



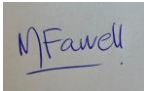
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International Comparators

Taumata Arowai

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GHD Limited 9429038699856

Contact: Claire Edmondson, Project Lead | GHD

27 Napier Street, GHD Centre Level 3

Freemans Bay, Auckland 1010, New Zealand

T +64 9 370 8000 | **F** +64 9 370 8001 | **E** aklmail@ghd.com | **ghd.com**

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Executive Summary

In partnership with MartinJenkins (MJJs), GHD has been commissioned to support the development of the National Engineering Design Standards (NEDS) framework and look at domestic and international comparators.

This report examines how four international jurisdictions regulate public water infrastructure outcomes and engineering expectations, with a focus on identifying lessons relevant to the development of NEDS in New Zealand. The analysis compares regulatory approaches in England and Wales, Scotland, Canada, and Australia across performance objectives, levels of prescription, asset classification, and treatment of stormwater.

Across all four of the international jurisdictions reviewed, regulators pursue broadly consistent high-level outcomes: protection of public health, environmental protection, service reliability, and long-term asset resilience. However, these outcomes are generally expressed as performance measures rather than being translated into explicit engineering requirements at the design stage. Most jurisdictions rely heavily on outcome monitoring, licensing, audits, and post-incident enforcement to demonstrate compliance once assets are operational. While effective at identifying failure after it occurs, these approaches provide limited assurance that risks have been systematically addressed during design.

Scotland stands apart as the only comparator that meaningfully links regulatory outcomes to nationally consistent and mandatory engineering expectations. It combines performance monitoring with prescribed national technical standards and formal design and adoption gateways for public water assets. This enables assurance earlier in the infrastructure lifecycle and materially reduces systemic risk by embedding design consistency upfront, rather than relying solely on downstream regulatory intervention.

Levels of prescription vary significantly across the four jurisdictions. England and Wales operate with very low prescription, relying largely on non-statutory guidance and outcomes-based economic regulation. Canada and Australia sit within a low-to-moderate range, with fragmented provincial or sector-specific standards and limited national consistency. In contrast, Scotland provides highly prescriptive, nationally mandated technical standards for public infrastructure, reflecting a deliberate effort to eliminate regional variability and ensure consistent asset performance.

The four jurisdictions also differ in their priorities for national standardisation. England and Wales emphasise outcomes at the point of harm, consistent with its focus on regulating monopoly provider performance. Canada prioritises baseline public health and environmental protection within a decentralised federal system. Australia concentrates more prescriptive controls on high-risk or building-level assets where safety consequences are immediate. Scotland, by contrast, prioritises nationally consistent design expectations for publicly owned assets, enabled by a governance model that supports central enforcement. New Zealand's proposed NEDS approach most closely aligns with this model, seeking to prevent hidden or systemic risks through standardisation of design expectations before assets are constructed.

Asset classification frameworks further illustrate Scotland's distinctiveness. It is the only jurisdiction reviewed that explicitly links asset categorisation and vesting status to nationally controlled design expectations. In the other three comparator jurisdictions, classification is primarily used to determine oversight intensity, monitoring frequency, or operator obligations, rather than to drive design consistency. This highlights a key opportunity for NEDS to establish a clear regulatory logic that links asset category to performance expectations and design requirements, improving transparency, scalability, and regulatory assurance.

Stormwater emerges as the least developed and least standardised component across all four jurisdictions. Compared to drinking water and wastewater, it lacks clear performance objectives, consistent design standards, and robust lifecycle assurance mechanisms. Responsibility is often fragmented across local or municipal authorities, with limited national coordination. This fragmentation results in variable performance and reduced visibility of system risk. As such, stormwater represents the most significant gap—and the greatest opportunity—for NEDS to deliver value through nationally consistent engineering expectations.

The report also provides a high-level overview of how Indigenous rights are upheld in Canada. Canada's constitution protects Indigenous land and water rights. The government must consult and, when necessary, accommodate Indigenous peoples, when water infrastructure projects impact their rights. Large or major projects may also require consent, especially where Aboriginal title is strong or established, which is common in British Columbia.

British Columbia is the only Canadian province that has enacted legislation to align all provincial laws with UNDRIP (UN Declaration on the Rights of Indigenous Peoples). This means that water service planning, permitting and infrastructure approaches are legally exposed and can be challenged in the courts (up to supreme court level) if Indigenous rights are not meaningfully respected. Further, Indigenous rights are not explicitly addressed within standards or codes, which are designed to remain culturally neutral and do not incorporate Indigenous values into performance criteria.

In order to address seismic risk in New Zealand, a review and comparison were conducted with Japan, Chile, and California to evaluate their implementation of design standards for seismic mitigation. The main takeaways from comparing these regions are:

- Strong governance and clear roles and enforcement powers are essential for success with the separation of economic/service performance, drinking water quality, and environmental protection functions.
- Drinking water and wastewater assets are generally more consistently regulated and managed than stormwater assets.
- Outcomes-based regulation works best when the outcomes are measurable and independently verified.
- Pragmatic regimes provide a minimum design standard or a deemed to comply pathway, but also enable alternatives that can be demonstrated to meet the same outcome
- Lifecycle and asset-health leading indicators are critical because the use of lagging indicators, such as incidents and failures, identifies problems too late.

1. Introduction

1.1 Purpose of this report

This report compares four international jurisdictions to inform the design of New Zealand's National Engineering Design Standards (NEDS). As NEDS are proposed as a new, nationally unified, performance-based framework and a significant departure from New Zealand's historically fragmented, prescriptive local standards, it benefits strongly from learning how similar reforms have worked or conversely not worked elsewhere.

Additionally, the report provides an overview of how Indigenous rights are maintained in Canada, and examines how seismic risk can be integrated into processes by reviewing approaches taken in Japan, Chile, and California.

2. Scope and limitations

2.1 Scope of work

The scope of work will support the development and refinement of the NEDS by establishing nationally consistent, performance-based requirements for the planning, design, construction, and renewal of drinking water, wastewater, and stormwater networks.

This includes defining clear service outcomes, functional performance criteria, and durability expectations across all three waters, informed by international best practice and scalable across different system sizes and environments. The scope will also address the whole-of-asset lifecycle considerations, including design life assumptions, resilience and climate adaptability, constructability, operation and maintenance requirements, and end-of-life management. In addition, it will specify minimum asset information and data requirements to support regulatory compliance, asset management, and long-term investment planning, ensuring interoperability with digital systems and enabling consistent decision-making across the water services sector.

2.2 Limitations

While international comparators provide valuable reference points for informing the design of the NEDS, their use is subject to several important limitations. Data availability and transparency vary significantly across jurisdictions, with differences in how performance outcomes, asset condition, and lifecycle costs are measured, documented, and reported, limiting the ability to draw direct or comprehensive comparisons.

Institutional contexts also differ materially, including governance arrangements, regulatory powers, funding models, risk allocation, and levels of centralisation, meaning that standards developed elsewhere may not translate directly to New Zealand's legislative, environmental, or sector structure.

As a result, many international comparisons are indicative rather than definitive. With the help of subject matter experts, they help illustrate possible approaches, design principles, and trade-offs, but cannot be adopted wholesale without adaptation. Accordingly, international evidence should be applied judiciously, complemented by local expertise and contextual analysis to allow NEDS to remain relevant within the New Zealand water services system.

2.3 Disclaimer

This report has been prepared by GHD for Taumata Arowai and may only be used and relied on by Taumata Arowai for the purpose agreed between GHD and Taumata Arowai.

GHD otherwise disclaims responsibility to any person other than Taumata Arowai arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed as of the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

3. Methodology

3.1 Jurisdiction Selection Criteria

International jurisdictions were chosen to guide NEDS development because they share legal and regulatory frameworks similar to New Zealand's, and statutory regulation plays a significant part in their water service delivery. Priority was given to jurisdictions facing similar infrastructure pressures, such as rapid urban growth, climate-driven hydrological variability, natural hazard risks (including seismicity where relevant), and ageing water assets.

The jurisdictions also had established standards or guidance covering all three waters, namely: drinking water, wastewater, and stormwater, to support an integrated systems perspective.

Jurisdictions that employ performance-based or outcomes-focused design requirements, ideally at a national level were also chosen.

3.2 Research Approach

The research approach is based on a structured desktop review of international material to address the following core questions:

- What is the overall structure (what is the legislation, the regulations beneath it, and relevant standards/codes. How are these structured? Who is responsible for that system - e.g. what is the role of the regulator vs industry bodies?)
- What are the specific performance outcomes for infrastructure that are regulated (for each of the waters, if they differ)
- What are the ways of demonstrating compliance, including through defined codes, etc.? What codes/standards exist?
- How does the regime approach data requirements, regional variation, and verification?

This includes referring to publicly available legislation, engineering standards, codes of practice, and additional guidance by subject matter experts across selected comparator jurisdictions. Findings are assessed using an analytical framework aligned to NEDS requirements, enabling systematic comparison of scope, performance-based design principles, asset lifecycle considerations, and information requirements, and ensuring insights are directly applicable to the objectives of a nationally consistent, performance-oriented standard for New Zealand's three waters sector

The work was carried out by international water sector practitioners, primarily from the perspective of the engineering user, and in response to the guiding questions provided in Appendix A. In some cases, questions could not be fully answered based on the reference material consulted and instead would benefit from conversations with regulatory authorities to understand their perspectives. Such communications were not carried out as part of the scope for this work.

4. Jurisdiction Overview Table

4.1 England and Wales

Table 1 England and Wales Jurisdiction Overview Table

	England and Wales
Jurisdiction Overview	What problem was this regulatory regime created to address? The water services regulatory regime in England and Wales was established following the 1989 privatisation of ten publicly owned regional water authorities, which transferred essential water and wastewater infrastructure into private monopoly ownership and created risks that could not be managed through market competition. Stormwater infrastructure management remained with local councils. The regime was designed to address three core problems: the absence of competitive pressure to constrain prices or sustain long-term investment; the continued public responsibility for health and environmental protection despite private ownership; and the risk that private companies could maximise short-term shareholder returns by deferring maintenance and renewal of assets with lifespans of multiple decades (Water Industry Act 1991). To manage these risks, the government created an outcomes-based regulatory system to replicate competitive discipline through regulation rather than ownership, establishing Ofwat as an independent economic regulator to control prices, require efficient investment, and penalise underperformance, alongside the Drinking Water Inspectorate and Environment Agency to safeguard public health and environmental outcomes. While early regulation prioritised price control and efficiency, subsequent pollution incidents, evidence of deteriorating asset condition, and declining public confidence demonstrated that this approach systematically undervalued long-term asset health and resilience, prompting successive reviews and reforms to strengthen performance accountability and sustainability (Cunliffe, 2020; Ofwat, 2019). How does the regime work overall? The water services regulatory regime in England and Wales operates as a multi-layered, outcomes-based system in which accountability is divided between Ofwat (economic and service performance), the Drinking Water Inspectorate (DWI) (public health), and the Environment Agency (EA) (environmental protection), each regulating what outcomes must be achieved rather than prescribing how infrastructure is engineered. The Water Industry Act 1991 establishes statutory duties for water companies to supply drinking water and provide sewerage services, including the drainage of surface water where it enters the public sewer network, but it does not regulate stormwater as a distinct service or set specific stormwater performance or design standards. As a result, stormwater (particularly in the form of runoff conveyed through combined sewer systems) is regulated indirectly through sewerage duties under the Act, with modern stormwater expectations addressed primarily through environmental permitting, planning controls, and subsequent legislation rather than the core water statute (Water Industry Act 1991; Environment Act 2021). High-level statutory duties are translated into quantified performance commitments through Ofwat's five-year price review process (e.g. PR19 and PR24), covering outcomes such as pollution incidents, supply interruptions, sewer flooding, and storm overflow

	England and Wales
	performance, while companies retain discretion over engineering and asset management approaches. Ofwat's performance framework regulates non-economic public outcomes using economic incentives. Regulatory behaviour is driven mainly through retrospective financial incentives and penalties, meaning that engineering standards operate largely as internal company documents and non-statutory guidance. Consequently, regulatory accountability flows from observed outcomes back to engineering decisions, with failures in drinking water quality, wastewater discharges, or storm overflow performance triggering investigation and enforcement rather than advanced technical approval (Ofwat, 2019, 2024; Cunliffe, 2020). How is the regulatory framework structured at a high level? The regulatory framework for water services in England and Wales is structured as a four-layer, non-linear system that separates statutory duties, performance enforcement, technical guidance, and assurance rather than operating as a single compliance pathway. At the top level, the Water Industry Act 1991 establishes the legal duties of water companies and the powers of regulators in relation to service provision, drinking water safety, and environmental protection, but deliberately contains no engineering design requirements. These duties are operationalised through the performance and economic framework administered by Ofwat, where five-yearly price reviews set Outcome Delivery Incentives (ODIs) that attach financial rewards or penalties to outcomes such as pollution incidents, supply interruptions, and sewer flooding (e.g. PR19, PR24). Beneath this sit non-statutory standards, guidance, and codes of practice, including company-specific engineering standards, Design and Construction Guidance (DCG), British Standards, and CIRIA manuals, which provide deemed good practice but have no legal force and may be departed from if justified. Compliance is assessed through a fourth layer of assurance, scrutiny, and enforcement, including annual regulatory reporting, independent assurance, inspections, incident investigations, and price review assessments, with escalation to fines or prosecution for persistent or serious failures. Critically, adherence to guidance or internal standards does not itself constitute compliance; companies must continuously demonstrate that their engineering and investment decisions are delivering the required outcomes in practice, not simply that a prescribed process was followed (Ofwat, 2019; Ofwat, 2024; Water Industry Act 1991). Who is the regulator, and what formal powers do they have to enforce the regime? Regulatory oversight of water services in England and Wales is exercised through a deliberately fragmented model involving three regulators with distinct and non-overlapping powers, rather than a single integrated authority. Ofwat, the economic regulator, controls prices through five-year price reviews, sets company-specific performance commitments, assesses business plans, and enforces compliance primarily through financial incentives, penalties, licence conditions, and, ultimately, licence revocation, but it does not inspect physical assets or approve engineering designs (Ofwat, 2019, 2024). The Drinking Water Inspectorate (DWI) regulates drinking water quality and safety, with powers to conduct audits and site inspections, issue legally binding enforcement notices, require remedial capital investment, and prosecute for serious breaches of water quality regulations (DWI, 2022). The Environment Agency (EA) regulates abstractions and environmental discharges through a permitting regime that applies to all wastewater treatment works and significant stormwater outlets, supported by inspection, investigation, and prosecution powers, including the imposition of substantial fines for illegal sewage discharges (Environment Agency, 2023). Defra sets overarching water policy and issues statutory guidance but does not directly regulate companies; however, the 2025 Independent Review of the Water Sector recommended closer alignment between Defra and Ofwat, which, if implemented, would reduce the traditional arm's-length separation between policy and economic regulation (Cunliffe, 2025).

	England and Wales Collectively, these bodies can require changes to operational practice and asset management, mandate investment where risks are unacceptable, impose financial and reputational penalties, and escalate persistent failures through formal enforcement. Crucially, none of the regulators mandates engineering design solutions in advance; instead, they hold companies accountable for the consequences of engineering decisions, meaning enforcement is triggered by outcome failure, for example, repeated sewer flooding or pollution incidents, rather than non-compliance with prescribed design standards (Water Industry Act 1991).
Setting performance requirements	What performance areas or outcomes are regulated (e.g. safety, reliability, environmental protection, service quality), and why? Water infrastructure performance regulation in England and Wales focuses on four interrelated outcome areas (public health, environmental protection, service reliability, and long-term resilience) each regulated because failure produces harm that it is perceived that monopoly markets struggle to self-correct. Drinking water safety and security of supply are regulated through mandatory water quality standards and service continuity metrics overseen by the Drinking Water Inspectorate, reflecting the immediate and non-negotiable risks to human health from contamination or loss of supply (Water Industry Act 1991, Drinking Water Inspectorate, 2022). Environmental protection outcomes, regulated by the Environment Agency, include pollution incident frequency and compliance with discharge permits, on the basis that wastewater companies are considered the largest source of water pollution in England and that ecological harm is often irreversible once it occurs (Environment Agency, 2023; Environment Act 2021). Service reliability and customer experience, such as sewer flooding, low-pressure risk, and complaint volumes, are regulated by Ofwat to protect customers who lack alternative providers in a natural monopoly context (Ofwat, 2019). Since PR19, Ofwat has also introduced explicit outcomes for long-term resilience and asset health, requiring companies to demonstrate that investment plans maintain network condition over time, in response to evidence that earlier incentive structures allowed short-term performance gains while asset deterioration accumulated invisibly until failure (Cunliffe, 2020; Ofwat, 2025). Across all four areas, regulation is applied through outcome metrics rather than engineering specifications, meaning companies are judged on the frequency and severity of failures, such as pollution incidents or service interruptions, rather than compliance with prescribed design standards (Ofwat, 2019). How are performance requirements set and structured, and to what level of detail? In England and Wales, performance requirements are established through Ofwat's five-yearly price review process (e.g. PR19 covering 2020–2025 and PR24 covering 2025–2030), in which each water and sewerage company proposes a tailored set of Performance Commitments for the forthcoming regulatory period (Ofwat, 2019; Ofwat, 2024). Each commitment is defined by a specific outcome metric (such as the number of Category 1 and 2 pollution incidents), a historical baseline, a target trajectory across the five years, and an associated Outcome Delivery Incentive (ODI) rate expressed as a financial reward or penalty per unit of out- or under-performance. These requirements are highly quantified at the outcome level but deliberately non-prescriptive at the engineering level: companies are free to determine how outcomes are delivered, whether through new assets, operational changes, monitoring technology, or demand management, provided they can demonstrate credibility through their business plans and asset strategies. As a consequence, two companies may face identical regulatory outcome targets yet adopt materially different engineering standards or design assumptions, a difference that is largely invisible to regulators unless or until performance diverges, illustrating a structural gap between outcome accountability and upstream design assurance (Cunliffe, 2020; Ofwat, 2019).

	England and Wales
	What are the compliance pathways and verification mechanisms? England and Wales do not operate a single, standardised compliance pathway for water infrastructure design that is based on conformance with prescribed technical standards; instead, companies must continuously demonstrate, through performance evidence and governance, that they are delivering their regulatory commitments. Compliance is verified through three complementary mechanisms. First, companies submit annual regulatory performance reports to Ofwat, the Environment Agency, and the Drinking Water Inspectorate, with independent assurance requirements that increase where companies' self-identify underperformance or where metrics carry high financial exposure (Ofwat, 2019). Second, at each five-year price review, Ofwat scrutinises company business plans, asset management strategies, and technical assumptions to assess whether proposed investments are credible and sufficient to deliver performance commitments; companies with weak or poorly evidenced plans receive reduced funding allowances and heightened regulatory oversight (Ofwat, 2024). Third, incident-based investigation and enforcement provide retrospective verification: when serious failures occur (such as pollution incidents, drinking water quality breaches, or widespread sewer flooding) regulators assess whether engineering decisions including design, maintenance practices, and governance arrangements were adequate, with escalation to enforcement action where necessary (Environment Agency, 2023; Drinking Water Inspectorate, 2022). Throughout the regime, alternative engineering approaches are implicitly permitted, and no regulator pre-approves designs; the adequacy of design and asset management choices becomes visible to regulators only once outcomes diverge from commitments, reinforcing the system's reliance on post-event accountability rather than ex-ante design assurance (Cunliffe, 2020). What standards or Codes of Practice support compliance? In England and Wales, the engineering standards and Codes of Practice that support regulatory compliance sit entirely outside the statutory framework and have no direct legal force, operating instead as guidance only. The primary layer consists of company-specific engineering standards, under which each water and sewerage company defines its own requirements for asset design, construction, and maintenance; these standards vary significantly in scope and technical conservatism, meaning that identical assets may be built to different specifications depending on the operator (Ofwat, 2019). Alongside these sit industry guidance documents, including the Design and Construction Guidance (formerly Sewers for Adoption), British Standards, and CIRIA manuals, which provide widely recognised reference points for good practice but are not mandatory and may be departed from if companies can justify alternative approaches on engineering grounds (Water UK, 2023). These standards cover all 3 waters across them, but not in a single, unified way. In addition, regulatory guidance issued by Ofwat, the Environment Agency, and the Drinking Water Inspectorate shapes expectations for investment planning, environmental compliance, and drinking water safety but does not prescribe technical design requirements (Drinking Water Inspectorate, 2022; Environment Agency, 2023). Regulators expect companies to apply recognised good practice and will scrutinise departures from guidance during price reviews or enforcement action; however, the absence of statutory design standards means that definitions of "good practice" remain company-specific, making inconsistency across the sector a structural feature rather than an isolated flaw (Cunliffe, 2020).

	England and Wales
	How often are requirements reviewed or changed, and why? In England and Wales, performance requirements for water and wastewater services are formally reviewed and reset every five years through Ofwat's price review cycle (most recently PR19 for 2020–2025 and PR24 for 2025–2030), during which baseline performance levels are recalibrated, targets are tightened or relaxed, and Outcome Delivery Incentive (ODI) rates are adjusted in light of observed performance and emerging risk (Ofwat, 2019, 2024). In England, stormwater design and performance are reviewed case-by-case through the development management (planning) process, rather than via a stand-alone regulatory approval regime. Lead Local Flood Authorities (LLFAs) typically county or unitary councils, act as statutory consultees for surface water drainage on major developments (for example, residential developments of 10 dwellings or more) under the Flood and Water Management Act 2010 framework. Their role is to technically review drainage strategies, Sustainable Drainage Systems (SuDS) proposals, exceedance routing, maintenance arrangements, and climate change allowances, and to advise the local planning authority on whether proposals are acceptable and compliant with national planning policy. Between price reviews, requirements can also change in response to three main triggers: significant incidents or compliance failures that expose systemic risk, for example, the widespread use of event duration monitoring after 2020 revealed the true frequency of storm overflow discharges and led to new overflow-specific performance expectations mid-cycle (Environment Agency, 2023); changes in primary legislation, most notably the Environment Act 2021, which introduced statutory duties to reduce storm overflows that translated directly into tighter regulatory expectations; and emerging evidence from climate risk assessments, asset health reporting, and sector-wide data programmes. This five-year review cycle provides certainty and stability for investment planning, but also creates a structural limitation, as systemic problems identified early in a regulatory period may not be fully addressed until the next price review is implemented several years later, reinforcing the regime's reliance on retrospective rather than anticipatory adjustment (Cunliffe, 2020). How are connections to the network covered? Connections to public water and sewer networks in England and Wales are governed by statutory rights and adoption processes under Sections 104 and 106 of the Water Industry Act 1991, which define who may connect and on what legal terms, but deliberately avoid prescribing engineering design requirements. Section 104 applies to the adoption of new sewers constructed by developers, while Section 106 provides a right to connect surface water and foul drainage directly to existing public sewers, subject to company consent. Although these provisions establish the legal framework for connection, technical design requirements, such as pipe materials, gradients, manhole spacing, and hydraulic capacity, are set through non-statutory, company-specific adoption standards, including the Design and Construction Guidance (DCG). As a result, identical developments may face materially different technical requirements depending on the receiving company; for example, a sewer designed for adoption by Wessex Water in Bristol may be subject to different standards than one adopted by Yorkshire Water in Leeds (Water UK, 2023). The section above does apply to stormwater (surface water) where that stormwater connects to the public sewer network, but it does not apply to stormwater more generally where drainage is managed through SuDS, watercourses, or highway drainage. Compliance is achieved contractually at the point of adoption, as companies will not vest assets that do not meet their standards, but once assets are adopted there is no ongoing regulatory mechanism to verify whether the design standards applied at construction remain adequate over the asset's operational life, reinforcing the regime's reliance on upfront acceptance rather than lifecycle assurance (Water Industry Act 1991; Ofwat, 2019).

	England and Wales
	How is asset management across the lifecycle covered? In England and Wales, asset management across the infrastructure lifecycle is addressed through regulatory expectations and reporting requirements rather than prescribed technical standards. The Water Industry Act 1991 imposes a general duty on water companies to maintain their networks in a condition fit for purpose but does not define minimum standards for maintenance, renewal, or replacement. Ofwat has progressively strengthened lifecycle oversight through the price review process, and since PR19 has required companies to report asset health metrics alongside investment plans demonstrating how long-term network condition will be maintained or improved (Ofwat, 2019). With most stormwater infrastructure sitting outside the public sewer network that is delivered through SuDS, highway drainage, and watercourses, the lifecycle asset management depends on planning conditions, adoption decisions, and local authority policy, rather than statutory standards. In England, ongoing maintenance is discretionary and varies widely between councils, often relying on commuted sums or private ownership, while in Wales, Schedule 3 of the Flood and Water Management Act provide a clearer pathway where approved SuDS vest to SuDS Approving Bodies, who then assume lifecycle management responsibility. In 2025, Ofwat introduced the Asset Health Measurement Framework, providing a more structured and comparable approach to assessing asset condition and risk across companies; however, this framework functions primarily as a reporting and assurance tool, not as a design or maintenance standard (Ofwat, 2025). Companies are also expected, though not legally required, to align with ISO 55001 as evidence of asset management maturity, with alignment considered during price review assessments. In practice, the use of Outcome Delivery Incentives (ODIs) has created a documented behavioural effect, whereby companies prioritise investments that improve short-term performance metrics within the five-year regulatory period while deferring maintenance or renewal that protects long-term asset condition but does not directly affect ODI scores, a dynamic often described as “sweating the assets” (Cunliffe, 2020). Although the Asset Health Measurement Framework is intended to counter this effect, a significant gap remains: companies can meet regulatory reporting expectations while managing individual asset classes, such as pumping stations, treatment works, or trunk mains, to widely varying internal standards, because there is no common, statutory baseline defining what constitutes adequate lifecycle management for specific asset types. What information requirements exist? In England and Wales, water companies are subject to extensive information and reporting requirements, but these are framed primarily around outcomes and performance metrics rather than standardised engineering data. Companies must publish Annual Performance Reports, which contain audited data against all regulatory commitments, including service quality, environmental performance, and asset health indicators, and which form the basis of Ofwat’s ongoing comparative and enforcement activity (Ofwat, 2019). In addition, companies submit detailed regulatory data returns, notably the annual June Return, covering operational and financial information in prescribed reporting categories; while these datasets are highly specified at the metric level, they do not mandate how underlying engineering information, such as design assumptions, asset condition data, or remaining life estimates are captured or managed (Ofwat, 2024). Separate incident reporting regimes require immediate notification to the Drinking Water Inspectorate of drinking water quality breaches and to the Environment Agency of pollution incidents, followed by investigation reports; however, the technical and engineering data used to explain causal factors are compiled by companies and

	England and Wales
	assessed retrospectively rather than reported through a common schema (Drinking Water Inspectorate, 2022; Environment Agency, 2023). There is no national standard or common data architecture for engineering asset records, as-built information, or condition assessments, and each company maintains its own asset register in its own format. While regulators can request detailed technical information, they currently lack the power to require consistent engineering data structures across the sector, limiting comparability and proactive assurance of asset adequacy (Cunliffe, 2020). Information requirements for stormwater (surface water drainage) are outcome-focused and decentralised, with obligations arising mainly through planning, approval, and adoption processes rather than a single national data standard. For new development, applicants must submit drainage strategies and supporting information to local authorities, primarily Lead Local Flood Authorities in England and SuDS Approving Bodies (SABs) in Wales, covering runoff rates and volumes, discharge destinations, exceedance routing, climate-change allowances, water-quality treatment, and proposed maintenance arrangements. Where stormwater assets are adopted (for example, SuDS vesting to SABs in Wales or surface water sewers adopted by water companies), handover information must be sufficient to support ongoing maintenance, yet there is no nationally standardised asset data schema or lifecycle reporting requirement. How is performance checked and reported? In England and Wales, performance is monitored through a combination of company self-reporting, independent assurance, and direct regulatory oversight, with financial consequences as the primary compliance lever. Water companies report annually against each of their regulatory performance commitments, with data subject to independent third-party assurance at a level of rigour that scales with materiality, metrics linked to higher Outcome Delivery Incentive (ODI) exposure require more stringent assurance (Ofwat, 2019). Ofwat publishes sector-wide performance scorecards each year, ranking companies on key service, environmental, and resilience metrics, which creates reputational pressure alongside financial incentives, as consistently poor performers attract intensified regulatory scrutiny, media attention, and parliamentary interest (Ofwat, 2024). In parallel, the Drinking Water Inspectorate (DWI) and Environment Agency (EA) operate independent inspection and monitoring programmes that provide a check on company-reported data; for example, the EA's event duration monitoring for storm overflows now delivers near-real-time discharge information that substantially reduces reliance on operator self-reporting (Environment Agency, 2023). At each five-year price review, Ofwat reconciles cumulative performance against commitments and applies net ODI rewards or penalties to future revenue allowances, under PR19, this resulted in net penalties of approximately £157 million across the sector, reinforcing the central role of economic incentives in enforcing performance, with reputational consequences operating as an increasingly powerful secondary mechanism (Ofwat, 2019; Cunliffe, 2020). For non-sewer stormwater systems, including SuDS, highway drainage, and ordinary watercourses, performance is checked primarily by local councils: in England via Lead Local Flood Authorities acting through planning conditions, post-construction inspections, and investigation of flooding under Section 19 of the Flood and Water Management Act 2010; and in Wales via SuDS Approving Bodies, which have powers to approve, inspect, adopt, and enforce compliance of SuDS schemes. Ongoing performance reporting is largely reactive rather than routine, triggered by flooding events, complaints, or pollution incidents, and there is no national, standardised performance reporting regime for stormwater systems comparable to those for drinking water or wastewater, resulting in limited consistency and visibility of long-term performance across the jurisdiction.

	England and Wales
	How does the economic and performance frameworks set by Ofwat relate to the NEDS scope? The economic and performance frameworks set by Ofwat and the scope of NEDS address complementary but distinct regulatory problems, operating at different points in the infrastructure lifecycle. Ofwat's framework regulates what outcomes water companies must deliver, such as reduced pollution incidents, improved service reliability, and stronger long-term resilience, using economic incentives, price controls, and performance penalties applied retrospectively through the five-year price review process (Ofwat, 2019, 2024). By contrast, NEDS-type frameworks are concerned with how infrastructure should be designed and built upfront, translating public outcomes into minimum engineering, data, and design requirements before assets enter service. The England and Wales experience demonstrates that Ofwat's outcomes-based approach, whilst applied in a retrospective manner, can improve transparency and accountability but leaves a design-assurance gap, as materially different engineering standards can sit behind identical performance commitments until failures occur (Cunliffe, 2020). In this context, NEDS would not duplicate Ofwat's role but could complement economic regulation by identifying key performance/outcome areas and embedding nationally consistent engineering requirements that reduce hidden risk and support earlier assurance of asset adequacy, rather than relying solely on lagging metrics.
How assets, activities or contexts are classified for regulation	How does the regime approach different waters (e.g. stormwater, wastewater, drinking water)? The regime in England and Wales regulates drinking water, wastewater, and stormwater as distinct services with different regulatory leads, reflecting their different risk profiles, even though much of the underlying infrastructure was not originally designed around that separation. Drinking water is regulated primarily for public-health risk, with the Drinking Water Inspectorate enforcing strict statutory quality standards and requiring mandatory investigation and remediation when failures occur. Wastewater is regulated mainly for environmental risk through Environment Agency permits that control the quality and volume of discharges, with enforcement focused on protecting receiving waters. Stormwater, particularly via combined sewer overflows, which constitute about 20% of the networks (Water UK, 2023), has become the most contentious area because modern regulatory expectations are imposed on legacy combined sewer systems; enhanced monitoring after 2020 revealed spill frequencies far higher than previously understood, prompting new statutory targets and tighter controls under the Environment Act framework. Across all three services, Ofwat plays a cross-cutting role, funding required investment through the price review process and applying financial penalties when outcomes are not met, regardless of service type. For stormwater that does not discharge via combined sewer overflows (CSOs), the England and Wales regime treats it largely outside the sewerage regulatory system, and instead manages it through planning, flood-risk, and local authority governance, rather than through the Environment Act CSO framework. Surface water that is managed separately, such as runoff conveyed via separate surface water sewers, SuDS, highway drainage, or direct discharge to watercourses, is not subject to the same CSO-specific monitoring, spill frequency targets, or national reduction obligations that apply to combined systems. Instead, responsibility sits primarily with local authorities: in England, Lead Local Flood Authorities (LLFAs) review and secure stormwater performance through the planning system (focusing on flood risk, runoff rates, exceedance, and maintenance arrangements), while the Environment Agency regulates only where discharges require permits and pose pollution risk. In Wales, SuDS Approving Bodies provide a more formal approval and adoption route, assessing compliance with statutory national SuDS standards before construction and assuming responsibility where assets vest. As a result, non-CSO stormwater is governed through preventive design controls and local approval processes, rather than through ongoing national performance targets or

	England and Wales
	economic regulation, making it the least centralised and least consistently monitored of the three waters compared with drinking water and wastewater. How does each regime classify different types of infrastructure (e.g. by asset types, operators, services, locations, risks)? In England and Wales, water infrastructure design standards categorise asset types primarily by service function and asset role, rather than by uniform system classes, reflecting the separation of drinking water, wastewater, and surface water responsibilities. Drinking water assets are addressed through water-sector guidance and British Standards, with assets typically classified as water mains, service pipes, valves, and associated fittings, supported by Water Industry Standards (WIS) and utility-specific requirements that complement national standards (Water UK, 2023). Wastewater and sewered stormwater assets are categorised in greater detail within the Design and Construction Guidance (DCG), which distinguishes between foul sewers, surface water sewers, combined sewers, lateral drains, manholes, pumping stations, and rising mains, each with tailored design, testing, and adoption requirements (Water UK, 2023). Stormwater assets outside the public sewer network, such as SuDS components (basins, swales, infiltration features), are categorised functionally by drainage purpose and hydraulic role within planning and approval guidance rather than sewerage standards, relying on national SuDS standards and CIRIA guidance rather than DCG (DEFRA, 2025). Overall, asset categorisation is functional and adoptability-driven, with differing levels of prescription depending on whether assets are intended to vest in water companies or remain within local authority or third-party maintenance regimes. What criteria are used for this classification (e.g. scale, criticality, risk profile, harm potential), and why? Regulatory classification and prioritisation in England and Wales are driven primarily by risk and consequence. The most important criteria are risk to public health, which places drinking water treatment and distribution assets under the highest scrutiny; risk of environmental harm, which focuses EA attention on large wastewater works, frequent storm overflows, and discharges to sensitive receiving waters; and criticality of service continuity, where failures would affect large populations or essential services. Scale acts as a practical proxy for all three larger assets, which generally pose greater health, environmental, and service risks, but it is not used as an explicit threshold. Instead, these criteria are applied through regulator judgement rather than a formal, standardised classification system. How is regional variation provided for (for example, geographic, climatic, and geological variations)? Regional variation in England and Wales is handled through site-specific and company-specific regulatory controls rather than differentiated national engineering standards. The framework is nationally uniform in structure, but locally specific in application: the Environment Agency sets site-specific permit conditions based on local ecology and hydrology; Ofwat allows region-specific investment proposals through the price review, where companies can evidence local needs such as water scarcity, flooding risk, or soil conditions; and drought planning requirements are more stringent in water-stressed regions. What regional variation does <i>not</i> do is mandate different engineering design standards by geography and regional context informs the asset owning organisation's judgement and funding decisions, but design requirements themselves remain discretionary rather than regulatory.

	England and Wales
	Are there clear tiers or levels with different regulatory requirements? There are no formally defined tiers or levels in England and Wales, with different regulatory requirements attached to asset classes. How does an asset or entity's category affect performance requirements (the standards it must meet)? An asset or entity's category affects what outcomes it must achieve, not how it must be designed. Performance requirements are set by service type: drinking water assets must meet strict, legally defined water-quality and supply-continuity standards enforced by the DWI; wastewater assets must comply with site-specific environmental permits and company-level pollution metrics overseen by the EA and Ofwat; and stormwater assets, especially combined sewer overflows, are now subject to spill-frequency and duration monitoring and related performance commitments. All requirements are expressed as outcomes, with no statutory engineering prescriptions for redundancy, design life, or capacity, meaning strong internal engineering governance can deliver resilient assets, while weaker governance can still meet short-term targets until failures become visible in performance data. How does an asset or entity's category affect inspection or oversight frequency (how often it is inspected or monitored)? Inspection and oversight frequency in England and Wales is risk-based and regulator-specific, rather than determined by asset category alone. Drinking water assets serving large populations or with known source risks are inspected more frequently by the DWI; wastewater sites with large discharges, sensitive receiving environments, or poor compliance histories are prioritised by the EA; and companies with weak performance or governance receive closer scrutiny from Ofwat, though its oversight is desk-based rather than site-based. In the absence of a national asset classification framework, similar assets can receive different levels of inspection depending on operator performance and regulatory engagement, rather than on inherent asset risk alone.
How regulatory intervention is prioritised	How does the regulator decide where to focus its attention and resources? Regulators in England and Wales prioritise attention and resources using a risk-based, intelligence-led approach rather than routine oversight, but this approach is heavily dependent on company-generated data. Priority is set through a combination of sector-wide benchmarking, such as Ofwat's annual performance comparisons to identify persistent underperformers, and company-specific signals, including incidents, missed commitments, weak assurance, governance concerns, or deteriorating asset health indicators. Escalation typically progresses from informal challenge to enhanced scrutiny and, where necessary, enforcement, although the speed and intensity depend on regulatory judgement and available capacity. The model is effective at responding to known, visible risks, but it is poorly suited to identifying emerging or hidden risks, such as gradual asset deterioration or future climate-driven underperformance, which often remain invisible until failures occur. What factors matter most when assessing risk or priority? When assessing risk or prioritising intervention, regulators focus on four main factors: the likelihood of failure, indicated by recent performance data, incident history, and asset condition; the consequence of harm, with public health and sensitive environmental impacts weighted most heavily; behavioural indicators, such as transparency, governance quality, and willingness to fund and address known risks; and the credibility of asset management systems, where companies with mature, demonstrably robust frameworks are treated with greater regulatory confidence than those without. Are prioritisation rules set out clearly, or left to judgement? Prioritisation rules are set out at a high-level but left largely to professional judgement in practice. Each regulator publishes principles for risk-based intervention, but these are not translated into explicit decision rules or thresholds. As a result, experienced regulatory

	England and Wales
	staff determine priorities using judgement informed by data, assurance findings, and long-standing knowledge of individual companies. This works when teams are stable and well-resourced, but it also creates variability: similar risks can attract different levels of attention depending on workload, regulatory relationships, and political context, and these decisions are not transparent or easy to challenge externally.
How has the regime changed, and what lessons have been learned	What major changes have been made, and why? Since privatisation in 1989, regulation in England and Wales has evolved through three broad phases driven by emerging failures and public pressure. The initial period focused on price control and financial viability, assuming companies would manage assets responsibly. From the early 2000s, recurring pollution incidents and evidence of asset deterioration led to stronger service quality metrics, transparency, and outcome-delivery incentives. Since around 2015, visible sewage pollution, rising bills, and concerns about underinvestment and dividends have driven a marked tightening of regulation, including explicit asset health requirements, statutory duties on storm overflows, stronger performance incentives, and proposals to curb dividends where companies underperform. The 2025 Independent Review of the Water Sector reflects this trajectory, signalling a shift toward stronger government oversight, earlier intervention powers, and clearer expectations to address long-term infrastructure and environmental risk rather than reacting after failure. Alongside the tightening of controls on combined sewer overflows since 2015, stormwater that does not pass through combined sewers has followed a different regulatory trajectory. Rather than being drawn into the strengthened national wastewater regime, non-combined stormwater has increasingly been pushed upstream into planning, flood-risk, and local authority control, particularly through the promotion of SuDS. Over the past decade, England has relied on planning policy, Lead Local Flood Authorities, and non-statutory (now moving toward statutory) SuDS standards to prevent new surface water connections to sewers, while Wales implemented Schedule 3 of the Flood and Water Management Act in 2019, creating a distinct approval and adoption regime for SuDS. This shift reflects a policy decision to manage stormwater through prevention and source control rather than retrospective regulation, but it has also resulted in weaker national performance, asset-health, and reporting requirements for non-sewer stormwater compared with drinking water, wastewater, and CSOs. As a result, while regulatory pressure has intensified sharply for legacy combined systems, non-combined stormwater has remained comparatively decentralised, locally variable, and only lightly regulated over the asset lifecycle, despite growing flood-risk and climate-change exposure. What were the drivers for these changes? Regulatory change in England and Wales has been consistently driven by four forces operating at different scales. High-profile failures, such as drinking water contamination events and widely publicised sewage discharges, made the consequences of under-regulation visible and created political pressure that incremental oversight could not. Improved monitoring and data, particularly the introduction of storm overflow event duration monitoring, revealed levels of environmental harm far beyond public expectations and directly prompted tighter controls. Formal reviews and inquiries then translated these signals into systemic diagnoses, identifying how incentive structures and outcome metrics were masking long-term infrastructure risk. Finally, changes in primary legislation, most notably the Environment Act 2021, raised the regulatory floor by converting environmental ambitions into statutory duties, shifting regulation from discretionary enforcement toward legally binding obligations.

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	How did these changes affect standards, compliance and outcomes? The regulatory changes improved transparency, comparability, and accountability, but delivered more reliable visibility of failure than consistent improvement in underlying asset condition. Outcomes-based regulation made performance more visible through public scorecards, financial penalties, and near-real-time environmental data, meaning poor performance could no longer be contained within regulatory cycles. Compliance strengthened materially with the shift from self-reported data to independent and automated monitoring, most notably through event-duration monitoring of storm overflows, which exposed previously unseen levels of non-compliance. However, because statutory engineering standards remained absent, companies often optimised against measured outcomes rather than investing in long-term asset health, meaning headline performance improved faster than the resilience of the infrastructure underpinning it. What has worked well in practice? Several elements of the regime have worked well in practice. Public performance reporting through league tables, annual scorecards, and measures such as C-MeX (Customer Measure of Experience) and B-MeX (Business Customer Experience) has created reputational pressure that meaningfully influences behaviour even in monopoly markets, with consistently poor performers attracting regulatory and political scrutiny. Financial Outcome Delivery Incentives have been effective where metrics are tightly defined, reliably measured, and material, such as supply interruption and sewer-flooding measures, which companies can directly influence through operational decisions and targeted investment. Most critically, independent and automated environmental monitoring, notably event-duration monitoring of storm overflows, has transformed accountability by removing reliance on self-reporting and revealing real levels of performance, demonstrating that outcomes-based regulation works best when outcome data is independently verified. What challenges or unintended consequences have emerged? Several challenges and unintended consequences have emerged as the regime has evolved. Strong reliance on five-year performance commitments has encouraged short-term optimisation of measurable outcomes at the expense of long-term asset condition, creating bias toward visible operational gains over sustained asset stewardship. In the absence of national engineering standards, materially different design and resilience choices can coexist undetected in performance data until failure occurs, leading to inconsistent asset performance across organisations. This lack of design clarity also pushes a heavy assurance burden onto regulators, who must judge the adequacy of company engineering decisions without a shared regulated benchmark for “what good looks like,” resulting in resource-intensive and sometimes inconsistent oversight. Finally, the effectiveness of the regime has proven governance-dependent: where company leadership and assurance are weak, as highlighted by Thames Water, regulatory tools have struggled to identify and intervene with accumulating risk, early enough to prevent harm. Lessons relevant to New Zealand The UK experience shows that outcomes-based regulation only works where data, assurance, and enforcement are strong. Where these are immature, greater prescription is needed to prevent hidden risk accumulation.

	England and Wales
	Independent data collection matters, for example, England's shift from self-reported sewage data to automated monitoring transformed accountability, illustrating the importance of how outcome data is generated, not just how it is used. Incentives or disincentives must also be financially material relative to investment costs if they are to change behaviour. Critically, outcomes regulation and engineering standards address different risks and work best together: without a minimum design floor, asset quality can diverge unnoticed until failure. Finally, sequencing matters. England's outcomes-based model evolved over decades alongside regulatory capability, raising the question of how much early design prescription NEDS should provide until New Zealand's regulatory systems, data infrastructure, and early-intervention powers reach comparable maturity. Infrastructure prioritisation and regulatory attention are often based on risk of harm to public health or the environment.
Guidelines/ standards for private 3Water assets (drinking water, wastewater and stormwater)	How do the jurisdictions enforce, regulate and monitor private assets? In England and Wales, private three-waters assets sit in a fragmented and largely permissive regulatory space, with enforcement focused on immediate public-health or environmental outcomes rather than long-term asset adequacy. Private drinking water supplies are regulated by local authorities under the Private Water Supplies Regulations, with variable consistency and limited powers beyond risk assessment and monitoring. Private wastewater systems are regulated by the Environment Agency only through discharge permits or exemptions, which control effluent quality and volume but not asset design life, resilience, or maintenance regimes. Private stormwater systems are effectively regulated only at the point of construction through planning and building controls, with no ongoing oversight once assets are built and conditions are discharged. As a result, private assets can remain fully compliant while accumulating significant structural or operational risk, revealing a regulatory gap between discharge-based compliance and whole-of-life infrastructure assurance.
Limitations/ constraints in the current performance-based approach	What changes or improvements would address these? The UK experience highlights several constraints in a purely performance-based regulatory approach. The absence of national minimum engineering requirements allows materially different design practices to meet the same outcome targets. This can be addressed by setting explicit performance outcomes and baseline design expectations for asset life, structural resilience, and hydraulic capacity. Heavy reliance on lagging performance metrics means risks are identified only after failures occur; introducing leading indicators of asset health would enable earlier intervention. Regulators also rely on company-defined engineering standards despite uneven capability across the sector, suggesting a need for periodic regulatory assessment of those standards against a common benchmark. Finally, stronger powers are required to mandate remedial action based on evidence of risk rather than post-failure outcomes. Without these changes, the regime remains effective at penalising failure but poorly equipped to prevent it.
How does reliance on engineering judgement contribute to inconsistency	Any examples? Reliance on engineering judgement contributes to inconsistency because, in the absence of shared standards or benchmarks, judgement is exercised relative to company-specific assumptions and pressures rather than a common reference point. Identical risks are therefore interpreted and managed differently depending on local design culture, risk appetite, legacy practices, and individual engineer experience. Regulators can confirm that an outcome target is met, but cannot readily distinguish between a robust, resilient design and one that narrowly complies by accepting higher latent risk. Over time, this produces systematic variation in resilience, asset life, and failure likelihood that is not visible in performance metrics until a stress event or incident exposes the consequences of earlier judgments.

	England and Wales
	Lessons learned Professional engineering judgement is indispensable for complex infrastructure systems, but without shared standards, it leads to inconsistent risk treatment and weak assurance. The England and Wales experience shows that outcomes-based regulation is most effective when judgment is anchored by common definitions, comparable data, and clear minimum expectations; without these, oversight becomes retrospective and disputes over what constitutes “reasonable” engineering are hard to resolve. Recent moves toward standardised asset health metrics reflect recognition that long-term risk cannot be managed or compared reliably without shared benchmarks.
Is there an explicit risk-based framework	How consistently is it applied across regions? Risk-based regulation in England and Wales is applied consistently within individual regulators but not consistently across regions or the sector as a whole. The Environment Agency, Drinking Water Inspectorate, and Ofwat each apply risk-based approaches using their own methods and thresholds, but these frameworks are not integrated or standardised. As a result, similar assets or risks may be assessed differently depending on the regulator and company, and there is no single national risk classification that provides a coherent picture of where infrastructure risk is concentrated across England and Wales. Stormwater networks managed at the council level show greater inconsistency, as each authority applies its own criteria and resources, resulting in different approaches with no common national framework.

4.1.1 Relevance and Lessons for New Zealand

England and Wales meet the jurisdiction selection criteria for informing the development of NEDS due to their nationally consistent, performance-based regulatory framework, comprehensive coverage of all three waters, and mature integration of economic, health, and environmental regulation.

However, the current state of the sector also provides an important cautionary context. Despite clear national performance outcomes and long-standing reliance on detailed Codes of Practice such as DCG, the system has experienced prolonged under-investment in asset renewal, declining asset condition, and a significant erosion of public confidence, culminating in a period of regulatory upheaval and reform. Recent tightening of rules, increased scrutiny, and the introduction of new regulatory requirements reflect an acknowledgement that outcome-based regulation without sufficiently strong lifecycle, data, and asset health safeguards can allow long-term risks to accumulate unnoticed.

The regime demonstrates how clear national performance outcomes can be supported by detailed Codes of Practice, such as the DCG, providing certainty while still enabling alternative solutions where performance can be demonstrated. For NEDS, key lessons include the benefits of strong national consistency, explicit lifecycle and data requirements, clear allocation of regulatory roles, and well-defined adoption processes for developer infrastructure, balanced against the need to avoid excessive regulatory complexity when translating outcomes into engineering practice.

4.2 Scotland

Table 2 Scotland Jurisdiction Overview Table

	Scotland
Jurisdiction overview	What problem was this regulatory regime created to address? Scotland's regime was introduced to reform a fragmented public water system that lacked effective oversight and investment. Before 2002, water and sewer services were run by regional authorities with no independent economic regulation, meaning there was no check on efficiency, fair pricing, or long-term asset upkeep. Drinking water quality oversight was not at arm's length from operators, posing conflict of interest risks (Scottish Government, 2016). The Water Industry (Scotland) Act 2002 addressed these failures by merging services into a single operator (Scottish Water) and creating independent regulators for economic performance (WICS), drinking water quality (DWQR), and environmental protection (SEPA) (Water Industry (Scotland) Act, 2002; Scottish Government, 2021). How does the regime work overall? Scotland's water services regime operates as a publicly owned, commercially run, independently regulated model. Scottish Water owns and operates all water and sewerage assets across Scotland as a single national entity, funded through customer charges set by an independent economic regulator and directed by Scottish Government ministerial objectives. This combination, public ownership, commercial disciplines, and independent regulatory oversight, is structurally distinct from both the privatised model in England and Wales and from the council-controlled model that preceded reform in Scotland. The regime works through five distinct but connected functions: Scottish Government sets ministerial objectives for Scottish Water at the start of each regulatory cycle, establishing the investment priorities, service standards, and affordability principles that shape what Scottish Water is expected to deliver and at what cost to customers. The Water Industry Commission for Scotland (WICS) translates those objectives into a legally binding economic determination through the Strategic Review of Charges, which caps what Scottish Water can charge customers, sets efficiency targets, and scrutinises the investment programme for credibility and value for money. The Drinking Water Quality Regulator for Scotland (DWQR) independently monitors, inspects, and enforces compliance with drinking water quality standards, separate from both Scottish Water and WICS. The Scottish Environment Protection Agency (SEPA) regulates discharges and environmental compliance through authorisations and permits, independently of the economic framework. Scottish Water delivers against all of these obligations as a single operator, managing a nationally integrated asset base to a set of centrally maintained technical standards. The critical operational difference from England and Wales is that engineering standards in Scotland are centralised. Scottish Water publishes and maintains national technical standards for the design and construction of water and drainage infrastructure, including assets to be vested by the public network. These standards apply uniformly across Scotland. A developer connecting a new housing estate in Inverness faces the same technical requirements as one connecting in

	Scotland
	Edinburgh. This consistency is a direct product of the single-operator model, it is structurally impossible in England and Wales, where nineteen companies each maintain their own standards. Regulators in Scotland focus on whether Scottish Water's investment plans, operational controls, and delivery record are producing the required outcomes and compliance, not on approving individual engineering decisions. The approach is outcomes-based in that sense, but the existence of centralised engineering standards means the baseline of acceptable practice is defined nationally rather than left to each operator's internal judgement. How is the regulatory framework structured at a high level? Scotland's regulatory framework for water infrastructure operates across four layers, parallel in structure to England and Wales but with important differences in the content and statutory weight of each layer: Primary legislation: the Water Industry (Scotland) Act 2002 establishes the institutional architecture of the regime. It creates WICS and defines its economic regulatory powers, including information-gathering and price determination functions. It creates the DWQR and defines its enforcement tools, including powers of entry, inspection, and the ability to issue enforcement notices. It establishes Scottish Water as a statutory body with defined obligations. Unlike England and Wales, where the Water Industry Act 1991 was written around a privatised model, the 2002 Act was written for a publicly owned operator under independent regulatory oversight, a structural difference that shapes the relationship between government, regulator, and operator throughout the framework (Water Industry (Scotland) Act, 2002). Regulatory outcomes and economic performance framework: WICS implements economic regulation through the Strategic Review of Charges, conducted every six years. The SRC sets charge caps, scrutinises Scottish Water's capital and operating expenditure, assesses delivery efficiency, and determines what investment Scottish Water is funded to carry out in the coming period. This is the direct equivalent of Ofwat's price review process in England and Wales but applies to a single operator across the whole of Scotland rather than to nineteen separate companies (Scottish Government, 2020; WICS, 2021). Standards, guidance, and technical specifications: Scottish Water publishes national technical standards for the design and construction of new water and drainage (predominantly wastewater and stormwater in combined networks) infrastructure, including the specifications that govern assets to be vested into the public network by developers. Sewers for Scotland is the primary technical specification for sewerage infrastructure design and construction, functioning as the national equivalent of Sewers for Adoption in England and Wales, but with the significant difference that it applies uniformly across Scotland as a single operator standard rather than varying by company. These documents are not primary legislation, but in practice, they function as a structured compliance pathway for new connections and adoptions, creating engineering consistency that has no equivalent in England and Wales (Scottish Water, 2018). Assurance, scrutiny, and enforcement: compliance is verified through multiple independent channels. DWQR conducts inspections and monitoring of Scottish Water's drinking water activities and has the power to issue enforcement notices and initiate prosecution for serious failures. SEPA oversees environmental compliance through its authorisation and permitting regime and has equivalent enforcement powers for discharge and environmental violations. WICS monitors Scottish Water's performance and investment delivery through the regulatory period and publishes comparative assessments. Scottish Parliamentary scrutiny provides a further accountability layer, with Scottish Water required to account for its performance to Parliament in a way that has no direct equivalent for privatised companies in England and Wales (Public Water Supplies (Scotland) Regulations, 2014; Controlled Activities Regulations, 2011).

	Scotland
	Who is the regulator, and what formal powers do they have to enforce the regime? The sector is overseen by four distinct regulators. WICS (economic regulator) sets price limits and efficiency targets, with authority to obtain information and enforce through funding decisions (Water Industry (Scotland) Act, 2002; WICS, 2021). DWQR (water quality regulator) monitors compliance with drinking water standards (Public Water Supplies (Scotland) Regulations, 2014) via audits and inspections and can issue enforcement notices or prosecute if water safety is at risk (DWQR, 2014; Scottish Government, 2019). SEPA (environment regulator) licenses wastewater discharges and combined storm overflows under environmental law and can impose penalties or prosecutions for pollution breaches (Controlled Activities Regulations, 2011; SEPA, 2018). The Scottish Government sets the ministerial objectives and principles that initiate each regulatory cycle, defining the strategic investment and service priorities that WICS then translates into an economic determination. The Scottish Government's role is explicitly policy-setting and strategic rather than operational, it does not regulate Scottish Water directly, but its objectives carry statutory weight as the starting point for the SRC process. Scottish Ministers set strategic objectives but do not directly regulate (Scottish Government, 2020). All of these regulators emphasise outcomes rather than dictating engineering standards.
Setting performance requirements	<u>Nature of requirements</u> What performance areas or outcomes are regulated (e.g. safety, reliability, environmental protection, service quality), and why? Performance regulation in Scotland covers four principal outcome areas (Scottish Government, 2020), each with distinct regulatory leads, mirroring the structure in England and Wales but delivered through a single national operator rather than nineteen competing companies: Drinking water safety and security of supply: the DWQR monitors Scottish Water's compliance with the Public Water Supplies (Scotland) Regulations 2014, enforcing limits across key parameters. Mandatory sampling programmes, incident reporting requirements, and DWQR inspection activity all focus on this area because failures carry immediate and direct public health consequences with no tolerance for gradual improvement. Environmental protection: SEPA regulates wastewater discharges, sewer overflows, and other water environment impacts through its Controlled Activities Regulations authorisation framework. Scottish Water's treatment works, combined network overflow infrastructure must operate within SEPA-set discharge limits that reflect the sensitivity of receiving waters. Enforcement can include formal notices, permit suspension, and prosecution. This is regulated because wastewater discharges are the primary source of water environment degradation (Public Water Supplies (Scotland) Regulations, 2014; Controlled Activities Regulations, 2011). Service reliability and customer experience: WICS monitors Scottish Water's service performance through the Strategic Review of Charges process, assessing metrics including supply interruptions, sewer flooding incidents, and customer response standards (WICS, 2021). Long-term resilience and asset stewardship: ministerial objectives set at the start of each SRC cycle explicitly address long-term asset condition, renewal investment, and infrastructure resilience. WICS scrutinises whether Scottish Water's capital programme is sufficient to maintain and improve asset health over the regulatory period, not just meet immediate service targets.

	Scotland
	All four areas are regulated through outcome requirements and compliance limits, not through prescribed engineering specifications. Scottish Water determines how to engineer its way to compliant outcomes; regulators assess whether those outcomes are being achieved. How are performance requirements set and structured, and to what level of detail? Scottish Ministers issue objectives at the start of each regulatory cycle, defining the investment priorities, service standards, and affordability principles that Scottish Water is expected to deliver. These objectives carry statutory weight and initiate the Strategic Review of Charges (SRC) process (Scottish Government, 2020). WICS translates ministerial objectives into an economic determination through the SRC, which sets the charge cap within which Scottish Water must operate, scrutinises the efficiency and credibility of the proposed capital and operating expenditure, and establishes the performance baseline against which delivery will be assessed. One set of expectations applies across the entire Scottish water and wastewater network (WICS, 2021). DWQR sets drinking water compliance expectations through its monitoring and inspection programme, enforcing against the statutory parameters in the Public Water Supplies (Scotland) Regulations 2014. Requirements are legally defined at the parameter level (specific concentration limits, sampling frequencies, and response obligations) rather than specifying any of the engineering design requirements. SEPA sets environmental compliance requirements through site-specific authorisation conditions under the Controlled Activities Regulations. Each treatment works, and significant discharge points operate under conditions tailored to the local environmental context, including the flow regime, ecology, and assimilative capacity of the receiving waterbody (Controlled Activities Regulations, 2011). Regulatory requirements are set at the outcome level and not at a prescriptive engineering design level. Scottish Water is not told how to design a pumping station or what redundancy standard to apply to a treatment works, it is told what the discharge must contain, how often supply can be interrupted, and what the water must be safe to drink. The engineering decisions that deliver those outcomes are Scottish Water's own. Scottish Water's engineering decisions are anchored by nationally consistent technical standards (Water for Scotland and Sewers for Scotland) that apply uniformly across the network. This means outcome requirements and design reference points coexist in Scotland in a way they do not in England and Wales, where company-specific design standards vary materially and have no national baseline. What are the compliance pathways and verification mechanisms? Compliance in Scotland is verified through three parallel regulatory channels, each independent of the others and each focused on a distinct outcome domain: DWQR conducts its own monitoring, audit, and inspection programme for drinking water quality, independent of Scottish Water's self-reporting. DWQR inspectors visit treatment works and distribution systems, review Scottish Water's own monitoring data, investigate incidents, and have powers to issue enforcement notices requiring specific remediation within defined timeframes. This means drinking water compliance is verified both by the operator and by an independent regulator with the authority to compel action (DWQR, 2014).

	Scotland
	SEPA verifies environmental compliance through its authorisation and monitoring framework. Scottish Water's wastewater treatment works and overflow infrastructure are subject to SEPA site inspections, compliance sampling, and review of Scottish Water's self-monitoring returns. SEPA maintains public registers of authorisations and compliance records, creating transparency about site-level environmental performance (SEPA, 2018). WICS verifies economic and service performance through its analysis of Scottish Water's regulatory submissions during and between SRC cycles. WICS assesses whether Scottish Water is delivering the investment and service outcomes committed to in the determination, whether costs are being managed efficiently, and whether the evidence base for future investment proposals is credible. Unlike Ofwat, WICS does not apply automatic financial penalties tied to specific performance metrics, regulatory consequences flow primarily through the next SRC determination rather than through annual financial adjustments (WICS, 2021). A range of engineering approaches is permitted, provided the compliance outcome is achieved. DWQR does not prescribe treatment process design; SEPA does not prescribe the engineering of a treatment works, provided its discharge meets permit conditions. The compliance test is the outcome, not the method. The vesting pathway for new developer assets is governed by Water for Scotland and Sewers for Scotland and functions as a structured compliance pathway at the design and construction stage. Developers must demonstrate conformance with Scottish Water's technical specifications to achieve vesting approval. This provides a defined engineering compliance pathway for new assets that has no equivalent in England and Wales, where each company's adoption standards are independently set. What standards or Codes of Practice support compliance? Supporting technical standards in Scotland is more centralised than in England and Wales, reflecting the single-operator structure. Rather than nineteen sets of company-specific engineering standards, there is one set of nationally applicable technical specifications maintained by Scottish Water: Water for Scotland sets out Scottish Water's technical requirements for the design and construction of new water supply infrastructure intended for vesting into the public network. It covers pipe materials, hydraulic design criteria, connection standards, and construction quality requirements. This document applies uniformly across Scotland. Sewers for Scotland performs the equivalent function for the predominantly combined drainage infrastructure. It specifies design criteria, pipe materials, gradient standards, manhole requirements, and hydraulic capacity thresholds for new sewerage infrastructure intended for adoption. SEPA publishes activity-specific regulatory guidance for Controlled Activities Regulations authorisations, supporting consistent approaches to discharge monitoring, compliance reporting, and operational controls across regulated sites. These documents carry practical force even though they are not primary legislation. For vested assets, conformance with Water for Scotland and Sewers for Scotland is a mandatory gateway, Scottish Water will not vest an asset that does not meet its specifications. For operational assets, the standards provide the reference framework within which Scottish Water's engineers make design and renewal decisions.

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	How often are requirements reviewed or changed, and why? Requirements are formally reviewed every six years through WICS's Strategic Review of Charges, which resets charge caps, efficiency targets, and the funded investment programme (WICS, 2021). Ministerial objectives are refreshed each cycle to reflect evolving priorities such as climate resilience, environmental standards, and affordability (Scottish Government, 2020). Between cycles, requirements can change due to DWQR enforcement findings, SEPA permit updates responding to new environmental evidence, or revisions to Scottish Water's technical standards. The six-year cycle provides greater investment certainty than the five-year cycle in England and Wales but can delay formal re-prioritisation of emerging systemic risks. How are connections to the network covered? New connections are governed by Scottish Water's vesting process, which applies to Water for Scotland and Sewers for Scotland as binding technical standards. Developers must obtain design approval before construction, demonstrate compliance during construction through inspection and testing, and submit as-built and commissioning records before vesting certificates are issued (Scottish Water, 2018; Scottish Water, 2019). Assets that do not meet the standards are not adopted. Once vested, assets become part of the national network and fall under Scottish Water's ongoing asset management obligations and WICS oversight, providing lifecycle continuity rather than point-in-time compliance. How is asset management across the lifecycle covered? Asset lifecycle management is embedded through ministerial objectives, WICS economic scrutiny, and Scottish Water's internal standards rather than prescriptive maintenance rules. Scottish Water must demonstrate in each regulatory submission that its capital programme addresses renewal and resilience as well as growth and compliance (Scottish Government, 2020). WICS assesses asset management capability and can challenge investment plans that defer necessary renewal (WICS, 2021). As a single national operator, Scottish Water applies consistent asset registers, condition assessment, and renewal prioritisation across the network, reducing regional variability in asset stewardship. The risk of short-term optimisation at the expense of long-term asset condition can result from the SRC's focus on efficiency, which can create pressure to minimise capital expenditure within the regulatory period. What information requirements exist? Scotland's information requirements operate across two distinct phases, with some structured design-stage requirements.: Design and construction phase: Water for Scotland and Sewers for Scotland specify mandatory information requirements as gateways to technical approval and vesting. Developers must submit approved design drawings, hydraulic calculations, ground condition assessments, and supporting evidence demonstrating conformance with specification requirements before construction can begin. During construction, compliance is evidenced through testing records, CCTV inspection results, as-built drawings, and health and safety documentation. All of these are prerequisites for vesting certificates. This means the information requirements for new assets entering the public network are defined, standardised, and enforced at the point of entry. Operational performance and regulatory reporting: once assets are vested, information requirements shift from design conformance to operational performance and compliance. Scottish Water reports water quality data to DWQR,

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	environmental compliance data to SEPA, and service performance and investment delivery data to WICS, in line with each regulator's statutory reporting requirements. Reporting standards are defined at the outcome and compliance metric level, with strong emphasis on accuracy, traceability, and assurance to support regulatory oversight and investment decisions. There is no national standard for how Scottish Water must structure, store, or share engineering asset data, design parameters, condition assessments, and remaining life estimates, beyond what is required for vesting and regulatory reporting. Scottish Water maintains its own national asset register and condition assessment frameworks, which are more internally consistent than anything achievable across nineteen separate companies, but which are still not subject to an externally prescribed data architecture. <u>Measurement and compliance</u> How is performance checked and reported? Performance monitoring in Scotland operates through three parallel regulatory channels, each independent of Scottish Water's self-reporting and each focused on a distinct outcome domain: DWQR conducts its own programme of inspections, audits, and monitoring of Scottish Water's drinking water systems. It publishes an annual report on drinking water quality in Scotland, providing a publicly accessible record of compliance rates, incidents, and enforcement actions. (DWQR, 2021). SEPA monitors environmental compliance through its authorisation framework, maintaining public registers of authorisation conditions and compliance records for Scottish Water's treatment works and overflow infrastructure. SEPA publishes data on pollution incidents and enforcement actions, creating transparency about environmental performance that operates alongside Scottish Water's own reporting (SEPA, 2018). WICS publishes comparative performance analysis as part of its oversight role, assessing Scottish Water's delivery against the commitments made in the current SRC determination and benchmarking efficiency against water companies in England and Wales where data allows (WICS, 2021).
How assets, activities or contexts are classified for regulation	How does the regime approach different waters in Scotland (e.g. drinking water, wastewater, stormwater)? Scotland regulates drinking water, wastewater, and stormwater as distinct services with separate statutory regulators, noting that the majority of the sewerage networks are combined systems. A historical legacy of combined sewer infrastructure applies: combined sewer systems carrying both foul sewage and surface water runoff in a single pipe were the standard engineering approach across Scottish towns and cities through most of the twentieth century, and the majority of older urban drainage networks in Scotland remain combined. The regulatory treatment of stormwater as a distinct service category is therefore layered over infrastructure that was not designed to support that separation. Drinking water is regulated for public health risk by the DWQR, enforcing the Public Water Supplies (Scotland) Regulations 2014. Scottish Water must meet compliance limits across all regulated parameters, with mandatory sampling, incident reporting, and DWQR inspection providing independent verification. Wastewater is regulated for environmental risk by SEPA through Controlled Activities Regulations authorisations. Each treatment works operates under site-specific discharge conditions reflecting the sensitivity of the receiving waterbody, a works discharging to a pristine upland catchment will face stricter conditions than one discharging to a large lowland river with greater assimilative capacity (SEPA, 2021; Scottish Government, 2021).

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	Stormwater, including combined sewer overflows, is regulated through SEPA authorisations and planning controls. Scottish Water operates an Improving Urban Waters programme that addresses CSO performance and surface water flooding, with investment scrutinised by WICS through the SRC process. Stormwater has historically been less explicitly framed as a regulated performance outcome than drinking water or wastewater, a gap that is becoming more visible as monitoring improves and climate-driven rainfall intensity increases. WICS's role cuts across all three service types: it funds Scottish Water's investment in drinking water, wastewater, and stormwater infrastructure through the SRC, and scrutinises whether that investment is delivering the required outcomes efficiently. How does the regime classify different types of infrastructure (e.g. by asset types, operators, services, locations, risks)? Infrastructure classification in Scotland is primarily service-based and regulator-led, with obligations attaching to Scottish Water as the single national operator across its entire network rather than to a standardised national asset taxonomy. The single-operator structure means there is no variation between operators in how assets are classified, one organisation applies one set of internal classification frameworks across all asset types. Differentiation occurs through two mechanisms: Regulatory regime by service type: drinking water assets, abstraction, treatment, storage, and distribution, fall under DWQR oversight. Wastewater treatment works, sewer networks, and storm overflows fall under SEPA authorisations. Service performance and investment delivery across all asset types are subject to WICS scrutiny through the SRC. Site-specific authorisation conditions: individual wastewater treatment works, and significant discharge points are subject to SEPA authorisation conditions tailored to the local environmental context, the sensitivity of the receiving waterbody, catchment hydrology, and ecological designations. A works discharging to a Special Area of Conservation's river will face materially stricter conditions than one discharging to a less sensitive watercourse. DWQR similarly applies a risk-based inspection model that differentiates treatment works by population served, source water vulnerability, and treatment process complexity (DWQR, 2014; SEPA, 2019). There is no formal national asset classification framework, no tiering system that places, for example, all pumping stations above a certain capacity into a defined category with attached regulatory requirements. Regulatory intensity varies in practice based on service type, site-specific risk, and performance history, but that variation is driven by regulator judgment rather than explicit classification rules. What criteria are used for classification, and why? Regulatory focus in Scotland is guided by the following primary risk criteria: Risk to public health: DWQR prioritises oversight of large or complex water treatment works and those with vulnerable source waters, on the basis that a failure there would have greater health consequences for more people (DWQR, 2014). Risk of environmental harm: SEPA concentrates on wastewater sites, and overflows with the highest pollution potential – for example, big treatment plants with high discharge volumes, outfalls in ecologically sensitive or protected waters (like

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	Sites of Special Scientific Interest), and any sites with a history of compliance issues get stricter conditions and more frequent checks (SEPA, 2019). Criticality of service continuity: Assets whose failure would cause major supply interruptions or sewerage outages for large numbers of customers (e.g. strategic water mains, key pumping stations) attract greater scrutiny, and ensuring their resilience is often reflected in ministerial objectives and WICS's planning expectations (Scottish Government, 2020; WICS, 2021). In essence, scale (population or volume) amplifies all these factors. Because Scottish Water is one national entity, these risk criteria are applied consistently across the network – unlike England and Wales, where each company might have varied risk frameworks - Scotland avoids inter-company inconsistencies in assessing and classifying risks (Scottish Government, 2021). How is regional variation provided for? Regional differences are handled through site-specific regulation and targeted investments rather than different regional standards. SEPA's permits are tailored to local conditions: a wastewater facility discharging into a small, sensitive Highland River will have stricter effluent limits and monitoring requirements than a similar facility discharging into a large, less sensitive river, reflecting differences in assimilative capacity and ecological importance (SEPA, 2019). WICS's investment determinations allow Scottish Water to allocate funds to region-specific needs such as improving supply on islands and remote areas (where systems are isolated and failures have high consequences), addressing high groundwater or peatland water treatment challenges, or accelerating asset replacements in areas with harsh weather or soil causing faster deterioration (Scottish Government, 2020). Local authorities' planning requirements also demand context-specific solutions like Sustainable Urban Drainage Systems in new developments especially in regions prone to flooding or with limited sewer capacity. Despite these localised adaptations, the underlying technical standards (Water for Scotland, Sewers for Scotland) remain uniform nationwide; any necessary deviations for local circumstances are managed case-by-case through the design approval process rather than through separate regional rule sets (Scottish Water, 2018). This maintains nationwide consistency in design expectations while allowing flexibility for local environmental and operational needs. Regulatory consequences of classification Regional variation is accommodated through site-specific regulation and targeted investments rather than different national standards. SEPA sets environmental permit conditions reflecting local hydrology and sensitivity, and WICS can approve regionally targeted investments to address unique needs such as remote communities or climate resilience (SEPA, 2019; Scottish Government, 2020). Technical design standards remain nationally consistent, with departures handled case by case instead of having separate rules for different regions. This approach means variations in risk or local circumstances are managed within a unified framework, rather than by creating formal tiers of differing requirements.

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	Are there clear tiers or levels with different regulatory requirements? No, Scotland does not operate a formal national tiering system for its water infrastructure. There is no predefined categorisation (e.g., “Tier 1” vs “Tier 2” assets) that comes with different regulatory rules or inspection schedules. All assets are expected to meet the relevant legal standards and outcome targets irrespective of size (Scottish Government, 2016; SEPA, 2019). In practice, there is a spectrum of regulatory attention: higher-risk or larger assets (major treatment plants, large networks, critical system components) receive closer scrutiny than smaller, lower-risk ones, but this is determined by risk assessment rather than by belonging to an official tier (DWQR, 2014; Scottish Government, 2021). Because of the single-operator model, the absence of formal tiers does not lead to inconsistent criteria – one organisation manages all assets with the same internal standards – so similar assets in different regions are subjected to equivalent expectations and procedures, unlike in a multi-company system where approaches might vary. How does an asset or entity’s category affect performance requirements? Performance requirements differ by service type rather than by asset category, reflecting regulatory goals. Drinking water assets must ensure potable water meets all health-based standards (e.g., microbiological, chemical limits) defined in the Public Water Supplies regulations, with effectively zero tolerance for persistent breaches since public health is at stake (Public Water Supplies (Scotland) Regulations, 2014). Wastewater assets (treatment works, sewer networks) must meet the discharge limits and operational conditions specified in SEPA’s permits – these typically include numeric limits on pollutants (like BOD, ammonia, phosphorus, solids) and rules on how often and how much storm overflow can occur, calibrated to protect the particular receiving waters (Controlled Activities Regulations, 2011; SEPA, 2019). Stormwater and combined sewer overflow assets fall under environmental controls as well, with performance measured by compliance with authorised spill frequencies and mitigation of flood risk; although historically less prescriptive, new programs are setting clearer outcome targets for reducing harmful overflows (SEPA, 2021). In all cases, the requirements are outcome metrics and compliance thresholds – Scottish Water is responsible for choosing and implementing whatever operational or capital measures are needed to meet them (Scottish Government, 2019). If a particular asset consistently fails to meet its required outcomes, the relevant regulator can enforce upgrades or changes, regardless of the asset’s category or location. How does an asset or entity’s category affect reporting obligations (how much reporting it must do)? Reporting obligations scale with risk and the significance of the asset’s impact rather than its label. Drinking water systems have mandatory sampling and reporting regimes linked to size and usage: large public water supplies must undergo frequent testing for a wide range of parameters with results regularly reported to DWQR, and any breach of key standards triggers immediate notification and corrective action reporting (Public Water Supplies (Scotland) Regulations, 2014; DWQR, 2021). Wastewater and stormwater facilities report data to SEPA as required by their permits: bigger or more critical treatment works often have continuous or daily monitoring of effluent quality and must submit results to SEPA; high-risk sewer overflows are increasingly equipped with Event Duration Monitors that record each spill event for periodic reporting (SEPA, 2018; SEPA, 2021). Less critical discharges might have simpler reporting (e.g. quarterly sample summaries). Company-

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	level reporting: WICS requires Scottish Water to report aggregated performance annually (covering customer service metrics, asset reliability indicators, financial performance, etc.), focusing on system-wide outcomes rather than every asset individually (WICS, 2021). Separately, during the vesting process, developers must supply Scottish Water with full design and testing documentation for new assets, ensuring that detailed technical information is captured at the point of connection (Scottish Water, 2019). How does an asset or entity's category affect inspection or oversight frequency (how often it is inspected or monitored)? Inspection and monitoring frequencies in Scotland are set by risk evaluations performed by each regulator, not by a fixed category schedule. DWQR uses a risk-based inspection model where water treatment plants serving large populations, using complex treatments, or having vulnerable sources (e.g., surface waters prone to contamination) are inspected and audited more often, whereas a small, consistently compliant rural supply might be inspected infrequently (DWQR, 2014). SEPA targets its site inspections toward assets with higher environmental risk: large wastewater works, discharges into sensitive or protected waters, and any sites with recent non-compliance or pollution incidents get more frequent visits. Conversely, a small treatment plant with a spotless record in a low-risk location may be inspected only occasionally (SEPA, 2018; SEPA, 2019). WICS does not perform field inspections; it relies on performance data and audits by the other regulators to inform its oversight, focusing on systemic issues rather than individual asset checks (WICS, 2021). Because Scottish Water applies a uniform risk management approach internally, an operational problem identified at one facility (say, a type of pump failure) can prompt the company to check similar assets nationwide – a benefit of the single-operator model that can improve consistency in preventive maintenance across regions (Scottish Government, 2021).
How regulatory intervention is prioritised	How does the regulator decide where to focus its attention and resources? Each regulator targets its efforts based on risk intelligence in line with its responsibilities. DWQR uses a risk-prioritisation model (e.g., as part of Drinking Water Safety Plans) that considers factors like population served, source water susceptibility, and treatment complexity; works serving large cities, or with known issues, are high on its inspection schedule, while smaller, low-risk systems get relatively less frequent attention (DWQR, 2021). SEPA allocates its inspection and enforcement resources using a risk-based compliance assessment (such as its Operator Monitoring Assessment scoring), focusing on facilities with significant environmental impact potential, sensitive receiving environments, or poor past performance. Sites scoring high on risk (for instance, a sewage works that has had breaches or is near protected waters) are inspected more often and may receive stricter permit conditions (SEPA, 2019). WICS concentrates its analysis where evidence shows potential underperformance or inefficiency – for example, if data indicates that Scottish Water is missing certain targets or if certain cost areas look high compared to peers, WICS will delve deeper into those areas (WICS, 2021). A structural advantage in Scotland is that regulators deal with only one operator, enabling them to develop a comprehensive, shared understanding of system risks and to coordinate responses more easily than would be possible with multiple companies (Scottish Government, 2021).

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	What factors matter most when assessing risk or priority? Regulators in Scotland emphasise three core factors when assessing risk and deciding priorities. There are: Consequence of harm: The potential impact of failure – threats to public health (from water quality issues) or to the environment (from pollution) – is paramount. A failure affecting a major city’s drinking water or a pollution incident in a highly sensitive river will draw intense regulator focus due to high consequences (DWQR, 2021; SEPA, 2019). Likelihood of failure: Asset condition, complexity, and past performance are evaluated to gauge how probable a problem is. For instance, older or poorly maintained infrastructure, or sites with recent near-misses, are considered higher likelihood for future issues and thus prioritised for oversight (WICS, 2021). Scale and criticality: The number of customers or size of area served by an asset influences priority – the larger the population or the more critical the service (e.g., a single source feeding many towns), the more crucial it is to ensure its reliability. Additionally, regulators consider operator behaviour and transparency: if Scottish Water is proactively managing and openly reporting risks, regulators may have more confidence; if issues appear under-recognised or downplayed, regulators may increase scrutiny (Scottish Government, 2021). Are prioritisation rules set out clearly, or left to judgement? High-level risk principles are published by each regulator, but their application is largely left to expert judgement. DWQR, SEPA, and WICS each have internal guidelines (e.g., DWQR’s enforcement policy, SEPA’s Compliance Assessment Scheme, WICS’s methodology for risk analysis) that outline factors to consider, but they do not provide a strict formula dictating how often to inspect every type of asset (DWQR, 2014; SEPA, 2019; WICS, 2021). Instead, regulators use their professional judgement, informed by data and experience, to allocate resources where they are needed most. Because all regulators focus on one utility, they can develop a deep collective understanding of Scottish Water’s system and adapt their focus as conditions change. This flexibility can lead to slight variations over time or between regulators in what is prioritised, but the single-operator context minimises inconsistency compared to a multi-company system (Scottish Government, 2021). In summary, the rules for prioritisation are principle-based and rely on regulator judgement rather than fixed, quantifiable thresholds for every scenario.
How the regime has changed, and what lessons have been learned	What major changes have been made, and why? Key phases in Scotland’s regime evolution include: 2002–2010 – Consolidation and catch-up: After the 2002 reforms, massive investments were made to upgrade infrastructure and meet EU standards, focusing on eliminating water quality problems (e.g., new treatment plants to end boil-water notices) and building/stabilising wastewater treatment to stop environmental pollution. These efforts addressed chronic underinvestment inherited from the regional system (Scottish Government, 2016). 2010–2020 – Efficiency and performance improvement: With acute compliance issues resolved, emphasis shifted to cost efficiency and service. WICS drove Scottish Water to reduce operating costs and improve productivity, resulting in some of the lowest water charges in the UK, while service reliability (e.g., fewer interruptions, leaks) and environmental compliance

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	continued to improve. During this period, environmental standards became stricter (e.g., tighter discharge limits) and drinking water compliance reached consistently above 99.9% (WICS, 2021; SEPA, 2019; DWQR, 2021). 2020–present – Resilience, climate, and stormwater focus: Recognising climate change and ageing assets, recent regulatory cycles (e.g. 2021–2027) prioritise long-term resilience. Investments now target issues like upgrading drainage to handle extreme rainfall, securing water supply during droughts, and expanding sewer overflow monitoring. SEPA and WICS have also put more weight on stormwater management and asset health metrics to ensure the sustainability of services (Scottish Government, 2020; SEPA, 2021). What were the drivers for these changes? Several factors drove these shifts: Pre-2002 failures: Documented issues (e.g., frequent water quality violations and sewage pollution events under the old fragmented system) created a political mandate for the 2002 overhaul – the solution was consolidation and stronger regulation to address those specific failures of inefficiency, inadequate health oversight, and poor asset condition (Scottish Government, 2016). Rising environmental standards: Over the 2000s and 2010s, both EU and Scottish environmental policies demanded better water quality and cleaner rivers/beaches. SEPA’s progressive tightening of discharge permits and requirement for better overflow control were driven by these higher standards and more accurate environmental data, which directly fed into Scottish Water’s investment requirements in each regulatory cycle (SEPA, 2019). Climate and resilience evidence: Increasing awareness of climate risks – such as heavier rainfall causing floods and sewer overflows, or drought conditions affecting water supply in some parts of Scotland – prompted the government and regulators to incorporate specific climate adaptation and resilience objectives (e.g. improving flood management, interconnecting supplies for robustness) in recent policy directives and funding decisions (Scottish Government, 2020). How did these changes affect standards, compliance and outcomes? The reforms and ongoing improvements have delivered measurable positive outcomes. Drinking water quality is now extremely high: compliance with standards across Scotland’s public water supplies is routinely 99.9% or above, significantly better than in the 1990s and on par with the best in the UK (DWQR, 2021). Environmental compliance has improved: serious sewage pollution incidents have fallen sharply since the early 2000s, even as monitoring and reporting became more rigorous, indicating that investments in treatment and sewer upgrades were effective (SEPA, 2018). Service performance has risen: customers experience fewer supply interruptions and sewer flooding incidents than in the past, and customer satisfaction has increased, partly due to quicker response times and better communication (WICS, 2021). Importantly, these gains were achieved by focusing on outcomes and robust regulation rather than micromanaging technical design – Scottish Water’s internal technical standards and the new regulatory framework together provided

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	structure and accountability that led to improved operational practices and investment decisions (Scottish Government, 2019). What has worked well in practice? Scotland has achieved high drinking water compliance (consistently above 99.9%), reduced serious pollution incidents, and relatively low household charges compared with the rest of the UK (DWQR, 2021; WICS, 2021). Public ownership without shareholder dividends allows reinvestment of surpluses, while independent economic regulation provides efficiency discipline. Nationally consistent technical standards enable uniform asset quality and simplify regulatory scrutiny, and six-year regulatory cycles provide investment certainty supporting long-term asset stewardship. What challenges or unintended consequences have emerged? Challenges include the absence of explicit minimum resilience benchmarks for existing assets, limited use of leading indicators of asset deterioration, and historically weaker regulatory focus on stormwater performance. Variable legacy resilience standards and climate allowances are often only revealed through failures or audits. Expansion of overflow monitoring has exposed higher-than-expected spill frequencies, prompting regulatory catch-up (Scottish Government, 2021; SEPA, 2021). Are there lessons or features especially relevant to New Zealand's context? The Scottish model is the closest international comparator to the regulatory structure New Zealand is building through its water services reforms. Both involve consolidating delivery from fragmented council or regional authority structures into larger, publicly accountable entities; separating delivery from economic regulation and from health and environmental oversight; and applying an outcomes-based regulatory framework rather than prescriptive engineering control. Scotland did not arrive at this structure instantly; the 2002 reforms were themselves a consolidation of what had previously been nine regional and area authorities, and the improvements in performance, compliance, and affordability took multiple regulatory cycles to fully materialise. Three features of the Scottish model are particularly relevant to New Zealand's context: A single accountable operator enables nationally consistent engineering standards in a way that a fragmented, multi-operator model does not. Scotland's ability to maintain Water for Scotland and Sewers for Scotland as uniform national specifications, applying the same design requirements to a housing development in the Highlands as to one in Edinburgh, is a direct product of having one operator own and apply those standards. New Zealand's move toward consolidated water services entities creates the structural precondition for equivalent national consistency, but that consistency will only materialise if the engineering standards framework is designed and governed to take advantage of it. Separation between delivery, economic regulation, and health and environmental oversight works in practice, but requires each regulator to have genuine independence and genuine enforcement powers. Scotland's DWQR, SEPA, and WICS each have distinct statutory mandates and the tools to enforce them. The effectiveness of Scotland's regulatory structure depends not on the structural separation itself but on each body having the capability, resources, and will to exercise its

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	powers. New Zealand should consider whether the equivalent bodies in its framework are resourced and empowered at an equivalent level from the outset, rather than assuming the structure alone will produce the intended accountability. Public ownership without market discipline requires the economic regulatory framework to do the work that competition would otherwise do. Scotland's experience demonstrates that WICS's multi-year charge determinations, efficiency scrutiny, and investment challenge can provide meaningful discipline on a publicly owned operator, but only when the regulatory process is robust, evidence-based, and prepared to reach conclusions that are uncomfortable for the operator. The affordability outcomes Scotland has achieved, among the lowest household charges in the UK alongside high compliance rates, are a product of that regulatory discipline, not simply of public ownership. Scotland also illustrates a risk that New Zealand should be alert to: good top-line performance outcomes can mask structural gaps in asset management and stormwater regulation that only become visible when monitoring improves, or climate conditions change. Scotland's drinking water compliance rates are strong, but the expansion of overflow monitoring has revealed that urban stormwater and combined sewer overflow performance was less well understood and less well managed than the headline outcomes suggested. New Zealand should consider whether its outcome metrics and monitoring frameworks are designed to surface these kinds of hidden risks, or whether they risk producing a similar pattern, strong reported performance masking accumulating asset condition or stormwater management issues that only become visible after the fact.
Guidelines/ standards for private 3Water assets (drinking water, wastewater and stormwater)	How are private assets enforced, regulated and monitored? Private 3-waters assets in Scotland (those not operated by Scottish Water) are overseen by separate frameworks, which are generally less stringent. Private drinking water supplies (e.g., wells serving rural communities) are regulated by local authorities under the Private Water Supplies (Scotland) Regulations 2016, with DWQR supervising local authorities' performance (Private Water Supplies (Scotland) Regulations, 2016; DWQR, 2020). Private owners must monitor and maintain their water quality, and councils can issue notices to fix hazards, but enforcement can be inconsistent due to resource constraints, and DWQR's role is limited to guiding and auditing councils rather than directly regulating individual private supplies. Private wastewater systems (like septic tanks or small treatment units) are subject to SEPA registration or permits focusing only on their discharges to the environment. As long as a private sewage system's effluent meets basic standards at the discharge point, it is considered compliant; SEPA does not routinely inspect the design or ongoing condition, and typically intervenes only if there are pollution complaints or failures (Controlled Activities Regulations, 2011; SEPA, 2018). Private stormwater infrastructure (e.g., drainage in private developments not adopted by Scottish Water) is mainly governed at the planning stage (developers must install agreed drainage solutions) and, once built, has no dedicated regulatory oversight for maintenance or performance unless problems arise. In summary, private systems operate under a lighter-touch regime, which can lead to gaps in oversight and potential risks if owners do not properly maintain their assets. Rural private water supplies in particular remain an area of concern due to variable monitoring and a higher incidence of issues (DWQR, 2020).
Limitations/ constraints in the current performance-based approach	What changes or improvements would address these? Scotland's performance-based framework has delivered strong outcomes in its principal regulated areas, but three structural constraints limit its effectiveness as a comprehensive risk management system:

	Scotland
	There is no explicit national minimum resilience floor for all operational asset types. Water for Scotland and Sewers for Scotland establish rigorous minimum standards for new infrastructure intended for vesting, but there are no equivalent baseline expectations applied systematically across Scottish Water's existing operational asset base, no defined minimum standby pump provision, no explicit climate allowance requirement for drainage infrastructure, and no standardised design life assumption for renewal planning across asset categories. Engineering decisions on resilience, redundancy, and renewal timing are left to Scottish Water's internal judgement, without an external reference point against which regulators can assess adequacy. This creates the same blind spot that exists in England and Wales: assets managed below an acceptable resilience standard are invisible to regulators until a failure produces a measurable outcome. Performance metrics rely predominantly on lagging indicators. DWQR, SEPA, and WICS all monitor compliance outcomes and incident data, information that reflects failures that have already occurred. Deterioration in asset condition that has not yet produced a compliance breach or service failure is largely invisible to current monitoring and reporting frameworks. A wastewater pumping station progressively approaching the end of life, or a drainage system whose hydraulic capacity is being incrementally eroded by root intrusion and sedimentation, will not appear in any regulatory dataset until it fails. Developing leading indicators, condition grades, failure probability scores, maintenance backlog metrics, and embedding them in regulatory reporting would allow intervention before harm occurs rather than after. Stormwater remains less explicitly framed as a regulated performance outcome than drinking water or wastewater. Regulatory expectations for stormwater performance have historically lagged behind the other service types, and investment prioritisation has reflected that hierarchy. As climate-driven rainfall intensification increases stress on combined and separate drainage systems, and as monitoring reveals that overflow spill frequencies are higher than previously understood, this gap is becoming more consequential. Explicit elevation of stormwater performance within WICS's outcomes framework, with defined performance metrics, investment commitments, and regulatory consequences equivalent to those that apply to drinking water and wastewater, would address a growing risk that is currently under-regulated relative to its public and environmental consequences.
How does reliance on engineering judgement contribute to inconsistency	Any examples? In Scotland, engineering judgement is exercised within a single national operator under a consistent internal governance framework, which structurally reduces the most significant source of inconsistency in England and Wales, the variation between nineteen separate companies applying nineteen different sets of engineering standards. A pumping station design decision made by Scottish Water's engineers in Inverness is subject to the same internal standards, the same asset management framework, and the same regulatory oversight as one made in Glasgow. This is a material structural advantage. However, inconsistency still arises within Scottish Water where engineering judgement is not anchored by explicit internal benchmarks, and three examples illustrate where this is most visible: Pumping station resilience standards have not been applied uniformly across the network. Stations designed and built in different decades reflect the design assumptions and engineering conservatism of the time, rather than a consistent current standard. Some installations incorporate full duty-assist-standby pump configurations providing two levels of redundancy; others were built to duty-standby arrangements; and some older stations rely on operational response and network flexibility rather than installed redundancy. The difference in resilience between these configurations is not reflected in any regulatory performance metric; it only becomes apparent when the duty pump fails during a peak flow event, and the available response is insufficient to prevent a flooding or overflow incident.

	Scotland
	Climate change allowances in hydraulic design vary across the asset base in a way that reflects when assets were last renewed rather than a consistent current standard. Infrastructure renewed or designed in recent years typically incorporates updated rainfall intensity data from current climate projections; infrastructure renewed in earlier periods may use design assumptions calibrated to historical rainfall patterns that systematically underestimate the frequency and magnitude of current storm events. There is no regulatory requirement for Scottish Water to systematically assess or disclose which parts of its network are operating under outdated hydraulic assumptions, meaning the extent of this exposure is not fully visible to SEPA, WICS, or the Scottish Government. Stormwater and combined sewer overflow upgrade decisions have historically varied in technical conservatism depending on investment priority and the timing of asset assessment. Some overflow structures have been upgraded to modern standards with defined spill frequency targets and environmental performance expectations; others continue to operate under configurations established decades earlier, with performance that only became visible when systematic event duration monitoring was introduced. The expansion of monitoring revealed that some overflow frequencies were materially higher than Scottish Water or SEPA had previously understood, a retrospective discovery rather than a product of proactive design assurance. Inconsistencies in Scotland are typically identified through SEPA compliance audits, DWQR inspections, investment programme reviews, or incident investigations rather than through systematic upfront design assurance against defined benchmarks. The single-operator structure provides a significant advantage when inconsistencies are identified: Scottish Water can assess all comparable assets across the national network and address the issue systematically, rather than requiring separate regulatory engagement with multiple companies. But the identification of the inconsistency in the first place still depends on a failure or audit finding rather than a proactive framework for assuring design adequacy across the asset base. Lessons learned Outcomes-based regulation functions well in Scotland because engineering judgement is exercised within a strong institutional framework, a single operator with a consistent internal engineering culture, nationally applied technical standards for new assets, and independent regulators with genuine enforcement powers. These conditions allow outcomes regulation to work without the statutory prescription of how every design decision must be made. Scotland largely demonstrates that this is achievable in practice, and that the results, high drinking water compliance, improved environmental performance, and sustained affordability, are quantifiable (Scottish Government, 2021; WICS, 2021). However, even within this relatively well-functioning model, the absence of explicit minimum engineering benchmarks for all operational asset types creates blind spots that only become visible retrospectively. Variable pump redundancy standards, inconsistent climate allowances, and historically under-monitored stormwater performance are all products of the same underlying gap. The Scottish experience offers three specific lessons for New Zealand's framework design: The structural conditions that make outcomes-based regulation work, a single accountable operator, strong independent regulators, and institutional engineering capability, need to be in place before prescription is relaxed, not assumed to develop naturally after the framework is established. Scotland built these conditions deliberately through the 2002 reforms, and the performance improvements that followed took multiple regulatory cycles to fully materialise.

	Scotland
	National consistency in engineering standards is a product of operator structure, not just regulatory design. Scotland's ability to apply Water for Scotland and Sewers for Scotland uniformly across the network is possible because there is one operator. New Zealand's consolidated water services entities create the same structural precondition, but capturing that advantage requires the engineering standards framework to be designed to operate at a national scale from the outset (Scottish Government, 2021). Strong top-line performance outcomes can mask structural gaps in asset condition and stormwater management that only become visible when monitoring improves or climate conditions change (Scottish Government, 2021; WICS, 2021). New Zealand should consider whether its outcome metrics are designed to surface hidden risks, particularly in stormwater and long-lived network assets, or whether they risk producing the same pattern Scotland has experienced: strong reported compliance masking accumulating asset condition issues that become visible only after the fact.
Is there an explicit risk-based framework	How consistently is it applied across regions? Each regulator applies a risk-based approach in its domain, but there is no single integrated risk classification for the whole sector. DWQR focuses on larger or more vulnerable water supplies, SEPA on high-impact discharges in sensitive environments, and WICS on service and asset risks in investment planning (Public Water Supplies (Scotland) Regulations, 2014; SEPA, 2019; WICS, 2021). Because Scottish Water is one national operator, risk management practices (e.g. asset standards and procedures) are applied uniformly across all regions, avoiding the inconsistencies that can arise with multiple companies (Scottish Government, 2021). However, a comprehensive view of overall infrastructure risk requires combining the separate assessments of DWQR, SEPA, and WICS.

4.2.1 Relevance and Lessons for New Zealand

Scotland closely aligns with England and Wales in its use of nationally defined performance outcomes, strong regulatory oversight, risk-based regulation, and whole-of-life asset focus. The key difference lies in governance: Scotland demonstrates how national consistency, lifecycle clarity, and data standardisation can be achieved more directly through a single public utility, whereas England and Wales rely on market mechanisms and regulatory controls to achieve similar outcomes.

Scotland demonstrates that outcomes-based regulation can function effectively without prescriptive engineering rules, provided three conditions are met: a single accountable operator that internalises consistent engineering standards; strong independent regulators with statutory powers and enforcement credibility; and sufficient institutional engineering capability within the operating entity to make well-informed judgements in the absence of external prescription. For New Zealand, the relevant question is not whether this model works in principle, Scotland shows that it can, but whether these three conditions can be established at sufficient scale and pace to support it from the outset of the reformed system.

For NEDS, Scotland highlights the benefits of clear national standards, integrated asset stewardship, and simplified adoption processes, while reinforcing lessons from England and Wales on the value of explicit performance outcomes supported by technical guidance rather than prescriptive design rules. The relevance lies in recognising that New Zealand does not have the same governance simplicity and must therefore achieve consistency through design standards rather than ownership structures. Together, these lessons underscore the role of NEDS design standards as the primary mechanism for embedding consistency, lifecycle clarity, and system stewardship across a fragmented delivery environment.

4.3 Canada

Table 3 Canada Jurisdiction Overview Table

	Canada
Jurisdiction Overview	What problem was this regulatory regime created to address? Canada's water regulatory regime was established to protect public health and the environment within a highly decentralised governance system that allocates responsibilities across federal, provincial/territorial, and municipal levels. At the federal level, national outcome expectations are set through instruments such as the Guidelines for Canadian Drinking Water Quality developed by Health Canada, which define health-based contaminant limits, and the Wastewater Systems Effluent Regulations under the Fisheries Act, which establish minimum effluent quality standards to protect aquatic ecosystems (Health Canada, 2022; Environment and Climate Change Canada [ECCC], 2012). These federal frameworks are primarily performance-based and design-neutral, with provinces and territories responsible for translating them into legally binding licences, approvals, and design guidance, and municipalities responsible for implementation and operation. The result is a tiered regulatory system in which national standards define what must be achieved, while minimum design requirements and technical standards vary by province and municipality to reflect local conditions and regulatory approaches (Health Canada, 2023; ECCC, 2012). How does the regime work overall? Canada's water regulatory regime operates as a tiered, outcomes-based system in which national performance expectations are set by the federal government, while compliance, design, and delivery are administered primarily at the provincial and municipal levels. At the federal level, Health Canada develops the Guidelines for Canadian Drinking Water Quality, which establish health-based contaminant limits and operational guidance but are not legally binding, while Environment and Climate Change Canada administers the Wastewater Systems Effluent Regulations under the Fisheries Act, which set enforceable national minimum effluent quality standards focused on protecting fish and aquatic ecosystems (Environment and Climate Change Canada [ECCC], 2012; Health Canada, 2022). Provinces and territories are responsible for translating these federal outcome requirements into binding legislation, licences, approvals, and design guidelines, and for regulating compliance through provincial ministries of environment and health. This approach varies by province: for example, in Ontario, both federal and provincial legislation apply, with the province issuing legally binding drinking water licences and environmental compliance approvals supported by provincial design guidelines, while municipalities are responsible for implementing, operating, and maintaining water, wastewater, and stormwater systems (Health Canada, 2023). Provincial design criteria are strongly influenced by federal requirements, particularly those related to fisheries and aquatic protection, while water services on federal lands and First Nations lands remain under federal jurisdiction. As a result, the Canadian regime provides national consistency in performance outcomes but allows significant variation in design standards and implementation practices at the provincial and municipal levels.

	Canada
	Who is the regulator, and what formal powers do they have to enforce the regime? Regulatory oversight of water services in Canada is shared across federal, provincial, and municipal levels, with enforcement powers concentrated primarily at the provincial level. Federally, Health Canada develops the Guidelines for Canadian Drinking Water Quality, which establish national health-based performance benchmarks but are not directly enforceable, while Environment and Climate Change Canada (ECCC) enforces environmental protection requirements for wastewater through binding instruments such as the Wastewater Systems Effluent Regulations under the Fisheries Act, including powers to mandate monitoring, reporting, and compliance with minimum effluent standards (Environment and Climate Change Canada [ECCC], 2012; Health Canada, 2022). Provinces and territories act as the primary regulators, issuing licences and approvals, conducting inspections and audits, and requiring corrective action or imposing penalties for non-compliance; for example, in Ontario, these functions are carried out by the Ministry of the Environment, Conservation and Parks (MECP). The majority of drinking water, wastewater, and stormwater systems are owned and operated by municipalities, which are responsible for meeting provincial requirements and implementing approved design and operational standards. In contrast, residents in rural or remote areas using private wells or small systems are generally responsible for testing and managing their own drinking water quality, resulting in variation in regulatory oversight, processes, and tools across system types and jurisdictions (Health Canada, 2023).
Setting performance requirements	<u>Nature of requirements</u> What performance areas or outcomes are regulated (e.g. safety, reliability, environmental protection, service quality), and why? In Canada, regulated performance outcomes for water services focus primarily on public health protection, environmental protection, and sustainable use of water resources, reflecting the essential nature of water supply and wastewater services. For drinking water, the central performance objective is water quality and safety at the consumer's tap, expressed through health-based limits for microbial, chemical, and radiological contaminants in the Guidelines for Canadian Drinking Water Quality, which are designed to protect vulnerable populations and support a preventive, multi-barrier approach from source to tap (Health Canada, 2022; Health Canada, 2023). For wastewater, performance requirements focus on environmental protection, particularly the prevention of harm to fish and aquatic ecosystems, implemented through national minimum effluent quality standards set out in the Wastewater Systems Effluent Regulations under the Fisheries Act, including limits on pollutants such as biochemical oxygen demand, suspended solids, and toxic substances (Environment and Climate Change Canada [ECCC], 2012). In addition, water quantity and source protection outcomes are increasingly regulated at the provincial level to manage the environmental impacts of excessive water abstraction for drinking water supply, with provinces imposing controls on water takings to protect ecosystems, downstream users, and long-term water availability. Canada's stormwater performance outcome is less uniformly regulated than drinking water or wastewater, but still centres on flood-risk reduction, water-quality protection, and climate resilience. Provinces set most of the technical expectations through manuals like Ontario's Stormwater Management Planning and Design Manuals, while national bodies influence outcomes through tools such as CSA W211:21 – the national stormwater management standards and the National Research Council's climate-resilient infrastructure guidance.

	Canada
	Together, these outcome areas reflect a regulatory emphasis on safeguarding human health, preserving environmental values, and ensuring sustainable water use, while allowing provinces and municipalities flexibility in how infrastructure is designed and operated to achieve these objectives. How are the performance requirements set and structured, and to what level of detail? In Canada, performance requirements for water services are structured through a tiered regulatory framework, with minimum outcome expectations established at the federal level and progressively elaborated at provincial and municipal levels. Federally, Health Canada sets national, science-based drinking water performance benchmarks through the Guidelines for Canadian Drinking Water Quality, while Environment and Climate Change Canada establishes enforceable baseline effluent quality standards for wastewater through the Wastewater Systems Effluent Regulations under the Fisheries Act (Environment and Climate Change Canada [ECCC], 2012; Health Canada, 2022). Provinces and territories adopt or adapt these federal requirements into legally binding standards, licences, and approval conditions, often adding province-specific requirements related to local risks, system scale, and environmental sensitivity. In some cases, municipalities further supplement provincial requirements through local bylaws, design standards, or servicing policies to address local service levels and growth pressures. As a result, performance requirements are nationally consistent at the outcome level, but vary in detail, prescriptiveness, and implementation across provinces and municipalities, reflecting local governance arrangements and environmental contexts (Health Canada, 2023). Canada uses a tiered system in which the federal government sets minimum national outcomes and provinces and municipalities add detail. Federally, Health Canada defines drinking-water performance through the <i>Guidelines for Canadian Drinking Water Quality</i>, and ECCC sets enforceable wastewater effluent standards under the <i>Wastewater Systems Effluent Regulations</i>. Provinces then turn these into binding rules, often adding requirements based on local risks, system size, and environmental sensitivity, with municipalities sometimes layering on further bylaws or servicing policies. Stormwater, which has no federal regulatory regime, is guided mainly by provincial manuals and voluntary national standards such as CSA W211:21, leading to more variation. The result is nationally consistent high-level outcomes for drinking water and wastewater, but differing levels of prescriptiveness and implementation detail across provinces and municipalities. What are the compliance pathways, e.g. equivalents to the Codes of Practice, standards, or acceptable solutions that demonstrate compliance? What are the verification processes for alternative pathways? In Canada, compliance pathways for water services performance are primarily established and enforced at the provincial and territorial level, using federal guidance as the baseline for legally binding requirements. For drinking water, provinces and territories commonly adopt the Guidelines for Canadian Drinking Water Quality (GCDWQ) developed by Health Canada as the foundation for enforceable standards, reflecting a multi-barrier, source-to-tap approach encompassing source protection, treatment, distribution, monitoring, and response (Health Canada, 2022; Health Canada, 2023). Compliance is demonstrated through provincial drinking water licences and approvals and environmental compliance approvals for wastewater and stormwater systems, which specify design criteria, monitoring obligations, and operational conditions.

	Canada
	Municipalities and other system owners are responsible for meeting these conditions, supported by inspections and audits carried out by provincial and municipal regulators (Environment and Climate Change Canada [ECCC], 2012). In some jurisdictions, such as Ontario, operating authorities must implement a Quality Management System, notably the Drinking Water Quality Management Standard (DWQMS), which requires documented risk management processes and third-party audits as a key verification mechanism. Ongoing compliance is verified through routine water quality monitoring, often using accredited laboratories, for parameters such as lead and aluminium, targeted programs for corrosion control and high-risk sites, and mandatory reporting to regulators. Alternative or equivalent approaches may be accepted where proponents can demonstrate compliance with provincial requirements through approved management systems, documented risk assessments, and audit outcomes, while federal initiatives continue to address gaps in oversight for drinking water services on First Nations lands (Health Canada, 2023). Specific Compliance Areas: • Lead Control: Monitoring programs targeting high-risk sites (e.g., galvanised steel pipes) at the tap. • Corrosion Control: Adjusting pH (typically 7.0–10.5) and alkalinity to manage corrosion in pipes. • First Nations Water Services: Federal efforts include developing new legislative frameworks to provide legal protection and safe drinking water standards on First Nation lands. • Wastewater compliance is demonstrated through to provincial approvals that incorporate federal Wastewater Systems Effluent Regulations. • Stormwater compliance is guided through provincial approvals and design manuals, supported by Voluntary national standards such as CSA W211:21. • Compliance across all three services is verified through inspections, regulatory reporting and third-party audits, with some provinces, such as Ontario, requiring accredited Quality Management Systems. • Governance and Oversight • Federal Responsibility: Health Canada works with federal, provincial, and territorial partners to create the GCDWQ, which acts as the national benchmark. • Local Responsibility: Municipalities or private operators are responsible for complying with the provincial requirements. • Auditing and Accreditation: Third-party audits are often required to confirm that operating authorities are meeting established QMS standards What standards or Codes of Practice are used to support meeting the performance requirements? Codes of Practice are typically developed at a provincial level for example: two provincially developed documents are used in Ontario to support compliance with drinking water and wastewater infrastructure requirements: the Design Guidelines for Drinking Water Systems and the Design Guidelines for Sewage Works, both issued by the Ontario Ministry of the Environment, Conservation and Parks (MECP) and applied through provincial approvals and licensing processes (Ontario Ministry of the Environment, Conservation and Parks [MECP], n.d.).

	Canada
	How often are requirements reviewed or changed, and why? In Canada, water regulations and guidance are reviewed on varied but structured cycles to ensure they remain aligned with emerging science, environmental risks, and societal expectations. At the federal level, the Guidelines for Canadian Drinking Water Quality (GCDWQ) are updated on an ongoing basis, with individual chemical and operational parameters typically re-evaluated every four to five years as new toxicological evidence, treatment technologies, or international benchmarks emerge (Health Canada, 2022). Major federal statutes that underpin environmental protection, including the Fisheries Act and the Canadian Navigable Waters Act, are subject to mandatory legislative reviews every five years, while broader reforms to water governance are underway through the modernisation of the Canada Water Act and the establishment of the Canada Water Agency (Environment and Climate Change Canada [ECCC], 2019; Government of Canada, 2024). In parallel, ECCC undertakes a 10-year Regulatory Stock Review (2019–2029) to systematically assess and update existing environmental regulations, including wastewater requirements. At the provincial level, instruments such as Provincial Water Quality Objectives (e.g. in Ontario) are updated periodically to reflect new science, climate change impacts, and local environmental pressures, while national environmental indicators, such as river water quantity, are reported at regular intervals (e.g. biennially). Together, these review cycles are designed to ensure that Canada’s water regulatory framework remains adaptive, science-based, and responsive to long-term risks, rather than static or solely compliance-driven. How do they cover connection of infrastructure to a water services network, e.g. by a developer? In Canada, the connection of new or developer-delivered infrastructure to drinking water, wastewater, and stormwater networks is regulated primarily at the provincial and municipal level, with municipalities acting as the approving and asset-owning authorities. Developers are required to design and construct infrastructure in accordance with provincial design guidelines and approval conditions, such as Ontario’s Design Guidelines for Drinking Water Systems and Design Guidelines for Sewage Works, as well as any applicable municipal servicing standards or bylaws (Ontario Ministry of the Environment, Conservation and Parks [MECP], n.d.). Compliance is typically assured through a combination of development approvals, construction quality assurance and quality control (QA/QC) processes, staged inspections, and certification prior to commissioning or assumption of the assets by the municipality. Municipalities are responsible for verifying that infrastructure has been constructed in accordance with approved designs and provincial requirements before connecting it to the public network and accepting ongoing ownership and operational responsibility, resulting in locally administered but provincially grounded connection and vesting processes (Health Canada, 2023). How do they cover asset management, including repair, upgrade, renewal, replacement, maintenance, and decommissioning of water services infrastructure that makes up water services networks? In Canada, responsibility for the asset management and lifecycle activities of drinking water, wastewater, and stormwater infrastructure, including repair, upgrade, renewal, replacement, maintenance, and decommissioning, rests primarily with municipal owners and operators, reflecting local ownership of water assets.

	Canada
	Municipalities are required to manage these activities in accordance with provincial regulatory requirements, asset management planning frameworks, and licence or approval conditions, often supported by long-term asset management plans. For certain activities, particularly system expansions, major upgrades, or changes in treatment capacity or process, municipalities must obtain provincial approval or amendments to existing licences and environmental compliance approvals, ensuring continued alignment with provincial and federal performance requirements (Health Canada, 2023; Ontario Ministry of the Environment, Conservation and Parks [MECP], n.d.). Federal requirements, such as national effluent standards under the Wastewater Systems Effluent Regulations, indirectly shape asset renewal and upgrade decisions by establishing minimum environmental performance thresholds that must be maintained over the asset lifecycle (Environment and Climate Change Canada [ECCC], 2012). As a result, asset management in Canada is locally delivered but constrained by provincial oversight and national outcome expectations, leading to variation in practices across municipalities while maintaining baseline regulatory consistency. What do they require about how information about the design, construction, and operational performance of water services infrastructure should be collected, kept, and shared? In Canada, requirements for collecting, retaining, and sharing information about the design, construction, and operational performance of water services infrastructure are primarily imposed through provincial licences and environmental approvals issued to municipalities and other system owners. Provincial regulators require municipalities to maintain records and submit annual or periodic compliance reports covering matters such as system performance, water quality monitoring results, operational incidents, and infrastructure changes, as a condition of drinking water licences and environmental compliance approvals for wastewater and stormwater systems (Health Canada, 2023; Ontario Ministry of the Environment, Conservation and Parks [MECP], n.d.). These requirements ensure that sufficient information is available to demonstrate ongoing compliance with provincial and federal performance standards, including national drinking water and effluent quality obligations. In addition, records and reports are typically required to be retained on site and made available for inspection by provincial regulators, supporting audit, enforcement, and public transparency while allowing provinces flexibility in specifying detailed reporting formats and data systems (Environment and Climate Change Canada [ECCC], 2012). <u>Measurement and compliance</u> How is performance checked and reported? In Canada, performance of drinking water, wastewater, and stormwater systems is checked and reported through a combination of binding regulatory requirements and proactive risk-management frameworks administered primarily at the provincial level. Provincial authorities establish legally enforceable water quality and operational requirements through licences and approvals, which must be met by system owners and operating authorities (Health Canada, 2023). In some provinces, notably Ontario, utilities are required to implement formal Quality Management Systems, such as the Drinking Water Quality Management Standard (DWQMS), which mandate documented operational procedures, continuous improvement processes, and independent third-party audits to verify compliance and effectiveness.

	Canada
	Utilities must also develop and maintain risk and hazard management plans, identifying potential threats such as source-water contamination and establishing control measures and corrective action protocols (Health Canada, 2022). Ongoing compliance is verified through mandatory water quality monitoring and periodic reporting to provincial regulators, supplemented by inspections and audits; in many cases, monitoring results and compliance reports are made publicly available to support transparency and accountability (Environment and Climate Change Canada [ECCC], 2012).
How assets, activities or contexts are classified for regulation	How does the regime approach different waters (e.g. stormwater, wastewater, drinking water)? Drinking water, wastewater, and stormwater are regulated through distinct but parallel legislative and approval frameworks, reflecting their different public health and environmental risk profiles. Drinking water is primarily governed through provincial drinking water statutes and licences informed by the Guidelines for Canadian Drinking Water Quality, with enforceable conditions focused on source-to-tap safety, treatment performance, and monitoring (Health Canada, 2022; Health Canada, 2023). Wastewater and, where regulated, stormwater discharges are subject to environmental legislation at both federal and provincial levels, including national minimum effluent standards under the Wastewater Systems Effluent Regulations and province-specific environmental approval regimes (Environment and Climate Change Canada [ECCC], 2012). In Ontario, this separation is reflected in the issuance of drinking water system licences and Environmental Compliance Approvals (ECAs) for wastewater and stormwater systems, each with tailored conditions that must be met by municipalities and system operators. Provincial inspectors are responsible for verifying compliance with these conditions through audits, inspections, and enforcement actions, ensuring that regulatory oversight is applied in a manner proportionate to the specific risks associated with each type of water service. How does each regime classify different types of infrastructure, e.g. by asset types, operators, services, locations, risks? The classification of water services infrastructure is largely determined at the provincial level, with Ontario providing a clear example through its legislated asset management framework under Ontario Regulation 588/17 (Asset Management Planning for Municipal Infrastructure). This regulation requires municipalities to classify and manage assets based on asset type, service function, and lifecycle attributes, with a particular emphasis on distinguishing core infrastructure from other municipal assets (Government of Ontario, 2017). Core infrastructure assets, addressed in Phase I of the regulation, include drinking water, wastewater, and stormwater systems, along with roads, bridges, and culverts, and are subject to detailed requirements for asset inventories, condition assessment, replacement cost estimation, and level-of-service reporting. Phases II and III expand the classification framework to include non-core assets, such as community facilities, fleet, and information technology systems, ensuring comprehensive municipal asset coverage. In addition, some municipalities are increasingly recognising natural assets, such as aquifers, drainage channels, and wetlands, as a distinct class managed alongside traditional engineered infrastructure. This classification approach supports risk-informed asset management by linking infrastructure type and service criticality to planning, reporting, and investment decisions, while allowing provincial consistency and local flexibility in implementation (Ontario Ministry of the Environment, Conservation and Parks [MECP], n.d.).

	Canada
	What criteria are used for this classification (e.g. scale, criticality, risk profile, harm potential), and why? Water infrastructure is classified using criteria focused on risk management, including population size served, treatment complexity, potential harm (safety and environmental), and system criticality. These criteria are used to determine operator certification requirements, maintenance needs, and to prioritise infrastructure investment to protect public health from contaminants and ensure system resilience against hazards. Canada classifies water, wastewater, and stormwater systems using criteria that reflect risk, because these factors determine the level of oversight, operator competency, and infrastructure performance needed to protect public health and the environment. Systems are typically differentiated by the population served, the complexity of treatment processes, the criticality of the asset, and the likelihood and severity of harm, an approach reinforced by national assessments such as Water Canada's "<i>A New Baseline for Water Infrastructure Risk in Canada</i>", which highlights ageing assets, extreme weather, and source-water contamination as key risk drivers. These criteria guide operator-certification requirements, monitoring intensity, maintenance expectations, and investment prioritisation, ensuring that higher-risk or higher-impact systems are subject to more stringent controls to maintain safety, reliability, and environmental protection. How is regional variation provided for (for example, geographic, climatic, and geological variations)? Canada's provinces set their own water, wastewater, and stormwater requirements, which means compliance pathways can be tailored to local hydrology, climate, infrastructure age, and environmental sensitivity. Regions with vulnerable source waters or dense urban systems often impose stricter monitoring and treatment expectations, while areas facing cold-climate challenges, high rainfall, or sensitive receiving environments adjust design and operational standards accordingly. This provincial flexibility allows regulations, approvals, and performance requirements to reflect location-specific risks and conditions, even as all jurisdictions work toward the same national public-health and environmental outcomes. Are there clear tiers or levels with different regulatory requirements? Water infrastructure in Canada is tiered, with regulatory requirements intensifying as the system grows in size, complexity, and potential risk to public health, especially for drinking water. The federal government sets baseline standards like the Guidelines for Canadian Drinking Water Quality, but the specific "tiers" and their mandatory rules are defined by each province, many of which use a 1-4 rating system for water and wastewater facilities. In British Columbia and Yukon, the EOCP's Facility Classification system assigns water and wastewater systems a level from I to IV based on treatment complexity, population served, and potential health or environmental risk. Higher-level facilities require more advanced operator certification and must meet stricter operational and monitoring requirements. This reflects the broader Canadian pattern in which provinces define their own tiering systems, often using a 1–4 scale, to ensure regulatory expectations scale with system size, complexity, and risk (Environmental Operators Certification Program, Facility Classification). How does an asset or entity's category affect: – Performance requirements (the standards it must meet)? – Reporting obligations (how much reporting it must do)?

	Canada
	– Inspection or oversight frequency (how often it is inspected or monitored)? As the risk and consequences of asset failure increase then so does the stringency of the standards it must meet, the operational oversight increases as does the monitoring and reporting requirements. This approach is stated, for example, in <u>Metro Vancouver's Asset Management for Water Services Policy</u> which directly states that as asset criticality (consequence of failure) increases, there is less tolerance for failure, resulting in more frequent monitoring and higher priority for inspection and is common asset management practice across the country and internationally through the adoption of standards such as the global standard for managing water infrastructure, largely formalised through the ISO 55000 series.
How regulatory intervention is prioritised	How does the regulator decide where to focus its attention and resources? Regulators focus their attention on the highest-risk systems, using structured risk assessments that weigh likelihood of failure, severity of consequences, and community vulnerability. This risk-based approach is reinforced by asset-management performance frameworks used across Canada, which evaluate utilities on factors such as asset condition, lifecycle planning, financial sustainability, and service reliability. National guidance such as the Federation of Canadian Municipalities' <i>Guide to the Measurement of Asset Management Performance</i> supports this approach by outlining indicators that help utilities and regulators prioritise investment and operational attention where risks are greatest, particularly as infrastructure ages and climate pressures intensify. What factors matter most when assessing risk or priority (e.g. likelihood of failure, consequence of harm, past performance)? as related to human health and environmental impacts. Regulators prioritise systems using a small set of factors that most strongly predict human-health and environmental risk. The key considerations are the likelihood of failure, the consequence of harm if failure occurs, and the system's past performance, including any history of non-compliance or advisories. This aligns with international guidance such as the <i>International Working Group on Drinking Water (IWGDW)</i>, which emphasises focusing oversight on systems where vulnerabilities are known and where failure would have the greatest public-health impact. Do policy or guidance documents set out clear prioritisation rules, or mainly left to regulator judgement? Prioritisation for water infrastructure assets is a blend of prescriptive legislative rules and regulator/municipality-led risk assessment frameworks. While federal guidelines set the quality/performance benchmarks, the actual "rules" for which pipe gets fixed first are largely codified in provincial regulations and local asset management policies. Provinces set the overarching health and safety standards that municipal systems must meet, for example for drinking water infrastructure, based on the <u>Guidelines for Canadian Drinking Water Quality</u>. Ability to meet these standards will feed into prioritisation of these assets.
How the regime has changed, and what lessons have been learned	What major changes have been made since the regime was introduced, and why? Since its introduction, Canada's water regulatory regime, particularly in Ontario, has undergone significant reform driven by major service failures and public health risks, most notably the Walkerton drinking water contamination (2000). The subsequent Walkerton Inquiry exposed systemic weaknesses in oversight, operator training, and reliance on voluntary standards, prompting a shift toward a mandatory, multi-barrier approach to drinking water safety.

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	Key changes included the introduction of legally enforceable drinking water standards, mandatory operator certification and ongoing training, expanded public reporting of water quality results, and a stronger emphasis on source water protection to manage risks before water reaches treatment plants (O'Connor, 2002). These reforms were embedded in Ontario through the Safe Drinking Water Act (2002), which regulates treatment, testing, monitoring, and operator accountability, and the Clean Water Act (2006), which focuses on identifying vulnerable drinking water sources and implementing locally developed source protection plans overseen by conservation authorities (Government of Ontario, 2002; Government of Ontario, 2006). While these changes significantly strengthened protection for municipal drinking water systems, which serve the majority of the population, non-municipal systems such as private wells remain outside the core scope of mandatory source protection tools, leaving residual risk in rural and remote communities. What were the drivers for these changes (e.g., service failures, reform programmes, cost pressures, climate resilience)? Regulatory change in Canada's water and wastewater sector has been driven primarily by major service failures, emerging environmental risks, and the need to strengthen public confidence, rather than incremental reform or cost pressures alone. In drinking water, high-profile public health incidents exposed systemic weaknesses in oversight and reliance on voluntary guidance, prompting a shift to legally binding, multi-barrier, source-to-tap regulation. The most significant trigger was the Walkerton, Ontario E. coli outbreak (2000), which resulted in seven deaths and led to the enactment of Ontario's Safe Drinking Water Act (2002) and Clean Water Act (2006), mandating stricter treatment, monitoring, operator certification, and watershed-level source protection (O'Connor, 2002; Government of Ontario, 2002, 2006). Similar failures reinforced this direction nationally, including the North Battleford cryptosporidium outbreak (2001), which drove strengthened laboratory standards and independent testing requirements, and the ongoing Kashechewan First Nation drinking water crisis, which highlighted gaps in regulatory protection for non-municipal and First Nations systems and prompted federal commitments to improved legislative frameworks. In the wastewater and environmental domain, growing concern over PFAS and other emerging contaminants, combined with major environmental disasters such as the Mount Polley tailings dam failure (British Columbia, 2014), accelerated scrutiny of industrial discharges, monitoring, and cumulative environmental impacts under federal environmental legislation (Environment and Climate Change Canada, 2016). Collectively, these drivers shifted Canada's regulatory approach from reactive, guidance-based systems toward mandatory standards, risk-based oversight, and stronger environmental accountability across the water sector. How did these changes affect standards, compliance and outcomes? The regulatory reforms introduced following the Walkerton drinking water tragedy fundamentally strengthened standards, compliance, and public health outcomes in Ontario and influenced broader Canadian practice. The Safe Drinking Water Act (2002) shifted Ontario from reliance on voluntary guidance to a system of legally binding requirements, establishing strict rules for drinking water treatment, testing, monitoring, public reporting, and operator accountability to ensure drinking water remains safe from the treatment plant to the consumer's tap (Government of Ontario, 2002; O'Connor, 2002). Complementing this, the Clean Water Act (2006) extended regulatory focus upstream by embedding

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	source water protection into the regime, requiring the identification of vulnerable drinking water areas, development of locally led protection plans to reduce or eliminate risks, and annual reporting by conservation authorities or other designated bodies on plan implementation and effectiveness (Government of Ontario, 2006). Together, these changes operationalised a robust multi-barrier approach that improved regulatory certainty, strengthened compliance monitoring and enforcement, increased transparency, and measurably reduced the likelihood of drinking water contamination events in regulated municipal systems, while highlighting ongoing gaps for non-municipal and private water supplies. What has worked well in practice? Is there evidence of quantified impacts associated with the regime (e.g. reduction in harm, improvement in service quality, reductions in time/cost to comply)? Based on the content presented above, positive outcomes have been achieved through changes to the regulations controlling drinking water quality. These have reduced the risk of adverse health impacts due to consuming substandard drinking water and improved service delivery. What challenges or unintended consequences have been observed? Insights derived in the context of the content above include: As with any significant change implementation of enforceable standards to replace voluntary guidance, there was a substantial cost to uplift due to increased monitoring, training and treatment plant upgrades, and in the early stages, there was a lack of capacity in operational staff to implement the new approach on the ground. Even with stronger standards in place, the delivery of outcomes still depends on infrastructure condition and funding, thus exposing ongoing investment needs and magnifying the legacy of underinvestment. Are there lessons or features that are especially relevant to New Zealand's context? All the above insights are relevant to the New Zealand context.
Guidelines/ standards for private 3 Waters assets (drinking water, wastewater and stormwater)	How the jurisdictions enforce, regulate and monitor private assets? In Canada, the enforcement, regulation, and monitoring of private water, wastewater, and stormwater assets vary by province and territory but are generally overseen by provincial ministries of the environment through permitting, monitoring, and inspection regimes. Private operators, including industrial and commercial facilities, are typically required to obtain Environmental Compliance Approvals (ECAs) or equivalent permits that specify effluent quality limits, monitoring requirements, and reporting obligations for wastewater and stormwater discharges (Environment and Climate Change Canada [ECCC], 2012). Provinces rely on a combination of mandatory self-reporting, regular compliance inspections, and audits to verify adherence to approval conditions; for example, in Ontario, private facilities must submit periodic effluent monitoring reports, often quarterly or annually, detailing parameters such as flow, chemical oxygen demand, and suspended solids, which are reviewed by the Ministry of the Environment, Conservation and Parks (MECP).

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	Provincial inspectors routinely conduct site visits, sample discharges, and investigate non-compliance, with enforcement tools including corrective orders, fines, and prosecutions where standards are breached. Through these mechanisms, private assets are regulated to ensure they do not compromise public water services, environmental quality, or statutory performance outcomes, while allowing provinces flexibility to tailor oversight to the scale and risk of each activity.
Limitations/ constraints in the current performance-based approach	What changes or improvements would address these? Based on the research carried out to prepare this document, the following are examples of improvements that could be made to the current approach. Provide equivalent coverage across all 3 waters – Water and Wastewater have stronger national outcome regulation (WSER), but stormwater lacks national standards, leading to greater variability in targets and design approaches. Improve consistency across geographies through national design guidance. Standardise risk frameworks for prioritisation of asset management
How does reliance on engineering judgement contribute to inconsistency	Any examples? In Canada, reliance on engineering judgement contributes to variability in water and wastewater infrastructure outcomes because municipalities retain discretion over risk tolerance, service levels, redundancy, and operational assumptions within broadly defined regulatory performance requirements. While provinces set minimum outcome expectations and issue approvals, many design decisions, such as the degree of system redundancy, allowance for future growth, resilience to extreme events, and operational flexibility, are determined at the municipal level and implemented through consulting engineering firms engaged by asset owners. As a result, similar systems may be designed differently across municipalities depending on local priorities, budget constraints, and professional judgement, even when subject to the same provincial regulations and guidelines (Government of Ontario, 2017). This is reinforced by the absence of nationally consistent design standards, meaning that engineering solutions are often optimised to meet owner-specified requirements and minimum regulatory thresholds rather than a uniform national baseline. While this approach allows flexibility and context-sensitive design, it can also lead to inconsistent levels of resilience, redundancy, and lifecycle performance across jurisdictions, particularly where procurement approaches, owner capability, or risk appetites differ (Ontario Ministry of the Environment, Conservation and Parks [MECP], n.d.). Lesson learned? In Canada, experience has shown that reliance on engineering judgement, when combined with variable procurement approaches, contributes to inconsistent water and wastewater infrastructure outcomes across municipalities. While provincial regulations set minimum performance expectations, detailed design decisions are typically delegated to consulting engineers engaged by municipalities, and outcomes can vary depending on the consultant's interpretation of risk, redundancy, and lifecycle priorities. This variability is amplified by procurement practices, as many municipalities select engineering services using price- and technical-weighted evaluation models under public-sector procurement rules, while

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	others adopt qualifications-based selection, prioritising experience and technical expertise (Ontario Treasury Board Secretariat, 2021). Differences in selection criteria can influence design ambition, resilience allowances, and long-term asset performance, even where systems are subject to the same regulatory framework. Asset management requirements under Ontario Regulation 588/17 reinforce the need for lifecycle-based planning, but do not prescribe design solutions, leaving outcomes sensitive to owner capability and consultant judgement (Government of Ontario, 2017). The key lesson is that flexibility and professional judgement, while valuable, require clearer baseline expectations and consistent design frameworks to reduce variability and ensure more uniform performance across jurisdictions.
Is there an explicit risk-based framework	How consistently is it applied across regions? Canada uses several explicit risk-based frameworks to inform drinking water, wastewater, and watershed management, although their application varies across jurisdictions and system types. At the federal level, Environment and Climate Change Canada (ECCC) applies a Risk-Based Approach to Watershed and Station Assessment to evaluate cumulative risks to water quality and aquatic ecosystems across more than 1,100 sub-drainage areas, considering pressures such as agriculture, transportation corridors, and pipelines (Environment and Climate Change Canada [ECCC], 2019). For drinking water, the widely adopted Multi-Barrier Approach, endorsed nationally through the Canadian Council of Ministers of the Environment, provides a preventive, risk-management framework that addresses threats from source protection through treatment and distribution (CCME, 2004; Health Canada, 2023). Application becomes more targeted at the provincial level: in Ontario, for example, risk-categorisation tools such as the Risk Categorisation (RCat) Tool are used by public health inspectors to assess and prioritise oversight of small and non-municipal drinking water systems, while broader Water Security Risk Assessment (WSRA) and source protection frameworks classify risk based on vulnerability and potential economic or health consequences at a watershed scale (Government of Ontario, 2017; Health Canada, 2023). Collectively, these frameworks demonstrate a strong risk-based intent, but their operationalisation and consistency vary by province, asset type, and regulatory context, resulting in uneven translation into design and operational requirements across Canada.

4.3.1 Upholding Indigenous Rights and Obligations

Canada's constitution protects Indigenous land and water rights. The government must consult and, when necessary, accommodate Indigenous Peoples if water infrastructure projects impact their rights; large or major projects may require consent, especially where Aboriginal title is strong or established, which is common in British Colombia.

British Colombia is the only Canadian province that has enacted legislation to align all provincial laws with UNDRIP (UN Declaration on the Rights of Indigenous Peoples). This means that water service planning, permitting and infrastructure approaches are legally exposed and can be challenged in the courts (up to supreme court level) if Indigenous rights are not meaningfully respected. UNDRIP cases are heard in the same courts that hear administrative, constitutional and judicial review cases. UNDRIP itself does not create an international court of complaint system, however, Indigenous Peoples can raise UNDRIP issues through the UN Human Rights Council mechanisms, including the Expert Mechanism on the Rights of Indigenous Peoples (EMRIP), the UN Permanent Forum on Indigenous Issue (UNPHFF), and the UN Special Rapporteur on the rights of Indigenous Peoples.

Indigenous rights are not explicitly addressed within standards or codes, which are designed to remain culturally neutral and do not incorporate Indigenous values into performance criteria.

4.3.2 Relevance and Lessons for New Zealand

Canada is a relevant comparator jurisdiction for the development of NEDS because it operates within a common-law legal framework, manages water services across multiple levels of government, and relies on nationally articulated performance outcomes supported by sub-national design guidance, rather than uniform federal design standards. The Canadian experience demonstrates the value of a clear national outcomes “backbone” such as the Guidelines for Canadian Drinking Water Quality and the Wastewater Systems Effluent Regulations, in providing consistency of public-health and environmental expectations, while allowing provinces and municipalities flexibility to tailor design and delivery to local conditions (Health Canada, 2022; Environment and Climate Change Canada, 2012). At the same time, Canada illustrates the limitations of a highly fragmented system, particularly in relation to consistency of asset lifecycle expectations, data standards, and risk classification. For NEDS, the Canadian experience reinforces the value of establishing a clear national performance backbone, supported by nationally consistent definitions, data expectations, and risk principles, while still potentially allowing Codes of Practice to be locally adapted where justified.

4.4 Australia

Table 4 Australia Jurisdiction Overview Table Australia

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Jurisdiction Overview	What problem was this regulatory regime created to address? Australia’s modern water regulatory regime was created to fix long standing fragmentation and failures across the entire water cycle. For decades, states managed water differently, leading to over extraction in the Murray-darling Basin, inconsistent and unsafe drinking water quality, incompatible plumbing and monopoly water utilities operating with limited oversight The reforms as the Water Act 2007, the Australian Drinking Water Guidelines (ADWG), the National Construction Code (NCC) including the Plumbing Code of Australia (PCA) and AS/NZS 3500, the establishment of state-based economic regulators such as IPART, and the formation of WSAA, were introduced to address these gaps. Together, they respond to systemic fragmentation by improving national consistency, safeguarding public health, supporting sustainable water resource management, regulating monopoly service providers, and providing the sector with a coordinated national voice for policy and technical standards. How does the regime work overall? Australia’s water regulatory regime is set up as a layered system; national bodies set the overarching rules for sustainable water resources (Water Act 2007) and drinking water safety (ADWG). Overall, the regime is fragmented and lacks consistency in terms of performance requirements, design standards and monitoring and enforcement with expectations for some water infrastructure being set at a national level and others council or utility specific. The Water Act does not relate to design or set performance objectives in relation to water infrastructure. However, the Australian Drinking Water Guidelines are set at a national level and function as the authoritative reference for managing municipal water supplies, although they are not themselves legally mandatory. Instead, their link to municipal infrastructure is

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	established through state-level regulation and preventive risk management frameworks that dictate how utilities design and operate their networks. State governments regulate utilities as monopolies, enforce pricing and service standards, and apply technical rules like the NCC/PCA/AS/NZS 3500; councils manage local water and wastewater systems, development approvals, and compliance on the ground and utilities operate treatment plants, networks, and customer services in line with all these requirements. WSAA sits alongside these levels as the sector's coordination body, governed by a board of utility leaders and developing consensus-based positions rather than setting policy itself, helping ensure the industry speaks with a unified, evidence-driven voice. WSAA's governance is led by a Board composed of CEOs and senior executives of major water utilities across Australia (e.g. the Managing Director of Sydney Water has served as WSAA's Board Chair) (WSAA, 2024). In practice, WSAA's role in the regulatory framework is to provide research, coordination and advice. It produces industry codes, best-practice guidelines and submissions on behalf of its members, but it does not have legislative authority to impose rules – any formal rules come from government Acts, regulators, and utility licences (WSAA, 2010; IPART, 2023). The overall framework thus consists of statutory regulation (e.g. via IPART and health/environment regulators) alongside WSAA's voluntary industry standards which influence and support regulatory goals without dictating them (WSAA, 2024). How is the regulatory framework structured at a high level? At a national level, the Water Act 3rd Sept 2007 manages water resources rather than assets. National-level guidance for drinking water and private networks is provided. Industry body WSAA provides design codes at this national level also. At a state level, The State EPA sets legislation from which standards for discharges from water infrastructure can be controlled and managed. State level planning guidance for stormwater – water sensitive design approaches can also be set at a state level e.g. : <u>Stormwater Management Manual for Western Australia</u> is a comprehensive state-level document published by the WA Department of Water. It outlines best practices for implementing Water Sensitive Urban Design (WSUD) to manage stormwater quality and quantity in new developments. At a council or utility level, specific design codes of practice or technical standards are set for water infrastructure. Who is the regulator, and what formal powers do they have to enforce the regime? In Australia's water sector, there is no single regulator for the whole regime; different regulators hold powers over different parts of the system. Environmental regulators, such as the EPA, have the power to enforce discharge licenses and environmental conditions, while health departments can enforce drinking water risk management requirements. They can set requirements about overarching performance requirements and seek to enforce those if not met, but their powers do not extend to water infrastructure design unless covered by elements of the National Construction Code. Only the utilities or councils have the ability to ensure that their design standards are adhered to prior to being vested in the public system. In New South Wales, the Independent Pricing and Regulatory Tribunal (IPART) serves as the principal regulator for water utilities, with formal powers established by legislation to set price caps, issue and enforce operating licences, and monitor utility performance (IPART, 2023). For example, IPART periodically reviews and approves the maximum prices that monopoly providers like Sydney Water and Hunter Water can charge, and it oversees their compliance with licence conditions (IPART,

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	2023). However, IPART's authority applies only to the water service providers themselves; it cannot direct or sanction WSAA, since WSAA is not a licensed utility but rather an industry association (WSAA, 2018). This means WSAA's contributions to regulatory matters (such as submissions to IPART inquiries) are influential in shaping policy and regulation, but WSAA is not subject to regulatory enforcement, nor can it enforce rules on others (WSAA, 2024). The enforcement of standards and regulations in the urban water sector remains the remit of government regulators and utility owners, not WSAA (Productivity Commission, 2021).
Setting performance requirements	<u>Nature of requirements</u> What performance areas or outcomes are regulated (e.g. safety, reliability, environmental protection, service quality), and why? Regulation in the Australian water sector focuses on four core performance areas of safety, reliability, environmental protection and service quality, as water and wastewater services are essential public infrastructure. State-based economic regulators and statutory water supply legislation impose enforceable service standards, licensing conditions and customer-protection requirements. Safety is regulated to protect public health and to prevent contamination, for example, through the Australian Drinking Water Guidelines (ADWG), which set performance requirements and are generally formulated as best-practice guidelines rather than legally enforceable standards. The ADWG provides a framework designed to ensure safe drinking water, which state and territory regulators then adopt Reliability is regulated by State authorities to ensure communities receive consistent pressure, flow and uninterrupted supply. Service quality is regulated to ensure customers receive pleasant water, utilities respond to issues promptly, and service remains transparent and fair. The Environmental Protection Agency regulates to prevent pollution, protect waterways, and manage wastewater responsibly. They set enforceable limits on a case by case basis in relation to specific permit applications. Clear performance requirements for private water assets are set out in the Plumbing Code of Australia, which is Volume Three of the National Construction Code (NCC) and sets the overarching Performance Requirements prior to connection to the public system and AS/NZ Standards series 3500 provides Deemed to Satisfy (DTS) solutions offering detailed technical specifications for design, installation, and commission of water, sanitary, stormwater and heated water services. These regulated outcomes ensure water systems remain safe, dependable, sustainable, and customer focused. WSAA's publications do not impose any binding performance targets on water utilities; that is the role of regulators and government-set licence conditions (WSAA, 2018). For instance, WSAA's strategy highlights goals such as water security, customer value, financial sustainability, resilience, public health protection, industry capability, and better outcomes for First Nations communities, rather than numeric benchmarks (WSAA, 2024). These high-level outcome areas reflect shared priorities across the sector and are used to guide collective efforts and best practices. The rationale is that by emphasising common goals – e.g. ensuring safe, reliable supply and environmental stewardship – WSAA can lift overall industry performance through collaboration, without duplicating the formal target-setting powers of health, environmental, or economic regulators (WSAA, 2024; IPART, 2019).

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	How are the performance requirements set and structured, and to what level of detail? Performance requirements are set as high-level outcome areas rather than detailed numeric targets. Regulators define what must be achieved protect public health, ensure reliable supply, minimise environmental harm, and deliver good customer service while the detailed indicators and targets are set by state regulators and individual utilities through licenses, Drinking Water Management Plans, and service standards. WSAA again, supports this at a national level by defining broad sector outcomes such as water security, customer value, financial sustainability, resilience, public health, capability, and First Nations outcomes, focusing on lifting performance collectively rather than prescribing hard performance thresholds. WSAA facilitates the development of guidelines, benchmarks, and case studies rather than strict rules. The structure of WSAA's guidance is typically high-level principles supported by recommended practices. This allows individual utilities to tailor their own detailed performance requirements (under their regulators' oversight) while still aligning with common objectives. By fostering collective commitment to these outcome areas, WSAA helps lift performance across the sector through shared learning and voluntary benchmarking, rather than through enforceable standards (WSAA, 2024; WSAA, 2010). What are the compliance pathways e.g. equivalents to the Codes of Practice, standards, or acceptable solutions that demonstrate compliance? What are the verification processes for alternative pathways? There are no nationally approved <i>design</i> compliance pathways or acceptable solutions across the country for municipal water infrastructure. Those that exist at a national level are in the form of voluntary guidance. Compliance pathways in the water sector include codes, standards, guidelines and accepted industry practices that demonstrate a system meets regulatory performance requirements. These pathways are not always enforceable and extend well beyond WSAA guidance to include the ADWG, PCA/NCC, AS/NZS standards, environmental licenses/permits, utility operating licenses, and internal design and construction manuals. WSAA's role is to provide guidance, benchmarks and consistency. WSAA develops industry codes of practice, manuals, and guidelines that serve as de facto standards, which many utilities adopt to design and operate their systems consistently (WSAA, 2010). These documents – such as the Water Supply and Sewerage Codes – offer accepted solutions and benchmarks that help utilities demonstrate compliance with regulatory expectations (WSAA, 2010). Verification of both standard and alternative pathways is carried out by regulators, independent auditors, certification bodies and internal governance processes, which assess whether the chosen solution is a Deemed to Satisfy method or an alternative approach, which meets the required performance outcomes for safety, reliability, environmental protection, and service quality. What standards or Codes of Practice are used to support meeting the performance requirements? A range of nationally recognised standards and Code of Practice are used to support meeting water-sector performance requirements. These are provided by the Water Services Association of Australia (WSAA) While WSAA does not provide mandatory standards, it does produce a suite of influential industry Codes and Manuals (often known as “WSAA” codes) that are widely used to guide design and operations (WSAA, 2010). These WSAA Codes of Practice for water supply, sewerage, and other areas are developed through industry consensus and reference existing Australian

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	Standards and regulations to ensure compatibility (WSAA, 2010; WSAA, 2018). In practice, most urban water utilities in Australia adopt WSAA's codes (sometimes with minor local supplements) as their technical standards – for example, Yarra Valley Water and many others use the latest WSAA codes for water and sewer design (WSAA, 2014). The key distinction is that WSAA's documents are considered voluntary best-practice standards. WSAA supports and aligns with the established regulatory instruments that utilities are expected to use. These include the Australian Drinking Water Guidelines (ADWG) for public health protection, and the Plumbing Code of Australia (PCA) and AS/NZS 3500 series for plumbing and drainage performance. AS/NZS 4020 for materials in contact with drinking water, numerous AS/NZS pipe, asset, electrical and safety standards, and EPA environmental licenses and guidelines for wastewater and environmental protection. Utilities also rely on their own design and construction manuals, operating licence conditions, and customer service standards to support compliance. The Australian Drinking Water Guidelines (ADWG) provide the national, risk-based framework for ensuring safe drinking water, while the WSAA Water Supply and Sewerage Codes are widely adopted as best-practice technical standards for the design and construction of water and wastewater infrastructure. Together, these instruments provide accepted pathways for demonstrating compliance with performance requirements. How often are requirements reviewed or changed, and why? Requirements in the water sector are reviewed or changed whenever a need arises, rather than on a fixed schedule. Updates occur when new science, technology, regulatory expectations, or sector lessons highlight gaps or issues in the current version. WSAA follows this same approach: its publications are updated as required, with clear version control to show what has changed and why. For example, WSAA has released multiple editions of its core Codes of Practice (e.g., the Sewerage Code WSA 02 has seen several revisions, such as a major update in 2014) to incorporate improved practices and address any issues identified in earlier versions (WSAA, 2014). Regulatory instruments such as the ADWG, PCA/NCC, AS/NZS standards, and EPA guidelines are also updated periodically for the same reasons to reflect emerging risks, improve clarity, and keep pace with best practice. How do they cover connection of infrastructure to a water services network, e.g. by a developer? This area is managed directly by water utilities, each of which sets its own requirements for design, construction, testing, approval, and handover before any new assets can be connected. Utilities issue their own developer servicing codes, design manuals, technical standards, and inspection/commissioning processes, which define exactly how new pipes, pump stations, and other assets must be built and proven safe and reliable before acceptance into the network. WSAA does not issue rules for property developers connecting new subdivisions or assets to existing water networks – such connection requirements are set by individual utilities and local regulators (Sydney Water, 2023). In practice, many utilities base their developer standards on WSAA's model codes and manuals. For example, outside the Sydney metro area, most NSW water utilities require designers and developers to follow the WSAA Water Supply and Sewerage Codes for new connections (WSAA, 2018). Sydney Water, as a large utility, uses its own editions of the WSAA codes (with specific local supplements) and mandates that accredited providers comply with those standards when connecting to its network (Sydney Water, 2023). Thus, while WSAA's design codes provide a common technical foundation, the actual connection and approval process – including applications, inspections, and compliance checks for new infrastructure – is managed by the utility or authority that owns the network, under the oversight of state laws and regulations (Sydney Water, 2023; NSW DPI, 2019).

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	How do they cover asset management, including repair, upgrade, renewal, replacement, maintenance, and decommissioning of water services infrastructure that makes up water services networks? Councils and utilities follow their own asset-management procedures, usually aligned with ISO 55000, state government asset-management requirements, and the ADWG where drinking-water assets affect public-health risk. These procedures cover condition assessment, maintenance, renewal planning, upgrades, and decommissioning, supported by internal frameworks such as asset registers, risk assessments, lifecycle plans, and capital works programs. Environmental regulators also require procedures for wastewater assets to prevent spills and environmental harm. WSAA supports consistency and shared practice, but the actual procedures are set and implemented by each utility or council and must justify these to its shareholders (often state governments) and regulators. WSAA's role in asset management is supportive and advisory rather than directive (WSAA, 2018). What do they require about how information about the design, construction, and operational performance of water services infrastructure should be collected, kept, and shared? Information about the design, construction, and operational performance of water-services infrastructure is managed by each utility, which must collect, keep, and share records in line with its regulatory obligations. AS5488 sets out how subsurface utility information must be documented, classified and maintained (AS5488:1:2022 Classification of Subsurface Utility Information). Utilities maintain design files, as-built drawings, asset registers, operational data, and maintenance records, supported by recognised frameworks such as AS/NZS standards (e.g., AS/NZS 5488 for asset information, AS/NZS ISO 55000 for asset management) and, for drinking water, the ADWG, which requires documented evidence to support risk management and public-health protection. Responsibility for how this information is managed and shared sits with each utility, accountable to its owners and regulators. WSAA does not impose any uniform requirements for data collection or transparency – those obligations are set by regulators (for example, through utility licence conditions or national reporting agreements) and by utility owners (WSAA, 2018). In Australia, operational and performance data are typically monitored internally by each water utility and reported to regulators or government bodies as required by law (Bureau of Meteorology, 2023). For instance, water utilities submit annual performance indicators to the Bureau of Meteorology's National Performance Report, under a framework co-developed by WSAA and government agencies, but this reporting is mandated through government commitment rather than by WSAA itself (Bureau of Meteorology, 2023). WSAA's contribution in this space is to streamline and standardise industry metrics – it has helped achieve widespread adoption of common performance indicators and facilitated benchmarking (WSAA, 2024). <u>Measurement and compliance</u> How is performance checked and reported? Performance is checked and reported through state and national reporting frameworks, with each utility responsible for supplying audited data to regulators. Nationally, utilities report each year to the National Performance Report (National Performance Report 2024-25: Water and Wastewater Service Provider. ISSN 1837-7572), while states publish their own regulatory performance reports covering water quality, environmental compliance, service reliability, and customer outcomes. Each utility measures and submits its own data and is accountable to state regulators and government owners for accuracy and compliance. Major utilities are subject to formal reporting obligations – for example, IPART publishes annual compliance reports on Sydney Water and Hunter Water's performance against licence standards, and the Bureau of Meteorology

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	publishes the National Performance Reports comparing utilities on a range of metrics (IPART, 2020; Bureau of Meteorology, 2023). Performance monitoring and reporting are carried out by water utilities and overseen by regulators, not by WSAA (IPART, 2019). WSAA plays a facilitative role: it coordinates voluntary benchmarking programs and provides a platform for members to share performance data and improvements (WSAA, 2024). Indeed, WSAA reports having successfully standardised performance measurement across the industry, enabling apples-to-apples comparisons and collective benchmarking of utilities' safety, reliability, customer service, environmental performance, etc. (WSAA, 2024). This data is often used by regulators and policymakers, but WSAA does not itself audit utility performance or enforce compliance (WSAA, 2018). Instead, each utility's performance is primarily checked through regulatory audits/inspections and public reporting requirements set by government regulators, ensuring accountability remains with the service providers (IPART, 2020).
How assets, activities or contexts are classified for regulation	<u>Clarification approach</u> How does the regime approach different waters (e.g. stormwater, wastewater, drinking water)? Stormwater, wastewater, and drinking water are all covered within the national and state framework, but their hierarchy and the strength of requirements differ. Drinking water safety is regulated by health agencies, environmental discharges by environment agencies, and so on, with different legal frameworks for each (NHMRC/NRMMC, 2011; NSW EPA, 2017). Drinking water infrastructure has the tightest, mandatory regime through the ADWG, the Building Code/PCA, and state public-health laws. Wastewater and stormwater rely more on non-mandatory design guidance (WSAA codes, AS/NZS standards) that is tailored to utility or council requirements and thus inconsistent across jurisdictions. National frameworks mainly cover drinking water and municipal wastewater systems, with no dedicated national stormwater regime. At state level, environmental and public-health laws apply to wastewater and stormwater, while councils and utilities use WSAA guidance or their own standards to manage Drinking Water, Wastewater, and Stormwater with responsibility resting on each organisation. Australia's urban water governance has increasingly moved toward a holistic "one water" approach, and WSAA strongly advocates managing water supply, wastewater, and stormwater in an integrated manner (WSAA, 2020). How does each regime classify different types of infrastructure (e.g. by asset types, operators, services, locations, risks)? Infrastructure is classified through national standards, state regulations, and each utility's own asset models. Nationally, the ADWG, PCA/Building Code, and AS/NZS standards classify assets by risk, function, and performance. States classify drinking-water, wastewater, and stormwater assets through public-health and environmental laws, often grouping them by treatment level, discharge risk, or operator type. Utilities and councils then apply their own enterprise asset hierarchies often based on asset type, service function, location, and operational responsibility, with WSAA's groupings used for consistency and shared understanding. WSAA does not impose a formal asset classification system on utilities, but its industry manuals often categorise infrastructure by type and function to promote a common language in design and asset management (WSAA, 2018). These categories are meant to help engineers and asset managers apply the correct standards and share best practices for each asset type. Importantly, any classification scheme in WSAA documents is advisory and geared towards consistency and benchmarking – it is not a regulatory mandate (WSAA, 2010). Different utilities might adapt WSAA's groupings to their own asset registers or risk frameworks, and many issue local supplements to WSAA codes to address regional conditions (Icon Water, 2025; TasWater, 2021).

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	Typical WSAA asset groupings (indicative, not exhaustive): • Water supply assets • Mains, valves, fittings • Pump stations • Storage (reservoirs) • Sewerage assets • Gravity sewers • Rising mains • Pump/lift stations • Maintenance structures • Associated appurtenances • Access chambers • Pressure control • Monitoring points What criteria are used for this classification (e.g. scale, criticality, risk profile, harm potential), and why? At the state and council level, assets are classified using practical criteria such as scale, criticality, risk profile, and potential for harm, so users can quickly identify which rules or guidance apply. States group drinking-water, wastewater, and stormwater assets according to public-health and environmental risk, while councils classify stormwater and local wastewater systems by location, function, and impact. The purpose is the same across jurisdictions: to make it easy for practitioners to find the relevant requirements and guidance for the specific type of infrastructure they are working with. In WSAA's guidance documents, assets are typically grouped by practical criteria such as their function, system, or role in the network, rather than by abstract risk tiers. For instance, a water main, pump station, and reservoir might be grouped under "water supply assets" because they form parts of a supply system, whereas a different section would cover "sewerage network assets" (WSAA, 2018). The rationale for these classifications is primarily to make the manuals user-friendly: readers (like designers, contractors, or utility staff) can quickly find the relevant technical requirements or best practices for a given type of asset (WSAA, 2018). In other words, the categories are chosen to reflect how practitioners in the industry typically think about their infrastructure. Factors like scale or criticality might be discussed within those categories (for example, a WSAA guideline may distinguish between minor and major pump stations or high-risk vs low-risk assets within a category), but again, this is for guidance and consistency, not a compulsory scheme. The overarching goal is to improve coherence in design and maintenance practices across different utilities by using familiar, functional classifications (WSAA, 2018). How is regional variation provided for (for example, geographic, climatic, and geological variations)? Regional variation is handled by using one core WSAA document across NSW, with flexibility for utilities to adapt it to local conditions. WSAA publications are written to be broadly applicable, but they allow utilities to modify requirements to suit

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	geographic, climatic, and geological differences. In practice, most NSW utilities adopt WSAA standards directly, while Sydney Water produces its own adapted version to reflect its specific soils, topography, network scale, and operational needs. This approach provides statewide consistency while still allowing local tailoring where conditions demand it. WSAA's model codes and guidelines are generally written to be applicable Australia-wide, but they are often adapted at the local level to account for regional conditions (WSAA, 2018). In practice, many water utilities in NSW and other states directly adopt the standard WSAA codes for design and construction – meaning a consultant designing a sewer in regional NSW would likely use the same base Sewerage Code as one in another state (Sydney Water, 2023). However, large utilities in major cities sometimes develop official supplements or modified editions of WSAA codes to address local requirements such as soil conditions, climate, or legacy practices (Sydney Water, 2023; Icon Water, 2025). For example, Sydney Water publishes its own edition of WSAA's codes and mandates that these be used instead of the unamended national version within its area of operations (Sydney Water, 2023). Similarly, water authorities in Victoria (through the MRWA editions) and other states have collectively tailored certain WSAA codes to their regional context (Yarra Valley Water, 2023). This approach – one national foundation with regional customisation – provides consistency in core design principles and asset definitions, while giving flexibility to accommodate local geological, climatic, or regulatory differences. WSAA supports this by encouraging members to share their regional learnings and by updating the national documents when common needs for change emerge (WSAA, 2020). <u>Regulatory consequences of classification</u> There are clear tiers, but they come from state regulation, national guidelines, and each utility's own risk frameworks. In Australia, differentiated regulatory requirements (tiers) are usually embedded in legislation or licences. For instance, some states may exempt small private water schemes from full regulation or apply stricter rules to “Critical Infrastructure” assets – these decisions are made by government bodies like health departments or economic regulators. (IPART, 2018; DWI NSW, 2019). Drinking water sits in the highest tier under the ADWG, PCA/Building Code, and state public-health laws, creating strict mandatory requirements. Wastewater and stormwater fall under state environmental regulation, supported by AS/NZS standards, WSAA codes, and utility or council guidelines, which create lower or more flexible tiers. These classifications reflect risk, criticality, scale, and harm potential, and the regulatory consequences are applied by each utility, accountable to its owners and regulators. WSAA does not establish any official “tiering” of assets or entities for regulatory purposes – such distinctions (for example, classifying infrastructure by size or risk to set inspection frequencies) are made by regulators or individual utilities, not by the Association (WSAA, 2018). In Australia, differentiated regulatory requirements (tiers) are usually embedded in legislation or licences. For instance, some states may exempt small private water schemes from full regulation or apply stricter rules to “Critical Infrastructure” assets – these decisions are made by government bodies like health departments or economic regulators, not by WSAA (IPART, 2018; DWI NSW, 2019). WSAA's guidance might acknowledge concepts like asset criticality or risk categories in asset management, but it doesn't create binding tiers. Each utility remains responsible for complying with whatever tiered requirements its regulators impose. In short, any graded regulatory treatment (e.g. more reporting for high-risk dams, or special standards for different provider sizes) is outside WSAA's mandate and is handled

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	through the formal regulatory system (Productivity Commission, 2021). WSAA's influence here is indirect – it can advise on appropriate risk-based approaches, but it cannot set or enforce tiered regulatory obligations (WSAA, 2018). How does an asset or entity's category affect performance requirements (the standards it must meet)? An asset or entity's category affects its performance requirements by determining which standards, rules, and assurance obligations apply, but the consequences are set by state regulators, national guidelines, and each utility's own risk frameworks. Higher-risk categories (e.g., drinking-water treatment, major wastewater systems) must meet strict public-health and environmental standards such as the ADWG, and state environmental licences. Lower-risk or local assets (e.g., minor stormwater systems) fall under council or utility standards supported by WSAA guidance and AS/NZS standards. In all cases, applying the correct category and meeting the associated performance requirements remains the responsibility of each utility, accountable to its owners and regulators. Any differences in performance requirements by asset or entity category are determined by regulators or internal utility policies (IPART, 2019). For example, a regulator might require more stringent standards for drinking water treatment plants than for stormwater systems due to the higher public health risk – those distinctions would be codified in health regulations or utility operating licences (NHMRC/NRMMC, 2011). WSAA does not issue separate standards for "critical" vs "non-critical" assets; instead, it provides general guidelines applicable across asset types, with notes that utilities should consider their own risk assessments. Ultimately, a utility's obligations (e.g. treatment standards, environmental discharge limits, reliability targets) depend on legal classifications and the regulatory regime, and utilities must meet those standards under the oversight of the relevant regulator (NSW Health, 2019; EPA NSW, 2017). How does an asset or entity's category affect inspection or oversight frequency (how often it is inspected or monitored)? An asset or entity's category drives how often it must be inspected or monitored, with higher-risk or higher-criticality categories requiring more frequent oversight. The ADWG states that monitoring frequency must reflect the level of public-health risk, with key characteristics and high-risk assets monitored more often (NHMRS and NRMMC, 2022). EPA environmental license sets mandatory monitoring schedules for wastewater treatment plans based on discharge risk and environmental sensitivity (NSW EPA, 2017). These sources confirm that the asset category defined by risk, consequences of failure and regulatory exposure determines how often an asset must be inspected or monitored. For instance, a high-risk dam or water treatment plant may be subject to more frequent safety inspections or more detailed performance reporting under state law, whereas smaller, lower-risk assets have lighter requirements – these rules come from regulators like dam safety offices, health departments, or economic regulators (NSW DSC, 2015; IPART, 2018). Each utility must comply with the inspection regimes and reporting standards mandated in its jurisdiction (for example, annual performance reports to regulators, periodic drinking water quality reports to health authorities, etc.) (NSW Health, 2019; DPIE NSW, 2021).
How regulatory intervention is prioritised	How does the regulator decide where to focus its attention and resources? A regulator focuses its attention and resources on the highest-risk categories of assets and services, using factors such as public-health risk, environmental harm potential, system criticality, past performance, and compliance history. Drinking-water treatment, major wastewater systems, and assets with significant safety or environmental consequences receive the most

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	scrutiny, while lower-risk stormwater and local systems receive proportionately less. Regulators also use state legislation, national guidelines, incident data, and utility reporting to prioritise where oversight is most needed. Responsibility for applying these priorities and meeting all regulatory expectations remains with each utility, accountable to its owners and regulators. Decisions on regulatory focus are made by regulators like IPART (for economic issues) or health and environmental agencies (for safety and environmental compliance), typically using a risk-based and performance-based approach (IPART, 2022). Regulators often consider factors such as the likelihood and consequences of service failures, historical compliance records of a utility, and emerging risks (like drought impacts or water quality incidents) to prioritise their oversight and interventions (IPART, 2022; NSW EPA, 2018). For example, a regulator might intensify scrutiny on a utility that has experienced water quality problems or is responsible for critical infrastructure, while applying a lighter touch to those with a solid track record. WSAA does not influence these prioritisation decisions directly; instead, it might support the process by providing comparative performance data or facilitating discussions on risk management practices. The key point is that regulatory agencies exercise independent judgment to target their efforts where they are most needed, consistent with policies of proportional regulation. What factors matter most when assessing risk or priority? In the Australian context, regulators commonly evaluate a range of factors to assess where to concentrate their oversight. These typically include the likelihood of failures or incidents, the potential consequences for public health, safety, or the environment, the utility's past compliance performance, and the criticality of the services or assets involved (IPART, 2019; NSW EPA, 2017). For example, a wastewater treatment plant discharging to a sensitive environment might be deemed a higher priority for inspections due to the high consequence of any failure (NSW EPA, 2017). Similarly, a history of non-compliance or customer complaints can elevate a utility's risk profile in the eyes of a regulator (IPART, 2019). These considerations are formalised in regulators' risk assessment frameworks. WSAA might collect and share information on common risk factors and encourage a consistent, risk-based mindset among utilities. The actual weighting of factors like likelihood vs consequence, however, is defined in government policies or regulators' internal guidelines (usually to ensure transparency and consistency in enforcement decisions) (Productivity Commission, 2020). Are prioritisation rules set out clearly, or left to judgement? Regulatory agencies often have published guidelines or frameworks for risk-based regulation, but they also retain discretion. Prioritisation rules are usually a mix of defined criteria and professional judgement. State regulators set high-level expectations through public-health and environmental laws, while national guidelines outline risk-based principles. Utilities then apply their own frameworks to interpret these rules, using judgment to weigh factors like harm potential, criticality, and past performance. How these rules are applied and how priorities are set remains the responsibility of each utility, accountable to its owners and regulators. As an example, IPART has adopted a "3Cs" framework (covering Customer outcomes, Cost efficiency, and Credibility of plans) to tailor the intensity of its price-setting reviews based on each utility's performance – effectively formalising how it shifts resources (IPART, 2022). Similarly, health and environmental regulators may issue risk-based inspection policies that spell out how frequently sites are audited depending on risk categorisation (NSW EPA, 2018). Nonetheless, within those frameworks, regulators exercise judgment; unforeseen issues (like a major service failure or contamination event) can prompt immediate intervention regardless of any preset schedule.

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How has the regime changed, and what lessons have been learnt	What major changes have been made, and why? Major changes are introduced when governments or utilities identify new risks, outdated guidance, or gaps created by climate pressures and growth. Recent reforms, such as the proposed National Water Agreement, which strengthens climate resilience and simplified national principles, the WA's State Planning Policy 2.9, which integrates water management into all development, show that updates are driven by the need for clearer, more consistent rules that reflect modern challenges. The key lesson is that water regulation must stay adaptive, integrated and forward-looking consistent with OECD water governance principles and UN Endorsed integrated water management frameworks to ensure regulatory systems remain practical and responsive to climate extremes emerging technologies and rapid urban growth. Over the past decades, WSAA's role and outputs have evolved in response to emerging challenges and member needs. The Association has periodically introduced new industry guidelines and codes of practice to fill gaps or address shared problems. For instance, during the 2000s, WSAA produced national codes for water and sewer design when utilities saw the benefit of standardising technical requirements across Australia (WSAA, 2010). In recent years, WSAA's focus has expanded to issues like climate resilience, asset management, and technological innovation. This has led to new guidance documents – e.g., WSAA's Health-Based Targets Manual for drinking water safety was published in 2015 to align the industry with national health guidelines (NHMRC/WSAA, 2015). What were the drivers for these changes? Recent changes have been driven by clear pressures: climate impacts exposing gaps in national policy, rapid urban growth straining local planning systems, and industry- identified risks that required coordinated guidance. The draft National Water Management Agreement (2024-25) was reshaped to strengthen climate resilience and simplify national principles, while WA's State Planning Policy 2.9 Water (2025) was introduced to integrate water management into fast-growing urban areas. These reforms show that updates occur when existing frameworks become outdated or inconsistent and when a clearer, more unified direction is needed to maintain safety, reliability and environmental protection. Historically, WSAA's new initiatives have often been sparked by collective industry recognition of emerging challenges or opportunities. For example, protracted droughts and climate variability (the Millennium Drought in the 2000s) drove the Australian water industry to explore diversified water sources – leading WSAA to produce its “All Options on the Table” report in 2020, which provided guidance on integrating recycled water and desalination for climate resilience (WSAA, 2020). Similarly, the increasing focus on public health outcomes in the early 2010s led WSAA to collaborate with health authorities on manuals for achieving microbiological safety targets in drinking water (NHMRC/WSAA, 2015). Major service failures or incidents can also prompt action: for instance, issues with network infiltration/inflow and sewer overflows led WSAA to develop national Good Practice Guidelines on I/I reduction, using shared data from 24 utilities, to improve performance in wet weather (WSAA, 2017). While WSAA's agenda is influenced by such factors, it does not typically address pure cost-cutting pressures – those are handled by individual utilities and their regulators through efficiency incentives in price reviews (IPART, 2021). How did these changes affect standards, compliance and outcomes? The recent changes have improved standards, compliance and outcomes by making guidance clearer and better aligned with today's risks.

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	The National Water Agreement has strengthened national consistency and climate-resilience planning, while WA's SPP 2.9 Water has lifted development standards by mandating integrated water management and Water Sensitive Design. Updates to drinking water frameworks have improved public-health protection through risk-based approaches, and climate-resilience and water-scarcity guidance have helped utilities diversify supplies and plan for drought. WSAA's own codes and guidelines, such as national design standards and infiltration/inflow guidance, have further supported utilities to meet regulatory expectations, reduce incidents and deliver more reliable, efficient services across the sector. Furthermore, the introduction of WSAA's various codes and guidelines has generally improved consistency and knowledge across the water industry, but it's important to note that WSAA's publications do not override or replace regulatory standards (WSAA, 2010). What has worked well in practice? What has worked well in practice is that the wider system has responded to major drivers' climate pressure, growth, water scarcity and public-health expectations with reforms that genuinely improve consistency, planning and outcomes. The updated National Water Agreement has helped jurisdictions align around clearer climate-resilience and water-security objectives, while WA's SPP 2.9 Water has strengthened development decisions by embedding integrated water management and Water Sensitive Design. Updates to drinking water standards have improved public-health protection through risk-based approaches, and climate-change and water-scarcity guidance have supported utilities to diversify supplies and plan more confidently for drought. These system-wide reforms have been reinforced by WSAA's practical tools, design codes, benchmarking and risk-based guidelines, which help utilities apply the changes on the ground, leading to more reliable services, fewer incidents and more consistent compliance across Australia. What challenges or unintended consequences have emerged? The wider reforms have also produced challenges that mirror the examples discussed earlier. The shift to risk-based, non-prescriptive approaches in drinking water, infiltration and inflow management, and national recreational water quality has created uncertainty, with different utilities and regulators interpreting "acceptable risk" in different ways. National reforms like the new National Water Agreement rely on voluntary alignment, so progress can be uneven across jurisdictions, while WA's SPP 2.9 Water has increased expectations on planners and developers, exposing capability gaps, particularly for smaller councils. Climate-resilience and water-scarcity initiatives have highlighted similar disparities, with larger utilities better able to invest in diversified supplies and advanced modelling. Even performance benchmarking can lead to metric-chasing rather than deeper service improvements. These issues show that while the reforms have lifted standards, they also require sustained capability building, clearer interpretation guidance and stronger alignment between regulators and utilities to avoid inconsistent outcomes across the sector. The modern water regulatory regime has largely worked because it directly fixed the fragmentation and failures that once undermined Australia's water sector. National laws like the Water Act 2007 brought basin-wide oversight to curb over-extraction. The Australian Drinking Water Guidelines created a consistent, risk-based approach to safe drinking water, and the NCC/PCA/AS/NZS 3500 harmonised plumbing and construction standards that were previously incompatible across states. Economic regulators such as IPRAT improved accountability for monopoly utilities, while WSAA provided shared codes, benchmarking and technical leadership that lifted capability across the industry.

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	The shift to risk-based, non-prescriptive guidance seen in drinking water health-based targets, the I/I Good Practice Guidelines, and WSAA's input on recreational water quality can create ambiguity, with different utilities or regulators interpreting "acceptable risk" differently. Lessons relevant to New Zealand New Zealand's water sector – currently undergoing reforms – can draw several lessons from the WSAA model in Australia. One key lesson is the value of nationally consistent technical guidance: having common codes and manuals (as WSAA provides) can help designers, contractors, and utilities across different regions of NZ work from the same playbook, reducing duplication and confusion (WSAA, 2018). This is particularly pertinent as New Zealand establishes new water services entities; standardised design and asset management practices (perhaps modelled on WSAA's codes or even adopting them with modifications) could ensure smaller communities benefit from big-utility expertise. Another lesson is the benefit of a unified industry voice: WSAA's experience shows that an industry body can constructively influence regulation and policy by presenting a cohesive front (WSAA, 2021). In the NZ context, a similar peak body or strengthened Water New Zealand (the industry association) might help channel the views of the new water entities and advocate for smart, risk-based regulation. However, there are also warnings: if a powerful industry voice is perceived as too resistant to change ("a detractor" in the case of New Zealand's water reforms, like the Three Waters/National Engineering Standards), it could face pushback (Water New Zealand, 2021). The NZ reforms (initiating centralised standards, known as National Engineering Design Standards – NEDS) are partly to eliminate inconsistencies that arise from each council having different rules. Australia's example suggests that while voluntary codes can greatly improve consistency, truly uniform national standards may require formal adoption or mandates. New Zealand might thus consider a hybrid approach: leveraging industry-developed guidelines (possibly adapting WSAA's codes for local conditions) but also providing regulatory backing to ensure they are applied consistently (Water New Zealand, 2020). In summary, the WSAA model offers a blueprint for collaboration and standardisation, but New Zealand will need to tailor it to local expectations and ensure it complements, rather than obstructs, the broader water reform objectives.
Guidelines/ standards for private 3Water assets (drinking water, wastewater and stormwater)	How do the jurisdictions enforce, regulate and monitor private assets? Oversight of small private water systems or privately owned asset infrastructure is handled through different pathways than large municipal water infrastructure. For example, in NSW, private water utilities (such as those serving new developments or private communities) are governed by the Water Industry Competition Act 2006 and must obtain licences from IPART, which then monitors their performance and compliance (IPART, 2024). Similarly, private plumbing installations and on-site wastewater systems are typically regulated by local councils or state plumbing regulators, not by any industry association (NSW Health, 2019). But ultimate regulatory authority over private water assets lies with government agencies, and there is currently no single national framework in Australia solely for "private 3-water assets" enforcement; it remains fragmented by state and local jurisdictions (Productivity Commission, 2021). In general, Australian jurisdictions regulate private water-related assets mainly through the Plumbing Code of Australia and the AS/NZS 3500 series, which set the mandatory technical requirements for design and installation. Compliance is enforced through licensed plumbers, inspections, audits, and approval processes run by state regulators and water utilities. Together, these frameworks ensure private plumbing and drainage assets meet national standards before they connect to public networks.

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Limitations/ constraints in the current performance-based approach	What changes or improvements would address these? This question appears to refer to potential improvements in the broader regulatory approach (e.g. moving from a prescriptive to a performance-based framework). The current performance-based approach has several built-in limitations and constraints that affect how consistently it works in practice. Because it relies on judgment rather than prescriptive rules, it can lead to variable interpretations between utilities, regulators, consultants, and communities. This creates uncertainty about what “good enough” looks like and can slow approvals or lead to rework. Performance-based frameworks also depend heavily on capability and maturity within each organisation. Smaller councils or less-resourced teams may struggle to apply them consistently. Finally, without clear examples or boundaries, risk-based approaches can drift toward over-engineering (to avoid regulatory challenge) or under-specification (to minimise cost), reducing the consistency and predictability that designers and developers need. Proposed improvements to Australia’s water infrastructure regime focus on modernising regulations to handle climate change, population growth, and ageing assets. This could be improved through Finalisation of the renewed <u>National Water Agreement</u> to replace the 2004 initiative with more ambitious, climate-responsive goals. (Department of Agriculture, Fisheries and Forestry, 2019). The revised NWA was signed in February 2026, and each state will now consider whether to sign it. Special consideration is currently being considered for the management of assets and reporting requirements for assets serving fewer than 1000 people. To make the effort and cost more commensurate with the risk. This would be a useful consideration for New Zealand, too. New Zealand’s water asset management systems are moving towards the need for standardised data and risk frameworks. The lesson from WSAA is that consistent definitions and data requirements are valuable, but implementing them may require formal coordination by regulators or governments, not just voluntary industry action (Water New Zealand, 2020).
How does reliance on engineering judgement contribute to inconsistency	Any examples? One of WSAA’s objectives in developing detailed codes and guidelines is indeed to reduce inconsistencies caused by individual engineers each applying personal judgment in design and operations (WSAA, 2018). By providing prescriptive guidance – for example, standardised pipework designs, material specifications, and design calculation methods – WSAA helps ensure that different engineers and consultants come to similar solutions for similar problems. This has been particularly helpful for less-resourced utilities and private practitioners, who can rely on WSAA manuals instead of starting from scratch or using potentially outdated local rules (WSAA, 2018). For instance, before the WSAA Water Supply Code was broadly adopted, each utility or city might have had slightly different pipe-laying standards, which sometimes led to confusion or errors when contractors worked across regions. With a common code, engineering decisions (like minimum pipe cover depth or bedding requirements) are largely predetermined, leaving less room for subjective interpretation and thus yielding more uniform outcomes (WSAA, 2015). However, it’s worth noting that overly prescriptive guidelines can have downsides – they might limit innovative solutions if followed too rigidly. WSAA tries to strike a balance by making its documents detailed enough to guide typical cases while still allowing professional judgment for unique situations (WSAA, 2020). Overall, the widespread use of WSAA’s prescriptive guidelines has greatly improved consistency in design and construction practices across the Australian water industry (WSAA, 2018). Lessons learned

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	The Australian experience shows that while standardised, prescriptive codes (such as those provided by WSAA) bring consistency, they can sometimes constrain innovation (WSAA, 2020). If engineers and utilities feel obliged to adhere strictly to the “letter” of a code, they may be less inclined to try new designs or technologies that deviate from the standard, even if those innovations could deliver better outcomes. WSAA itself recognises this tension: it increasingly advocates for performance-based or outcomes-focused approaches in areas where innovation is needed, precisely because overly detailed rules can make risk-averse utilities reluctant to experiment (WSAA, 2020; Productivity Commission, 2021). Australian water utilities, like many around the world, tend to be risk-averse due to their mandate to protect public health and avoid service failures – this cultural conservatism can indeed be a blocker to trying unproven solutions (Productivity Commission, 2021). The key lesson is that the sector needs to allow room for flexibility: having standard codes is valuable for consistency, but those codes should be adaptable to new technologies and methods (WSAA, 2020). WSAA has addressed this by updating its documents (as seen with new digital metering standards and revisions to existing codes) and by supporting trials and innovation hubs. Thus, the Australian case suggests that maintaining a balance between guidance and professional judgment – i.e. using codes as a baseline rather than a ceiling – is crucial to avoid stifling innovation in a risk-averse industry (WSAA, 2020; AWA, 2019).
Is there an explicit risk-based framework	How consistently is it applied across regions? Risk-based approaches are broadly adopted across Australia, but their consistency varies because each state, regulator and utility applies them with different capabilities and risk tolerance. Drinking water is the most uniform, with almost all providers using ADWG-based risk management plans, though the AWA (Australian Water Association) notes their effectiveness still depends on having an adequate plan, a champion to drive it and an enabling environment. In other areas like sewer, I/I management, recreational water quality, climate-resilience planning and water-scarcity work application is more uneven, with larger utilities generally implementing risk frameworks more consistently than smaller or regional ones. With the exception of the ADWG’s 12-element framework, there is no nationally standardised method for applying risk-based approaches, so interpretations vary widely across states and even within utilities. Larger organisations tend to apply risk-based asset management more rigorously, for example, SA Water’s 30-Year Asset Management Framework uses structured likelihood-and-consequence assessments to prioritise renewals across critical mains and treatment assets, while smaller councils often fall back on age-based replacement or reactive maintenance due to limited data and capability. The AWA’s analysis of risk-management implementation (Hasan, 2017, <i>Water e-Journal</i>) confirms that effectiveness depends heavily on organisational maturity and the “ACE” pillars, which explains why practice remains patchy despite broad acceptance of risk-based principles. Each jurisdiction and utility develops its own risk management practices under the guidance of regulators and internal policies (WSAA, 2018). However, WSAA strongly encourages a risk-based approach in asset management and regulation. For example, WSAA’s submissions and reports often argue for investment and maintenance to be prioritised based on risk (e.g., focusing OPEX/CAPEX on the highest-risk infrastructure and failure points) to achieve better value for money (WSAA, 2020). Many of WSAA’s member utilities have adopted risk management standards like ISO 31000 and ISO 55000 series for asset management, and WSAA’s Asset Management Committee has developed tools to help apply these standards consistently (WSAA, 2021).

4.4.1 Relevance and Lessons for New Zealand

The Australian water industry (like many other countries) faces challenges due to population growth, increased demand from data centres, resilience concerns, and climate change. Over the years, price submissions are often reduced to keep costs low, resulting in weaker asset preparedness and condition. Although regulating the industry is not currently part of this scope of work, establishing a legal framework that promotes efficient investment and optimised asset renewal could significantly reduce the shocks associated with price increases due to infrastructure costs that could have been planned for. Whilst the Regulator speaks out for the customer and EPA for the environment, water companies often find themselves defending price increases and cutting programs of work to meet these. This often means there is no spokesperson for the needs of the water infrastructure.

This also illustrates the risks associated with fragmentation, particularly where utility-specific standards, bespoke EPA licence conditions, and variable data requirements undermine national consistency. For NEDS, the Australian experience underscores the value of a clear national performance backbone supported by nationally coordinated Codes of Practice, to reduce duplication, improve consistency, and still allow innovation and local adaptation.

4.5 Japan, Chile, California

The four jurisdictions previously mentioned have minimal seismic risk. As a result, Japan, Chile, and California, regions with significant earthquake exposure, were examined at a high level to understand how seismic hazards directly influence infrastructure design standards, especially for water and other essential lifeline systems. Unlike many jurisdictions where seismic resilience is treated implicitly or as a secondary consideration, these jurisdictions demonstrate different but well-established models for embedding seismic risk into engineering design standards, performance requirements, funding decisions, and asset lifecycle planning. Together, they offer valuable insights for how NEDS could more explicitly address seismic resilience within a national, performance-based design framework suited to New Zealand's own hazard profile.

Japan represents a highly integrated, centrally governed system where seismic resilience is treated as a national resilience objective, explicitly regulated and linked to funding and asset management.

Chile provides a contrasting example where seismic risk is front-loaded into legally binding design codes, with infrastructure deliberately engineered to withstand very high-magnitude events.

California sits between these models, demonstrating strong technical treatment of seismic risk for critical facilities but within a fragmented governance and regulatory landscape.

Together, these jurisdictions demonstrate that in high-seismic-risk environments, effective water infrastructure regulation requires the following:

- Explicit recognition of seismic hazard in design and performance assumptions
- Clear expectations for asset survivability and recoverability, not just normal-operation performance
- Use of graduated performance categories that are tied to asset criticality and consequence of failure
- Alignment between design standards, lifecycle planning, and emergency response

4.5.1 Japan

Japan has embedded earthquake resilience directly into the planning, design, operation, and renewal of water and wastewater infrastructure. National legislation sets explicit seismic performance objectives, with infrastructure required to remain operational under frequent earthquakes and avoid catastrophic failure under extreme events.

A defining feature of the Japanese approach is the use of Level 1 and Level 2 seismic performance categories, which are reflected in sector guidance such as that issued by the Japan Water Works Association (JWWA) and the Japan Sewage Works Association (JSWA). Under this framework:

- Level 1 events represent more frequent earthquakes under which critical water infrastructure is expected to remain operational or experience only minor, repairable damage.
- Level 2 events represent rare but extreme earthquakes, under which infrastructure must avoid catastrophic failure, protect life and public health, and enable rapid service recovery, even if temporary service disruption occurs.

JWWA and JSWA manuals function as nationally recognised deemed-to-comply design pathways, translating these performance objectives into detailed engineering expectations for pipelines, treatment plants, reservoirs, and pumping stations.

These performance objectives are asset- and function-specific, meaning that treatment plants, trunk mains, reservoirs, and emergency supply systems are designed to different seismic standards depending on their role and consequence of failure, while allowing alternatives where performance can be demonstrated.

For NEDS, Japan demonstrates how explicit hazard-based performance categories can be embedded at the design-standard level, providing clear national expectations without mandating a single prescriptive solution.

4.5.2 Chile

Chile experiences frequent, very high-magnitude earthquakes and operates a privatised but tightly regulated water sector. Seismic resilience is embedded through national building and infrastructure standards, combined with strong regulatory expectations for business continuity, rapid service restoration, and asset renewal following seismic events. Unlike Japan's performance-tiered approach, Chile's system is more prescriptive and code-driven, with mandatory seismic coefficients, load combinations, and deformation criteria specified for buildings and lifeline infrastructure, including water and wastewater systems.

Examples of relevant national standards, codes, and infrastructure regulations include:

Primary national standards and regulations

- Chilean Seismic Design Code (Norma Sísmica): The National building and infrastructure seismic codes establish mandatory seismic coefficients, load combinations, and deformation limits for structures.
- General Building and Urban Planning Ordinance (OGUC): Incorporates seismic requirements into planning and construction regulations applicable to infrastructure and related facilities.
- Infrastructure and lifeline-specific standards
- National Structural Design Standards for Infrastructure

Apply seismic provisions to essential facilities such as:

- Water treatment plants
- Reservoirs and tanks
- Pump stations
- Major pipelines and conveyance systems

The National standards mentioned above explicitly require infrastructure to be designed for very high-magnitude events, rather than probabilistic averages, and address issues such as:

- Ground failure and liquefaction
- Large-deformation structural response
- Continuity of critical lifelines during and after earthquakes

Major seismic events routinely trigger formal reviews and revisions of national codes, ensuring that lessons learned are reflected directly in updated design requirements. While Chile's water sector includes private operators, seismic resilience is treated as non-negotiable, with compliance enforced through national standards and regulatory oversight.

For NEDS, Chile illustrates the advantages and limitations of a front-loaded, prescriptive seismic design model: it provides clarity and consistency in hazard treatment but relies heavily on code compliance and may offer less flexibility than a performance-based system.

4.5.3 California

California faces significant earthquake, wildfire, and climate risks, with seismic hazards strongly influencing water infrastructure design due to the scale and criticality of inter-basin conveyance, dams, and urban networks. While regulatory responsibility is fragmented across state and local agencies, seismic design requirements are enforced

through building codes, dam safety regulations, and state guidance, particularly for critical facilities. Seismic performance is regulated through a combination of:

- Building and structural codes, notably ASCE 7 seismic load provisions
- Sector-specific guidance, including AWWA seismic standards for pipelines and facilities
- Dam safety regulations, which impose stringent seismic criteria for failure-intolerant assets

These frameworks establish explicit seismic design requirements, particularly for critical facilities, with a primary focus on life safety, structural integrity, and post-event recoverability. However, regulatory responsibility is fragmented across state agencies, local governments, and special districts, meaning that consistency of application varies and there is no single national or statewide design baseline for all water assets.

California, therefore, provides a mixed lesson for NEDS: it demonstrates the importance of explicit seismic design criteria for critical assets, while also highlighting the risks that arise when hazard-based design expectations are not embedded within a unified national framework.

4.5.4 Relevance and Lessons for New Zealand

Taken together, Japan, Chile, and California show that seismic resilience can be embedded into water infrastructure design through different regulatory models, but all rely on explicit design-stage recognition of hazard and consequence. For New Zealand, the most transferable lessons include:

- Defining seismic performance objectives that distinguish between normal operation, damage control, and recovery
- Scaling design expectations based on asset criticality and public health consequence, rather than asset type alone
- Providing clear design pathways, potentially through Codes of Practice, that translate seismic performance intent into engineering requirements
- Ensuring alignment between design standards, renewal planning, and emergency response objectives

5. State/Province Level Jurisdiction Comparator Table

Table 5 below, compares national and state/provincial water infrastructure frameworks in Australia (New South Wales/Sydney, Victoria) and Canada (Ontario). It reviews how performance outcomes are set, where expectations originate, design standards in practice, and responsibility distribution.

Overall, Australia lacks national legislation on water infrastructure performance but provides national guidance that states implement via their own laws and voluntary standards. States like NSW and Victoria use utility-owned technical standards to translate these frameworks into practical design, often referencing national guidance selectively, which leads to consistent intent but fragmented execution.

In Canada, although the federal government sets health and environmental benchmarks, provinces control infrastructure regulation. Ontario incorporates national outcomes into provincial guidelines mainly for treatment facilities, while network design and data requirements are handled at the municipal level, resulting in variation.

Both countries show limited direct national influence over asset design standards; authorities interpret national concepts with discretion, leading to inconsistent application. Even high-performing regions like NSW and Ontario lack nationally uniform design frameworks, causing fragmented approaches across engineering, data, and resilience.

Table 5 State/Province Level Jurisdiction Comparator Table

Dimension	Australia – National level	Australia – NSW (Sydney)	Australia – Victoria	Canada – National level	Canada – Ontario
Role of the national framework	Sets outcome-based guidance (drinking water, recycling, environmental quality); no binding design standards for networks <i>Australian Drinking Water Guidelines (ADWG)</i> <i>Australian Guidelines for Water Recycling (AGWR)</i> <i>National Water Quality Management Strategy (NWQMS)</i> <i>Water Services Association of Australia</i> Weblink: <u>Shop</u>	National guidance applied through state law and utility practice <i>Protection of the Environment Operations Act (POEO Act)</i> <i>NSW Water Quality Objectives</i> <i>Australian Drinking Water Guidelines (applied via NSW Health)</i> <i>Sydney Water Operating Licence</i>	Same as NSW; national guidance filtered through state institutions <i>Environment Protection Act 2017</i> <i>State Environment Protection Policies (SEPP- Water)</i> <i>Victorian Planning Provisions (VPP)</i> <i>Australian Drinking Water Guidelines (via DHHS)</i>	Sets national health and environmental outcomes (e.g. drinking water guidelines, wastewater effluent limits) <i>Canadian Drinking Water Quality Guidelines</i> <i>Canadian Environmental Quality Guidelines (CCME)</i> <i>Wastewater Systems Effluent Regulations (WSER)</i>	Federal outcomes implemented through provincial law and approvals <i>Safe Drinking Water Act (SDWA)</i> <i>Ontario Water Resources Act (OWRA)</i> <i>Environmental Protection Act (EPA)</i> <i>Clean Water Act, 2006 (CWA)</i> <i>Environment Assessment Act (EAA)</i>
Presence of national design standards	<i>AS/NZS 3500 series for domestic water networks (water services, sanitary drainage, stormwater drainage)</i> <i>(ADWG do not function as a design standard for municipal water, wastewater or stormwater networks. They set out a risk-based framework for managing drinking water safety)</i> None for municipal water, wastewater, stormwater networks	In relation to private systems : <i>AS/NZS 3500.1 – Water Services</i> <i>AS/NZS 3500.2 – Sanitary Plumbing & Drainage</i> <i>AS/NZS 3500.3 – Stormwater Drainage</i> <i>National Construction Code (NCC) – Plumbing Code of Australia (PCA)</i> None for municipal water, wastewater, stormwater networks	None (relies on utility and planning standards) <i>AS/NZS 3500.1, 3500.2, 3500.3, NCC – Plumbing Code of Australia (PCA)</i> <i>Melbourne Water's Design Standards</i> None for municipal water, wastewater, stormwater networks	None	None (provincial design guidance instead) <i>Design Guidelines for Drinking-Water Systems (Ontario Ministry of Environment)</i> <i>Ontario Drinking-Water Quality Standards (O. Reg 169/03)</i> <i>Procedure for Disinfection of Drinking Water in Ontario (O. Reg 170/03)</i> <i>Design Guidelines for Sewage Works (MOECC)</i> <i>Ontario Stormwater Management Planning and Design Manual</i>

Dimension	Australia – National level	Australia – NSW (Sydney)	Australia – Victoria	Canada – National level	Canada – Ontario
Where design standards are set in practice	State-level and utility specific	Strongly utility-centric (Sydney Water standards, as follows, act as de facto rules) <i>Water Servicing Code of Australia Sewerage Code of Australia</i> <i>Stormwater Drainage Manual</i> <i>Asset Creation Developer Works Process</i> <i>Asset Information Requirements (as-constructed data)</i> <i>Local Government – Council Development Engineering Standards (Varies by LGA)</i>	Utility standards + stronger planning guidance (WSUD) <i>Water Servicing Code of Australia Sewerage Code of Australia</i> Utility-specific supplements to WSAA codes <i>Asset Creation Developer Works Process</i> <i>Asset Information Requirements (as-constructed data)</i> <i>Melbourne Water – Land Development Manual, Drainage & Flood Management Guidelines, As-constructed Requirements</i> <i>Victoria Stormwater Planning Requirements (BPEM- Best Practice Environmental Management)</i> <i>MUSIC Guidelines (stormwater modelling)</i> <i>WSUD Engineering Procedures (Melbourne Water)</i>	Provinces and municipalities	Provincial design guidelines for drinking water and sewage works <i>Provincial Guidelines (Mandatory for approvals):</i> <i>Design Guidelines for Drinking-Water Systems (MECP)</i> <i>Design Guidelines for Sewage Works (MECP)</i> <i>Stormwater Management Planning and Design Manual (MECP, 2003)</i> <i>Municipal engineering standards:</i> <i>City of Toronto – Design Criteria for Sewers and Watermains</i> <i>City of Toronto – Wet Weather Flow Management Guidelines</i> <i>Conservation authority requirements, specific examples include:</i> <i>Toronto and Region Conservation Authority (TRCA)</i> <i>Lake Simcoe Region Conservation Authority (LSRCA)</i>
Performance-based vs prescriptive design	At the national level, elements of the framework is performance-based but design-neutral. Outcomes are set for health and environmental outcomes without	Mixed: outcomes via EPA licences, prescriptive utility standards for design	Mixed: performance outcomes + prescriptive WSUD and utility specs	National outcomes are performance-based	Provincial guidance is semi-prescriptive, especially for treatment assets

Dimension	Australia – National level	Australia – NSW (Sydney)	Australia – Victoria	Canada – National level	Canada – Ontario
	mandating specific engineering design inputs/outputs. In practice, however, these outcomes are implemented through state or provincial codes, which are predominantly prescriptive. As a result, the overall system combines performance-based intent with prescriptive design standards.	<i>EPA licence conditions (performance-based)</i> <i>Sydney Water design manuals (prescriptive)</i>	<i>WSUD and BPEM provide performance targets</i> <i>WSAA codes provide prescriptive design requirements</i>		<i>Drinking Water Guidelines include detailed design criteria (e.g. hydraulics, treatment, processes)</i> <i>Regulations specify minimum treatment, monitoring and quality requirements.</i>
Treatment of developer infrastructure	No national approach	Developer assets must meet utility adoption standards; varies by utility <i>Sydney Water Developer Works Deed</i> <i>Sydney Water Asset Creation Standards</i> <i>Local council subdivision engineering requirements</i>	Like NSW, adoption rules embedded in utility and planning controls <i>Utility Asset Creation Manuals</i> <i>Melbourne Water Development Services Schemes</i> <i>Council subdivision engineering standards</i>	No national consistency	Regulated via provincial approvals + municipal standards; still variable
As-built data and information standards	No national standard	Utility-defined requirements; inconsistent beyond the utility boundary <i>Sydney Water Asset Information Requirements</i> <i>Sydney Water GIS & CAD Submission Standards</i> <i>Council-specific as-built requirements</i>	Utility and council requirements; variable <i>Melbourne Water As-constructed Requirements</i> <i>WSAA As-constructed Data Specification</i> <i>Utility-specific GIS / CAD standards</i>	No national standard for Canada and the United States. Both countries rely on local utility, municipal, or state/ provincial standards.	Some provincial requirements, but municipal variability remains.
Asset lifecycle embedded in design standards	No	Weak – lifecycle driven by utility AMP/economic	Similar to NSW	No	Limited – lifecycle addressed through approval and AMP

Dimension	Australia – National level	Australia – NSW (Sydney)	Australia – Victoria	Canada – National level	Canada – Ontario
		regulation, not design rules <i>Sydney Water Asset Management Framework (not a design standard)</i>	<i>Victoria Water Industry Asset Management Framework</i>		expectations, not design codes
Renewal & decommissioning expectations	Addressed through planning and funding, not design	Managed via utility asset management	Same	Varies by province and municipality	Considered in approvals, but not codified in design standards
Seismic or hazard-based design expectations	Not a national driver for water infrastructure <i>General structural codes (AS1170)</i>	Not explicit (structural codes only) <i>AS1170 – Structural Design Actions</i>	Not explicit	Minimal national relevance	Not explicit in water infrastructure design
Risk classification linked to design requirements	None nationally	Risk influences regulatory oversight, not design tiers <i>EPA risk categories (regulatory oversight)</i> <i>No risk tiered design standards</i>	Same	None nationally	None; risk handled through approvals
Degree of regional inconsistency	High in relation to Design, asset management, data collection, reporting and enforcement approach	High between utilities and regions	High but mitigated to a degree by stronger planning integration	High between provinces/municipalities	Lower than some provinces, but still significant municipal variation
Primary lesson for NEDS	Outcomes alone are insufficient to ensure consistent design, especially when limited to one or two dimensions. Design guidance is provided through the industry body, WSAA, at a national level, but uptake is voluntary.	Utility-led standards create fragmentation of design approach, inconsistency in lifecycle asset management requirements, data collection, reporting and enforcement.	In Victoria, the planning process and provision of state-level guidance help enable consistency across the state, but do not replace the need for a national design backbone.	Overall lack of clarity in relation to outcomes sought, and no consistency in design approach set at the national level.	Provincial water sector leadership helps, but does not resolve national inconsistency in design, asset management, reporting and enforcement mechanisms.
Key performance objectives	Safe drinking water; environmental protection; public health protection	Service reliability; environmental compliance; customer outcomes	Flood mitigation; water quality; integrated urban water outcomes	Public health protection; environmental protection	Public health; regulatory compliance; system reliability

Dimension	Australia – National level	Australia – NSW (Sydney)	Australia – Victoria	Canada – National level	Canada – Ontario
		<i>Sydney Water Operating Licence (IPART-regulated)</i> <i>National Performance Report (Urban Water Utilities)</i>			<i>Ontario Drinking Water Quality Management Standard (DWQMS)</i> <i>Safe Drinking Water Act, 2002</i>
How performance objectives affect water asset design	Objectives do not translate into design rules; designers rely on professional judgement	Objectives influence what must be achieved, but the design response is utility-specific and inconsistent	Performance objectives strongly shape outcomes (e.g. flood reduction) but do not define national design baselines	National outcomes are clear, but design implications are left to provinces and municipalities	Provincial outcome clarity informs approvals, but does not create consistent lifecycle or resilience-based design requirements

6. Cross-Jurisdiction Thematic Analysis and relevance to New Zealand

Across the four jurisdictions reviewed, Australia, England and Wales, Scotland, and Canada, a consistent theme emerges: the setting of nationally mandated performance standards for water infrastructure design is uncommon. Instead, most jurisdictions establish national performance outcomes focused primarily on public health protection (drinking water safety) and environmental protection (wastewater and discharge impacts), with limited or no nationally prescribed engineering design requirements. Design is typically managed at a sub-national level (states, provinces) or through sector-led bodies producing voluntary codes, such as WSAA in Australia, industry guidance in England and Wales, or provincial manuals in Canada. These arrangements provide flexibility and local responsiveness, but they also result in variability in design standards, asset resilience, and lifecycle performance, often only becoming visible once failures occur.

6.1 Usefulness of international examples for NEDS

Among the four jurisdictions studied, Scotland provides the most useful and directly transferable model for the New Zealand NEDS. Unlike England and Wales, which focus primarily on economic regulation, or Canada's highly decentralised system, Scotland adopts:

- a single, nationally mandated provider (Scottish Water),
- clear national technical standards and specifications, and
- a strong regulatory emphasis on whole-of-life asset performance, data consistency, and assurance.

This creates a system where national outcomes are tightly linked to national design and delivery expectations, reducing reliance on retrospective enforcement and minimising variability in engineering quality. For New Zealand, Scotland demonstrates how national design standards can coexist with performance regulation and enable earlier assurance of asset adequacy, resilience, and safety, which is a core objective of NEDS.

6.2 Common performance outcome areas identified

Across all four jurisdictions, the following performance outcome areas were identified and could be considered for inclusion in the NEDS:

- Whole-of-lifecycle asset performance
 - Outcomes requiring infrastructure to be designed for durability, maintainability, and renewability over its intended life, including consideration of inspection access, replacement feasibility, and long-term operating risk, not just initial compliance.
- Asset health and resilience
 - Performance expectations relating to structural integrity, failure likelihood, redundancy, and the ability to withstand foreseeable stresses (including climate change, growth, and operational shocks), aimed at preventing the gradual degradation seen in England and Wales.
- Service reliability and continuity
 - Outcomes addressing continuity of service across all three waters, including minimising unplanned outages, flooding incidents, and recurrent failures, with a clear link between design decisions and operational reliability.
- Environmental protection beyond compliance minima
 - Outcomes that support achieving environmental objectives over the long term, rather than merely meeting short-term discharge limits, recognising that compliance-based outcomes alone did not prevent cumulative environmental harm in England and Wales.

- Risk-based infrastructure classification
 - Explicit differentiation of infrastructure based on consequence of failure, vulnerability of receiving environments or communities, and criticality, enabling proportionate design and assurance rather than uniform minimum standards.
- Data, monitoring, and transparency readiness
 - Outcomes requiring assets to be capable of generating reliable operational, condition, and performance data, supporting early intervention and avoiding the delayed visibility that characterised storm overflow performance in England and Wales.
- Adoptability and ownership clarity
 - Outcomes ensuring that new infrastructure is designed to be adoptable, maintainable, and clearly assigned to a responsible asset owner, reducing long-term uncertainty and fragmentation in ownership and accountability.
- Constructability and quality assurance
 - Performance outcomes that implicitly require designs to be buildable, verifiable, and inspectable, recognising that poor construction quality contributed to asset deterioration under England and Wales' otherwise robust design guidance.
- Future adaptability
 - Outcomes requiring designs to allow for future upgrades, network separation, digital integration, or increased treatment standards, reducing the need for disruptive retrofits when regulatory or environmental expectations change.

Notably, these outcomes are almost always expressed as performance metrics, rather than translated into engineering requirements.

6.3 Infrastructure classification and design regulation

For design codes and standards, infrastructure is commonly classified by:

- Asset type and function (e.g. treatment plants, networks, pump stations),
- Scale or population served, and
- Risk or consequence of failure (particularly for drinking water and environmentally sensitive discharges).

This classification is typically driven by health and environmental risk, rather than by service consistency or lifecycle cost optimisation. Where national classification frameworks are absent (e.g. Canada, England and Wales), regulatory effort and inspection intensity vary widely. Scotland again stands out by linking asset classification directly to nationally consistent specifications and assurance processes.

6.4 Special consideration: Seismic risk

A critical difference for New Zealand is seismic risk, which was absent in the four main comparator jurisdictions. In the three jurisdictions that were compared due to their seismic risk (Chile, Japan and Canada), none of these jurisdictions embed seismic resilience into national water design requirements. New Zealand should explicitly integrate seismic performance expectations into NEDS.

6.5 Broader trends across jurisdictions

Several cross-cutting trends were observed:

- Asset management: All jurisdictions recognise the importance of lifecycle asset management, but only Scotland embeds this consistently through enforceable national standards. Elsewhere, asset management is performance-driven, creating incentives for short-term optimisation rather than long-term resilience.
- Data and reporting: Data requirements tend to be outcome-focused and fragmented, with limited standardisation of engineering or asset data (particularly in Canada and England and Wales). Scotland shows stronger alignment between data standards, design, and regulatory assurance.

- Enforcement regimes: England and Wales rely heavily on economic and reputational incentives applied retrospectively, while Canada and Australia depend on provincial/state enforcement. Scotland again demonstrates earlier intervention capability through standardised expectations.
- Response to growth, climate, and investment pressures: All jurisdictions face challenges from population growth, climate variability, and funding constraints. Those with clearer national frameworks (Scotland) are better positioned to coordinate investment and respond strategically, rather than reactively.

6.6 Relevance for New Zealand and NEDS

Taken together, the cross-jurisdiction analysis shows that:

- Outcomes-only regulation is insufficient to manage long-term infrastructure risk.
- Design variability and hidden asset risk are common where national engineering standards are absent.

Scotland appears to be best practice and translates nationally agreed outcomes into clear, consistent, upstream engineering expectations.

For New Zealand, NEDS should therefore:

- Complement economic and performance regulation, not duplicate it.
- Establish minimum national standards for engineering design, data collection and reporting, and risk baselines, including seismic resilience.
- Allow for “acceptable solutions” and/or verification to allow for local variation through Codes of Practice; and
- Enable earlier assurance and intervention, reducing reliance on post-failure enforcement.

In this sense, the international evidence strongly supports NEDS as a necessary evolution in New Zealand’s water regulatory framework. The cross-jurisdiction analysis strongly supports NEDS being designed as the primary mechanism for embedding national consistency in a currently fragmented delivery environment.

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Appendix A

MartinJenkins : NEDS – Comparable international jurisdictions

Jurisdiction Scan Template

Dimension	What to capture	Purpose of this information
Jurisdiction overview	What problem was this regulatory regime created to address? How does the regime work overall? How is the regulatory framework structured at a high level (e.g. primary legislation, performance standards, Codes of Practice or compliance pathways, and the relationship between these)? Who is the regulator, and what formal powers do they have to enforce the regime?	Provides essential context to understand why the regulatory regime is designed the way it is and to ensure comparisons are interpreted correctly.
Setting performance requirements	Nature of requirements What performance areas or outcomes are regulated (e.g. safety, reliability, environmental protection, service quality), and why? How are the performance requirements set and structured, and to what level of detail? What are the compliance pathways, e.g. equivalents to the Codes of Practice, standards, or acceptable solutions that demonstrate compliance? What are the verification processes for alternative pathways? What standards or Codes of Practice are used to support meeting the performance requirements? How often are requirements reviewed or changed, and why? How do they cover connection of infrastructure to a water services network, e.g. by a developer? How do they cover asset management, including repair, upgrade, renewal, replacement, maintenance, and	Identifies what the regime defines as acceptable performance, what 'good looks like', how it is operationalised, and how much flexibility versus certainty it builds into regulatory expectations.

MartinJenkins : NEDS – Comparable international jurisdictions

Jurisdiction Scan Template

Dimension	What to capture	Purpose of this information
	decommissioning of water services infrastructure that makes up water services networks? What do they require about how information about the design, construction, and operational performance of water services infrastructure should be collected, kept, and shared? Measurement and compliance How is performance checked and reported?	
How assets, activities or contexts are classified for regulation	Classification approach How does the regime approach different waters (e.g. stormwater, wastewater, drinking water)? How does each regime classify different types of infrastructure, e.g. by asset types, operators, services, locations, risks? What criteria are used for this classification (e.g. scale, criticality, risk profile, harm potential), and why? How is regional variation provided for (for example, geographic, climatic, and geological variations)? Regulatory consequences of classification Are there clear tiers or levels with different regulatory requirements? How does an asset or entity's category affect: Performance requirements (the standards it must meet)? Reporting obligations (how much reporting it must do)?	Explains how the regime differentiates between regulated entities or situations, which underpins how regulatory effort is targeted and differentiated.

MartinJenkins : NEDS – Comparable international jurisdictions

Jurisdiction Scan Template

Dimension	What to capture	Purpose of this information
	Inspection or oversight frequency (how often it is inspected or monitored)?	
How regulatory intervention is prioritised	How does the regulator decide where to focus its attention and resources? What factors matter most when assessing risk or priority (e.g. likelihood of failure, consequence of harm, past performance)? Do policy or guidance documents set out clear prioritisation rules, or mainly left to the regulator judgement?	Provides a summary of how regulators decide where to focus attention and resources, revealing the underlying risk and proportionality logic of the system.
How the regime has changed, and what lessons have been learned	What major changes have been made since the regime was introduced, and why? What were the drivers for these changes (e.g., service failures, reform programmes, cost pressures, climate resilience)? How did these changes affect standards, compliance and outcomes? What has worked well in practice? Is there evidence of quantified impacts associated with the regime (e.g. reduction in harm, improvement in service quality, reductions in time/cost to comply)? What challenges or unintended consequences have been observed? Are there lessons or features that are especially relevant to New Zealand's context?	Highlight which elements from overseas could be usefully and realistically applied in our context.

MartinJenkins : NEDS – Comparable international jurisdictions

Jurisdiction Scan Template

Dimension	What to capture	Purpose of this information
Guidelines/ standards for private 3Water assets (drinking water, wastewater and stormwater)	How do the jurisdictions enforce, regulate and monitor private assets?	To understand how comparable jurisdictions regulate private water assets, as NZ currently has fragmented or inconsistent approaches.
Limitations/ constraints in the current performance-based approach	What changes or improvements would address these?	NEDS need this insight to reduce ambiguity of design data standards.
How does reliance on engineering judgement contribute to inconsistency	Any examples? Lesson learns?	To understand why NZ needs standardised definitions, risk categories, and data requirements.
Is there an explicit risk-based framework	How consistently is it applied across regions?	To determine how NZ should design a national risk-based framework

