid, leading to the rapid deterioration of concrete and metal structures, a process known as Microbiologically Influenced Corrosion (MIC)

3.2.4 Outputs - *Immediate and downstream consequences of the process.*

Hydrogen sulphide (H_2S) gas

- Odour emissions (“rotten egg” smell)
- Public odour complaints
- Worker exposure risk
- Non-compliance with odour and safety thresholds

Asset degradation (concrete, metals) from MIC

- SPS Wet Well
- SPS Valves and Pipework
- Rising mains (Ductile Iron, Concrete Lining, Asbestos Cement)
- Air valves
- Gravity Sewer Pipework (Asbestos cement)
- Access Chambers (Concrete)
- Inlet screens
- Sewage Treatment Plant

Air Valves turned off / isolated due to odour or leakage

- Reduced
  - Velocity

- Energy Efficiency
  - Pump life
- Increased
  - Slime growth
  - Detention time
  - Pump reactive maintenance

3.2.5 Customers - *Those impacted by the outputs, directly or indirectly.*

- Network operators
- Environment
- Operations & maintenance personnel
- Nearby communities and the public
- Asset owners (utility / council)
- Regulators (EPA, WHS authorities)
- Upstream and downstream assets
- Rate Payers

3.3 Key Insight

Analysis identified detention time as the primary driver of H_2S generation across the network. This indicates that risk is governed by system behaviour (residence time) rather than isolated asset condition. Even with limited predictive modelling, the combination of observed evidence, operational experience, and consequence is sufficient to justify action.

This shifts the intervention approach from condition-based renewal to causal risk reduction, including:

- Trialling operational changes first
- Targeting maintenance based on risk exposure
- Justifying capital works that directly address system drivers

Interventions become aligned to a simplified hierarchy of control:

- **Eliminate (system-level controls)**
  - Network balancing to reduce septicity
  - Upstream condition control
- **Prevent (reduce likelihood)**
  - Optimised pump operation
  - Targeted chemical dosing
  - Risk-based monitoring and inspection
- **Mitigate (reduce consequence)**
  - Protective coatings
  - Ventilation and odour control
  - SPS upgrades and network augmentation

This reframes decision-making from *"which assets need upgrading?"* to:
"Which interventions most effectively reduce risk, and where should they be applied?"

3.4 From Reactive Work to Structured Planning

Implementation is ongoing, and results are preliminary. However, several early shifts are evident:

- Improved visibility between risk, service levels, and interventions
- Increased use of low-cost operational solutions
- Stronger focus on consequence-driven decision-making

While long-term outcomes are not yet quantified, this represents a shift in how decisions are framed, forming a foundation for more mature asset management.

3.5 Shifting Risk Culture from Awareness to Ownership

Recent workshops and operational discussions also show that when teams are given a clear system-level view of risk, ownership increases. Structured scenarios and system maps help individuals see how their roles connect to service outcomes and failure pathways.

As risks become tangible, discussion becomes more practical and action oriented. Teams begin identifying realistic opportunities to influence outcomes within existing capability, even before additional funding is available.

This shift is notable. Initial responses often reflect a degree of frustration or perceived lack of control. However, as risks are clarified and made tangible, discussions become increasingly action oriented. Individuals and teams naturally begin to identify practical opportunities to influence outcomes within their control, even in the absence of additional resources or capital.

Importantly, this response is not driven by mandate or process alone. It reflects a genuine sense of ownership and responsibility for service delivery and the wellbeing of others. When risk is clearly understood and shared, it creates alignment not only in decision making, but in intent - supporting a more proactive and cohesive approach to managing complex systems like water and wastewater.

4.0 CONCLUSION

Credible critical risk provides a practical mechanism to connect risk frameworks with asset decision-making. By grounding risk in operational reality, clarifying ownership, and linking consequence directly to action, utilities can improve prioritisation, strengthen investment justification, and reduce the persistent gap between known risks and delivered outcomes.

Importantly, this approach enables effective decision-making even where reliability data is limited. Observable system behaviour, operational experience, and consequence provide a sufficient basis to act, allowing earlier intervention while data maturity continues to develop. Structured methodologies, such as SIPOC, support this by clarifying system boundaries and causal relationships, enabling intervention at the point of cause rather than consequence.

Applying a simplified hierarchy of control ensures responses are proportionate and effective across operational, maintenance, and capital solutions. This shifts the focus from condition-based renewal toward targeted risk reduction, improving both efficiency and impact of investment.

This paper demonstrates that improved outcomes are not achieved through additional risk frameworks alone, but through defining risk in a way that enables action. When risk is credible, shared, and clearly connected to service consequences, it changes how decisions are made, how work is prioritised, and how teams respond.

For water and wastewater utilities, the opportunity is clear - to move beyond risk awareness and toward risk-driven action that delivers measurable service and asset outcomes.

5.0 ACKNOWLEDGEMENTS

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6.0 REFERENCES

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