Do public records document PFAS drinking-water response handoffs? A 51-jurisdiction audit

Gustavo Pedro Ricou
School of Computer Science and Statistics, Trinity College Dublin, the University of Dublin
College Green, Dublin 2, D02 PN40, Ireland
Corresponding author: pedrorig@tcd.ie

24 September 2026

Non-peer-reviewed preprint submitted to EarthArXiv.

Abstract

PFAS monitoring, assistance, and project records are often public, yet a reader may still be unable to trace a named response across administrative stages. We conducted a registered, frozen public-source audit of the 50 states and the District of Columbia. The registered test documented 13/204 predeclared strict relationships; no later relationship met the rule. The audit shows when a public accountability question can be answered from the named record packet and identifies the evidence bridge a reader would need to inspect next. It offers a reproducible way to distinguish a documented public relationship from adjacent records that happen to be visible. It is a public-record finding, not evidence of state inaction, programme performance, treatment, exposure, health effects, or a national policy requirement.

Keywords: PFAS; drinking-water utilities; public records; infrastructure finance; accountability; interoperability; governance

1 Introduction: the accountability question

PFAS policy creates a deceptively simple public question: after a drinking-water concern becomes visible, what happened next? A reader may find a monitoring result, a priority list, an announced award, a project description, or a later treatment reference. Those records can be accurate for their own purposes while still leaving the relationship between them unproved. The public accountability question is therefore narrower than whether a programme acted: can a named relationship be checked against the public record that is actually available?

That question has several parts. A reader must identify the entity or project to which a record refers, determine what the source-defined status means, locate the relevant universe and period, and establish whether the earlier and later records describe the same administrative path. Each part can fail independently. A water-system identifier may be stable while a finance record names a borrower or project; a priority list may identify a decision universe while omitting the disposition of a particular applicant; an award page may be current while the agreement or correction history is held elsewhere. The audit treats these as distinct information conditions rather than as a single deficit labelled "missing data."

The distinction matters for how public evidence is used. Regulators, programme administrators, utilities, community organisations, journalists, and evaluators approach the same record environment with different questions. One may ask whether a named public water system entered a stated assistance universe; another may need to distinguish a public announcement from an executed relationship; a third may be deciding whether the available record can support a credible evaluation question. The paper supplies a common, inspectable way to describe the relationship a source establishes while preserving the varied administrative purposes of the underlying records.

The paper uses one analogy to make that distinction concrete. A public response record is like a relay: a baton is useful only if it can be followed between runners. Here the runners are source-defined stages–monitoring, programme entry, decision, agreement, implementation, and, where applicable, verification. The registered audit finds that visible components rarely compose into a traceable response relay: 13 of 204 strict historical relationships meet the rule, all at the first two transitions. The result gives the rest of the paper its centre of gravity.

This matters because PFAS response crosses administrative domains. Monitoring is often organised through drinking-water and laboratory reporting; assistance and selection pass through finance programmes; implementation and verification may be held by a utility, contractor, another office, or a controlled system. EPA distinguishes occurrence data, compliance context, notification, and Drinking Water State Revolving Fund (DWSRF) assistance, while state programmes add their own intake, priority, agreement, and project records [14, 19, 20]. GAO's national DWSRF analysis records a partial linkage constraint: some assistance agreements lack matchable PWS identifiers [31]. Existing utility-policy research likewise treats data availability, information flows, consumer access, and institutional diversity as governance concerns [1, 2, 3, 4, 7, 8, 6]. The question here is whether those separately visible records support a particular public answer.

The literature also helps clarify what the study contributes. A recent 50-state CEC study scores regulatory infrastructure and capacity across states [32]. The present audit asks whether a named public relationship is documented, rather than ranking jurisdictions or scoring policy capacity [32]. Information disclosure can influence behaviour and compliance [5], a subsequent empirical question with its own endpoint. Likewise, data-exchange and reporting systems can preserve identifiers, controlled vocabularies, validation, correction, and version information, while a cross-programme relationship requires its own documented bridge. The present contribution is a public-record audit of whether a predeclared relationship can be demonstrated from the preserved evidence packet.

The audit is deliberately source-faithful. It treats heterogeneous native formats as evidence of locally defined administrative activity and preserves jurisdiction-specific institutional arrangements. It tests predeclared relationships inside a fixed 51-jurisdiction historical frame. The paper first sets out public traceability as an accountability capability, then reports the frozen audit and its denominator objects, and only then derives a conditional policy implication. That implication asks what a source-faithful traceability profile would need to preserve so that one declared relationship can be audited. Interoperability precedents support preservation of identifiers, semantics, version information, controlled vocabularies, validation, and exchange rules [15, 16, 17, 18, 29, 30]; the relation at issue remains a separately documented object.

The audit frame makes the comparison disciplined rather than uniform. States differ in programme structure, ownership patterns, scale, delegated authority, source formats, and disclosure practice. A common protocol holds the evidence question constant while leaving the source-defined meaning of each record intact. This makes it possible to compare answerability across the registered frame while preserving source-specific explanations for any missing bridge. The findings guide a reader toward the relationship with public support and the next evidence question.

2 Public traceability as an accountability capability

Public traceability is the capability to audit a stated relationship between evidence-bearing events. A reader should be able to identify the relevant system or project, interpret the source-defined meaning and universe of a record, locate its event and release timing, and determine whether the adjacent relation is documented. Those conditions draw on familiar work on information quality, surveillance evaluation, implementation measurement, and data versioning [24, 25, 26, 27, 28], but their purpose here is specific: to keep a public claim attached to the evidence required by that claim.

The capability is relational rather than archival. A large collection of accurate component records may leave a downstream question unresolved if the records carry different identifiers, status meanings, periods, or correction histories. Conversely, a small set of source-owned records can support a strong but narrow relation when the relevant bridge is explicit. This is why the unit of analysis is the declared question between records, rather than the completeness of a portal, the size of a data catalogue, or the apparent sophistication of a programme website.

The distinction makes missingness actionable. An identity gap calls for a resolvable source-owned link; a semantics gap calls for a codebook or definition; a denominator gap calls for a stated universe and inclusion rule; a timing gap calls for an event or release record at the precision supplied; and a version gap calls for a retained correction or supersession relation. These remedies point to different responsible actors. A traceability audit therefore identifies the next evidence question without prescribing a uniform administrative process.

Figure 1 is an early conceptual map of source-defined conditional paths. Solid arrows carry relationship questions; dashed branches make withdrawal, carry-forward, inapplicability, and multiple phases visible. A traceable answer is therefore question-specific, relational, and version-aware: it depends on the relation a reader wants to establish.

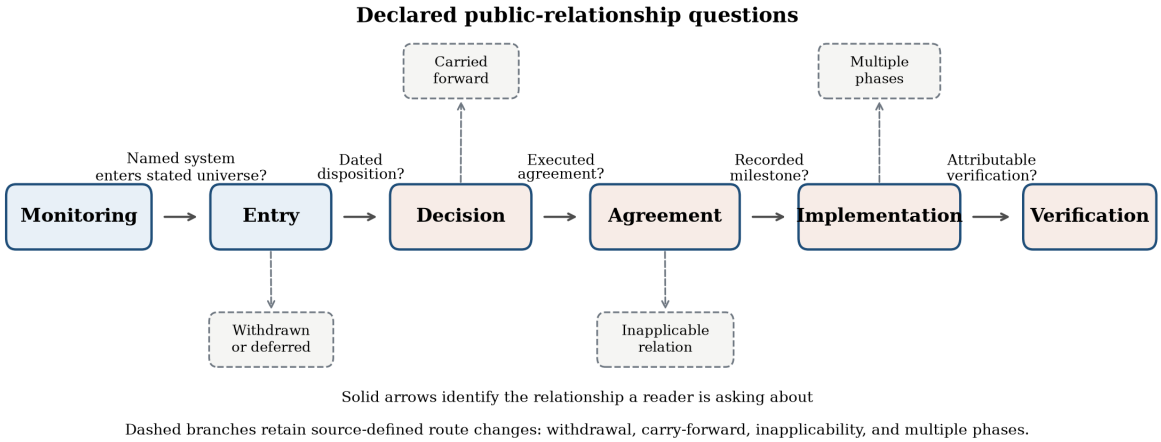

Figure 1: Analytical map of source-defined PFAS-response paths. Solid arrows name relationship questions; dashed branches show withdrawal, carry-forward, inapplicability, and multiple phases.

The audit's empirical centre appears in Figure 2. It brings the three denominator objects forward before the detailed method: 121/612 direct component cells, 13/204 strict historical relationships, and 12/255 all-factor relationships. The figure states the result that the following sections classify and interpret.

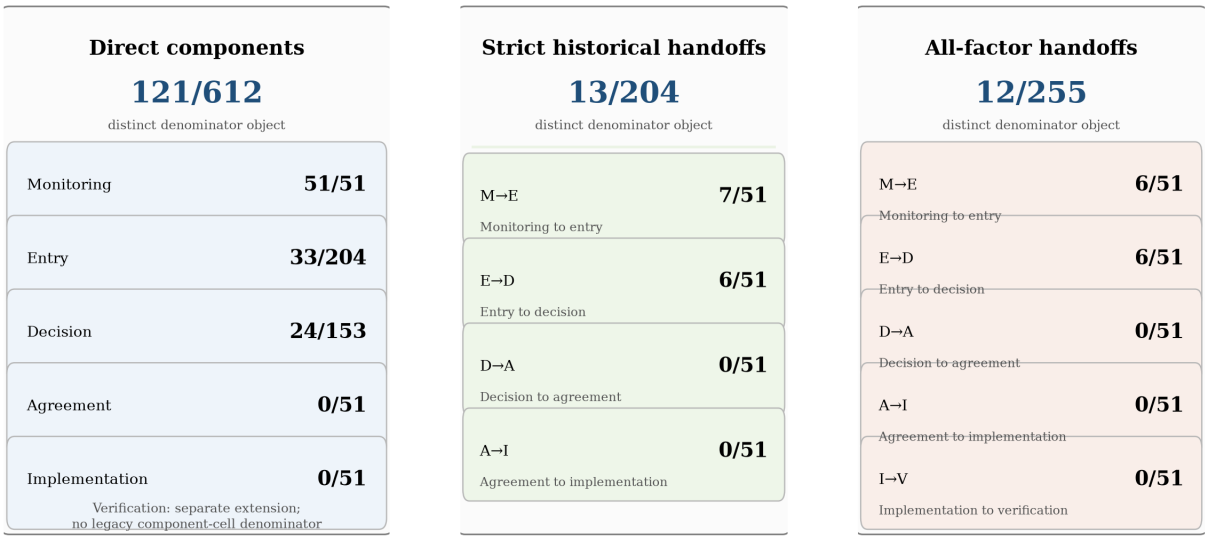

Figure 2: What the frozen packet documents. The left panel gives 121/612 direct component cells; the centre panel gives 13/204 strict historical handoffs; the right panel gives 12/255 all-factor handoffs. Component cells and handoffs answer different questions and are not jurisdictional performance rates. Post-treatment verification is a separately classified extension, not a zero-valued legacy cell.

The practical value is diagnostic. A missing identity bridge calls for a source-owned mapping; a missing denominator calls for a stated universe and period; a missing disposition calls for status history; and a missing version relation calls for a retained correction path. A programme administrator, source owner, community reader, or future evaluator can therefore locate the exact public question that remains open. That preserves institutional pluralism: state, territorial, Tribal, utility, laboratory, and federal systems may retain different identifiers, statuses, release formats, and decision routes while an exchange layer preserves what a native record means.

Public accessibility and controlled access can coexist within that account. A catalogue may identify an official source, custodian, version, codebook, and lawful route for a record whose operational detail is controlled. The audit treats a public discovery route, a controlled route, and an unavailable route as different states of answerability. It thereby avoids a false choice between centralising every field and leaving the relation entirely opaque. The relevant design question is which source-defined information must be visible, governed, or reproducible for a stated relationship to be checked.

3 Methods: frozen public-record audit

3.1 Frame, evidence classes, and inference boundary

The empirical input is a preserved 50-state-plus-DC public-record packet. It contains 612 jurisdiction–stage cells across twelve source-defined stages, 204 predeclared historical adjacent relationship questions, and a separately classified post-treatment-verification extension. The registered packet is a versioned acquisition frame. Counts describe the packet.

The frame was assembled from official public-source materials using a registered source and claim protocol. A jurisdiction–stage cell records whether a named source directly establishes the stage that its source-defined content purports to describe. The registry preserves the source location, record form, relevant identifier, event or reporting period when supplied, retrieval vintage, directness classification, and the limited claim that the record can bear. This permits another reader to inspect a classification against the same source rather than reconstructing it from a later, unregistered search.

Coding begins with source interpretation. A monitoring record may carry analytical detail without an assistance-universe identifier; an entry record may define eligibility or priority without locating a later project; an implementation page may describe construction without documenting the PFAS-related relation that prompted it. Such records remain useful components. A strict relationship is recorded only when the registered evidence establishes the relation needed by the next public question. The method therefore separates a readable component from an auditable bridge and retains partial evidence as contextual material.

The study separates seven evidence classes and keeps each result tied to its evidence type: observed repository data; derived observed result; external authoritative precedent; synthetic contract test; normative decision rule; prospective protocol; and external review pending. The historical audit rests on the first two. The other classes identify bounded precedents, test a proposed validator, record a policy choice, or specify a future study. Their distinct roles direct legal authority, consultation, consent, cost, equity, adoption, and outcome questions to the evidence needed for each.

The evidence-class distinction controls how the audit travels from source to conclusion. Observed repository data describe a record in the frozen packet; a derived observed result reports the output of the predeclared classification rule. Authoritative precedents describe an external reporting, exchange, or governance practice. Synthetic contract tests examine whether an explicit validation rule accepts or rejects declared inputs. Normative decisions state a design trade-off, while prospective protocols identify what later field work would measure. Keeping these classes visible maintains the distinction among technical tests, analogues, proposals, and realised institutional results.

For each source-defined stage, the registered protocol records the official source location, content type, identifier, date or period where available, directness classification, and the limits of the source's claim. Source interpretation precedes linkage. Direct evidence establishes the named stage itself; partial evidence is retained as context and awaits additional evidence for a strict relationship. The 51 jurisdictions define the historical frame, the 612 cells describe components, the four historical contracts generate 204 opportunities, and the five-transition extension generates 255. These are distinct denominator objects. The post-treatment relation remains a separate extension because it has its own evidentiary question.

The audit therefore describes the registered public-record packet and its declared relationships. It is not a probability sample or an exhaustive census of agency files, applications, projects, or

actions; it does not establish programme performance, treatment, exposure, health effects, equity, implementation, legal authority, or a national policy decision.

The denominator structure follows the question being asked. The 51-jurisdiction frame defines the scope of the historical audit. The 612 cells describe whether source-defined components are directly established. The 204 historical opportunities test four adjacent relations, whereas the 255 extension tests five relations using the full factor rule. The extensive acquisition and reconciliation work required to build the packet is recorded separately because that effort has a different denominator from either component availability or relationship evidence. Presenting the objects side by side makes the audit legible while preserving their non-interchangeable meanings.

The three denominators serve distinct audit functions. The cell denominator asks whether a source directly establishes a defined administrative object. The historical relationship denominator asks whether an adjacent relation can be traced under four fixed contracts. The extension adds a verification relation and applies the full factor rule. Stating each numerator with its denominator permits a replication team to preserve the original question when a later source provides a different record type, period, or release. This is the operational role of the denominator-led display: it keeps record scope, linkage scope, and verification scope visible throughout the audit.

3.2 Relationship rule and reproducibility

The audit evaluates whether a declared adjacent relationship preserves enough information to support the question carried by that relation. Seven factor classes are used when the question requires them: identity, semantics, denominator, timing, disposition, version lineage, and mature follow-up. The stable repository locator retains the technical implementation record; the reader-facing rule stays with the factor classes and their use for the declared question.

The seven factors assess the sufficiency of a declared claim. Identity permits a reader to resolve the relevant system, facility, project, award, or result. Semantics retains the source's own distinction among such statuses as eligibility, priority, award, agreement, and implementation. Denominator and timing locate the relation in its stated universe and sequence. Disposition records whether the relevant administrative path moved forward, was refused, withdrew, deferred, or remained pending. Version lineage and mature follow-up protect a public answer from being carried beyond the correction history or outcome record that supports it.

Table 1: Seven information conditions for a strict public relationship. A condition enters the rule only when the declared question needs it.

Condition	Purpose for the stated relationship
Identity	Resolves the system, facility, project, award, or result.
Semantics	Preserves source labels such as “eligible,” “awarded,” and “implemented.”
Denominator	Locates the stated programme universe or cycle.
Timing	Preserves sequence at the source's stated precision.
Disposition	Records support, refusal, withdrawal, deferral, or pending status.
Version lineage	Retains earlier public meaning across correction or supersession.
Mature follow-up	Separates award or construction records from attributable verification.

The rule is applied to the stated public question. A narrow component question can require fewer factors than a complete relay question; the latter uses all seven because every factor protects a distinct element of the declared relation. The stable repository locator retains the technical record.

The supplement records the factor classes and classification logic.

A failed relationship directs a reader to the evidence class required for the next question while preserving the underlying source's value for its stated component question. A dated disposition, executed agreement, attributable verification, and stable release lineage answer distinct public questions.

Reproducibility is part of the inference boundary. Each source retains its official location, retrieval vintage, source-defined meaning, and permitted use; historical material is classified as native, deterministically usable, source-only, or excluded. A name-only match remains contextual evidence, and a changed release preserves the earlier answer through its retained lineage. The post-freeze Minnesota and UCMR5/SDWARS materials are implementation-context checks with their own provenance; the 51-jurisdiction frame, strict-relationship denominator, and reported result therefore remain fixed.

The post-freeze separation is important for both audit integrity and policy interpretation. Minnesota materials and the later UCMR5/SDWARS documents provide useful context about state and federal record practices, but they arrived after the historical packet was frozen. They remain visible as implementation-context checks with their own provenance. Historical cells and denominators retain their original classification, preserving the original empirical result from later documentary progress.

4 Results: what the packet establishes

The frozen packet contains 121 direct-evidence cells: 101 row-level and 20 document-level. Direct components are unevenly distributed. Monitoring is directly documented for all 51 jurisdictions; programme entry and decisions are observed less often; agreement and implementation cells are rarely established; post-treatment verification is a separately classified extension rather than a missing zero in the legacy matrix.

The component pattern makes clear why an inventory alone is insufficient. The registered packet contains direct monitoring records for 51 of 51 monitoring objects, 33 of 204 programme-entry objects, and 24 of 153 decision objects. It contains no direct agreement or implementation component cell in their respective 51-object displays. These counts identify where the packet supplies source-defined evidence for an individual stage. The next public question asks whether a reader can follow the same named response from one stage to the next.

The distribution keeps visibility and relationship evidence distinct. Monitoring, entry, and decision materials are present in different forms and at different levels of specificity. What varies is the evidence available for linking those materials while retaining their source-defined identity, status, period, and history. The result is therefore most informative at the point where a public narrative moves from a visible component to an asserted relationship.

The audit's central result concerns documented relationships. Of 204 predeclared historical relationship questions, 13 met the strict direct-evidence rule: seven monitoring-to-entry relationships and six entry-to-decision relationships. No decision-to-agreement or agreement-to-implementation relationship met the rule. The broader all-factor extension retained six monitoring-to-entry and six entry-to-decision relationships out of 255 opportunities, with no later relationship. Figure 2 displays those distinct denominator objects as raw counts.

The transition-specific result matters. The historical rule identifies seven instances in which a monitoring record and programme entry can be related under the direct-evidence conditions, and

six in which an entry and decision can be related. Those are the only observed strict historical bridges. The later transitions require their own evidence-bearing relationships: a decision linked to an agreement, an agreement linked to implementation, and, in the extension, implementation linked to attributable verification. The observed pattern keeps each question visible instead of allowing an earlier component to carry a later claim by implication.

The transition pattern is also an administrative distinction. The first relationship connects a monitoring record to a programme universe; the second connects that universe to a recorded decision. Later questions require a different chain of documentary authority: an agreement that identifies the response, an implementation record that identifies the same project, and, where relevant, a verification record attributable to that action. This keeps the evidence bridge visible at every transition.

The audit gives a reader a practical route through that distinction. It identifies the additional record or relation to seek, the actor likely to hold it, and the provenance needed to interpret it. That matters where public information travels through different offices, release schedules, and access conditions. The result turns a general request for integration into a sequence of answerable, source-specific questions.

The registered classification supports three complementary readings of this pattern. First, the direct component result tells a reader where the packet contains evidence for individual administrative objects. Second, the strict historical result asks whether adjacent objects can be related under the original four-transition protocol. Third, the all-factor extension asks whether the five-transition sequence, including the additional verification question, can be supported under the more demanding rule. These readings have a common source packet but different numerator–denominator pairs and different evidentiary burdens. Reporting all three makes the result auditable without compressing them into one synthetic index.

The pattern is equally useful for interpreting a positive relationship and a failed one. A passing early relationship demonstrates that source-defined records can retain enough information to support a declared relation. A failed relationship identifies the evidence relation that needs recovery: a resolvable system or project, a stated programme universe or disposition, an event sequence, or a retained release lineage. The classification thus preserves both the value of existing component records and the next public question.

This distinction makes the audit reviewable by readers with different stakes. A source owner can identify an opportunity for a resolvable crosswalk or a retained status history. A programme administrator can distinguish a component report from a documented programme pathway. A community reader can see the difference between an available record and a verifiable relationship. An evaluator can identify the records that a later comparison would need before describing an implementation, treatment, or outcome pathway. The empirical result supplies an accountability map for record-specific inquiry.

The pattern identifies where public answerability stops. A reader can locate a PFAS result and, in some cases, a programme-entry or decision record, yet still lack the documented project bridge, executed arrangement, implementation milestone, or attributable follow-up needed for the next question. The audit reports the available evidence for a continuous named relationship beyond the early stages and identifies the exact bridge that would support the next relationship question.

Figure 2 is deliberately denominator-led. Its left panel describes direct component cells, its centre panel describes strict historical relationships, and its right panel describes the all-factor extension. The visual preserves the distinct questions through the raw numerator and denominator attached

to each object: 121/612, 13/204, and 12/255. Post-treatment verification is shown as a separate extension because it carries a different evidentiary question from the legacy cell display.

The passing early handoffs are informative in their own right. They show that existing administrative records can support a narrow relationship when identifiers, source-defined statuses, timing, and disposition information align. The contrast with the visible component counts is the empirical contribution: public traceability is a property of the documented relation. The result supplies a record-level account of the specific bridge a reader would need to inspect.

The pattern also explains why each factor has a separate role. A reader who can resolve a water system in a monitoring record still needs a source-defined link to the programme universe in which that system appears. A record describing a decision still needs enough status and timing information to distinguish selection, award, agreement, withdrawal, or deferral. A later project reference still requires a documented relation and mature follow-up before it answers an attributable verification question. These are different evidentiary tasks; the audit preserves that difference in the reported failures and in the next questions that the source packet leaves open.

Version lineage supplies the same discipline over time. The archived Massachusetts comparison shows why a reproducible answer needs a retained earlier release, correction, or supersession path. The supplementary record describes the classification approach; the technical repository retains the detailed comparison and counterfactual windows. Release lineage identifies whether a claim remains inspectable after a public record changes.

This temporal result has a practical consequence for public accountability. A current page can be valuable while an earlier record remains necessary to reproduce an earlier decision, a prior source-defined meaning, or a later correction. The audit records release lineage as part of the relationship evidence rather than treating it as a documentation afterthought. That allows a future reader to distinguish a changed record from a changed administrative event and to trace which public answer remains supported by the retained materials.

The historical and extended denominators converge on the same bounded finding while retaining their distinct meanings. The historical rule preserves continuity with the frozen four-transition baseline. The all-factor extension tests the additional verification relation. Both locate the documented relationships at entry and decision and preserve the packet's status as a source-specific audit.

The one-relationship difference between the historical and extended totals also illustrates the value of predeclared scope. The historical count retains seven monitoring-to-entry bridges and six entry-to-decision bridges; the extended rule retains six of each. The paper reports both totals because each follows a stated question and factor requirement. Their agreement on the location of the visible bridges strengthens the empirical diagnosis while their different denominators remain visible to the reader.

The result also supplies a structured return path to the underlying sources. Each directly documented stage carries its own source location, content type, identifier, event or reporting period where available, and retrieval vintage. Each strict bridge carries the evidence relation that connects adjacent stages. A reader can therefore move from the summary count to a source-specific question, inspect the basis for its classification, and identify the information that would resolve a later bridge. This record-level design supports reproducible public inquiry across heterogeneous administrative settings.

The result therefore supplies a common accountability unit: a stated relationship with a named record, declared universe, timing, and version lineage. It permits comparison across unlike administrative systems while preserving source-defined meanings, distinguishes an inspectable bridge from an adjacent record, and directs each reader to the evidence needed for the next public question.

5 Conditional policy implication

The audit reveals a bounded policy problem: public records can be useful separately while leaving a named relationship undocumented. P2R-US Core is offered as a conditional traceability profile for that problem. Its minimum package identifies the source record, event or status, declared relation, relevant time or release, codebook, and public, controlled, or unavailable access route. A validator can distinguish structural validity, disclosure completeness, and claim sufficiency while retaining the source-defined scope of a component record.

The profile is source-faithful. Source-owned identifiers and statuses retain their meaning until a documented mapping supports a bridge; a catalogue can make provenance and an access route discoverable without assuming custody of every native field. The SDWARS/UCMR materials provide a bounded workflow precedent for persistent identifiers, relation rules, controlled values, validation, rejection, correction, and resubmission [11, 12, 13]. The transferable design principle is simple: allow different native formats, but require the exchange layer to preserve what the data mean.

In practical terms, the profile is a statement about what has to travel with a public claim. A record and relation need resolvable identifiers; a status needs its source-defined meaning; a decision or event needs a relevant date or reporting period; and a change needs a visible version relation. A codebook and a route for public or controlled access allow a reader to discover how the record should be interpreted. These claim-oriented elements preserve source systems and their status vocabularies across jurisdictions.

The UCMR/SDWARS documentation is useful precisely because it makes a mature reporting workflow concrete. Its data elements, relationship rules, validation feedback, correction, and resubmission procedures show how a system can retain links and meanings across an exchange boundary. The audit uses that evidence as a format-and-workflow precedent for a future adapter discussion. A water-finance or state-response setting would still require its own source-owner mapping, governance, and access decisions before the same structure could be used beyond the documented record relationship.

The distinction between a voluntary profile and an implementation programme is consequential. The former makes a proposed relation and its evidentiary needs explicit. The latter requires participating partners, governance, mapping work, correction processes, access controls, and measured activity. The actor map retains those separate responsibilities in a compact form.

This division of labour is also a safeguard against over-centralisation. A source owner remains responsible for the native record; an adapter describes a declared relation without changing the source's meaning; a validator checks the sufficiency of the relation for a specified claim; and a catalogue helps a reader discover the provenance, version, and access route. Evaluation remains a separate, governed activity because it asks questions about implementation, burden, equity, or outcomes that are different from the question whether a public relationship is documented.

Table 2: Actor, access, and permitted-claim map for a source-faithful traceability profile.

Actor	Holds or publishes	Current public-claim boundary
Source owner	Official record under source-defined public, controlled, or unavailable conditions	Source-defined component claim
Adapter	Versioned event, declared relation, codebook, and manifest	Structural validity and stated mapping scope
Validator	Integrity, disclosure, and claim checks; public and controlled outputs	Whether a declared relationship is auditable
Catalogue	Provenance, version, and access-route metadata; no custody claim	Discovery and reproducibility route
Evaluation partner	Governed implementation, burden, equity, and outcome records	Separately approved evaluation claim

The policy choice is staged rather than binary. Existing portals address component questions; a voluntary profile can expose a declared relation; a governed pilot can examine feasibility and consequences under partner oversight. A national requirement would require a distinct decision record. Table 3 makes the external evidence gates visible.

The stages have different purposes. A voluntary profile tests whether a source-defined relation can be represented faithfully. A governed pilot would generate observations about mapping effort, correction workflows, user experience, access, security, and distribution of burden under a predeclared protocol. A wider requirement would depend on those results alongside authorised legal, records, privacy, and participation decisions. Keeping these stages separate makes the audit useful to a source owner today while preserving the empirical questions that must be answered before institutional scale-up.

Table 3: Conditional policy responses and the evidence required for a stronger decision. The table makes the current decision boundary visible; it is not a recommendation to impose a national requirement.

Response	What can be discussed from this audit	Evidence required before a stronger decision
Status quo releases	Existing public records answer bounded component questions.	No additional claim of a documented response chain.
Voluntary traceability profile	A source-faithful package can specify a declared relationship.	Source-owner agreement, field authority, security, and access review.
Governed pilot	A comparison protocol and candidate measures can be prepared.	Participating partners, lawful governance, observed mapping, correction, usability, burden, and equity data.
Wider requirement	The audit identifies questions a requirement would need to solve.	External legal, security, portability, burden, participation, and outcome evidence; this paper does not establish a national requirement.

This staged account preserves institutional variation. States and the District of Columbia, Puerto Rico, other territories, and federally recognised Tribal or direct-implementation contexts require source- and governance-specific routes. Tribal participation, consent, co-design, disclosure preferences, and authority use authorised processes appropriate to each context [23, 21, 22].

6 Discussion

6.1 What the frozen audit establishes

The frozen audit establishes a public-record fact: in the registered historical packet, separately visible components rarely compose into a strict named relationship beyond the earliest stages. Its contribution is a reproducible account of which relation can be inspected from the packet. A monitoring result, a programme intake, a decision, an agreement, an implementation milestone, and a later result each answer a different question; the relationship rule keeps those objects distinct.

This distinction lets a reader state what is established, identify the undocumented bridge, and preserve source context for a later authorised inquiry. It turns a diffuse information problem into evidence questions for the responsible record owner or governance process.

Information availability is already recognised as a governance resource, while the institutional use and consequences of information remain context dependent [2, 3, 4, 10]. The audit contributes the record conditions under which a later accountability, administrative-burden, equity, implementation, or outcome question can be specified and checked.

Computational reproducibility lets a reader rerun the registered classification against the retained packet. Public-record reproducibility keeps evidence inspectable when a source changes, corrects, or replaces a release. Together they make the audit reviewable and keep a public answer attached to its supporting version.

6.2 Why the result matters for utility accountability

Public claims shape decisions before they shape outcomes. A state administrator may need a documented bridge to correct a project report; a federal programme may need to distinguish inaccessible information from a public record without a stable identifier or release lineage; a community may need to test a stated assistance relationship. The audit gives each actor a way to identify the missing relation and the source owner best placed to resolve it.

For a source owner, the audit record turns a broad request for data integration into a focused conversation about a declared bridge. It locates the identifiers, statuses, time elements, version relation, and access route relevant to a particular public question. That focus helps a utility or programme team identify the record steward, agreement, mapping task, or governance decision needed for a future authorised initiative. It also gives community readers language for requesting a defined relationship instead of a general portal improvement.

For utilities, this is an accountability capability focused on documented relations. A utility can be associated with a monitoring record, a programme application, a project, or a construction milestone through different identifiers and systems. The audit shows why a reader needs a documented relation before treating those appearances as one continuous response. Comparable drinking-water research provides precedent that transparent information flows and community-engaged data tools can support communication and coordination among utilities, public agencies, and communities [8, 9].

Actor, access, and claim boundaries travel together. A programme administrator may document a decision while a utility, laboratory, or finance programme holds a different part of the record. The profile makes those divisions visible, supports public discovery alongside lawful controlled access, and preserves local semantics and source ownership for the relation a reader wants to check. That

separation prevents a catalogue from implying custody of each underlying record.

Institutional diversity is central rather than incidental. State, territorial, Tribal, federal, laboratory, and utility settings may allocate authority, data stewardship, and disclosure differently. A source-faithful approach holds the requested public relation to a common evidentiary standard while respecting those arrangements. It creates a common language for an audit question, then leaves decisions about participation, consent, disclosure, and governance to the authorised process that owns them.

6.3 What remains outside this paper

Implementation, cost, burden, equity, access, and causal outcome questions use their own observed evidence. EPA's PFAS economic analysis offers contextual reporting-burden values [33]. A later study would use an agency or partner agreement, source-owner governance, field-level access decisions, a frozen protocol, a credible comparison, predeclared equity strata, and actual workload, correction, access, implementation, and outcome records. It would also distinguish technical assistance, application, award, agreement, implementation, and verified follow-up.

That future evidence agenda is deliberately operational. It identifies the records a partner would need to collect before comparing a voluntary mapping effort with current practice, and it identifies the governance decisions that must precede any collection of controlled or equity-relevant information. The present audit supplies an input to that design: a reproducible definition of the relationship whose visibility, correction history, and access route would be assessed. It keeps an implementation evaluation measurable rather than allowing the word "response" to collapse several administrative events into one endpoint.

The empirical frame is the historical 50-state-plus-DC packet. A comparable audit elsewhere would require source-owned identifiers, declared event meanings, a stated universe, documented relationships, and release lineage. Those are transportability conditions for the method; they guide reuse of the audit logic without assigning another setting the same pattern or response. The literature and governance sources provide a bounded policy landscape and a disciplined starting point for future authorised review.

7 Conclusion

Responsible evaluation connects PFAS monitoring and public investment through documented relationships. In the registered public packet, a reader can often locate a component but rarely document a strict named relationship beyond the early stages. That finding makes a practical accountability question visible: whether the public record substantiates the relation being claimed.

The durable contribution is a public-record finding: a method for distinguishing a documented relation from an attractive narrative assembled from adjacent records. It preserves the distinction between a public component and a public relationship.

Acknowledgements

The author thanks Todd Johnson of the Minnesota Department of Health for providing the approved SFY 2023–2025 Drinking Water Revolving Fund Intended Use Plans, directing the author to the

2026 Project Priority List, and clarifying how PFAS-related projects are identified in these records. This acknowledgement is informational and conveys no endorsement of the analysis or conclusions.

Data and code availability

The registered audit materials, official-source ledger, analysis code, and supporting documentation are available at `https://github.com/Gustolandia/pfas-administrative-response`. Raw records remain governed by their original public sources; file size, release terms, and source controls determine the available access route. The repository records acquisition routes and distinguishes historical evidence, conditional design material, and future external work.

References

[1] Berg SV. Seven elements affecting governance and performance in the water sector. *Utilities Policy*. 2016;43:4–13. doi:10.1016/j.jup.2016.04.013.

[2] Berg SV, Phillips MA. Data availability as a key tool for regulating government-owned water utilities. *Utilities Policy*. 2017;49:30–37. doi:10.1016/j.jup.2017.06.012.

[3] Sirkiä J, Laakso T, Ahopelto S, Ylijoki O, Porras J, Vahala R. Data utilization at Finnish water and wastewater utilities: current practices vs. state of the art. *Utilities Policy*. 2017;45:69–75. doi:10.1016/j.jup.2017.02.002.

[4] Nicholas S, Vedachalam S. Poor accessibility of water utilities' consumer confidence reports. *Utilities Policy*. 2021;72:101272. doi:10.1016/j.jup.2021.101272.

[5] Bennear LS, Olmstead SM. The impacts of the "right to know": information disclosure and the violation of drinking water standards. *Journal of Environmental Economics and Management*. 2008;56(2):117–130. doi:10.1016/j.jeem.2008.03.002.

[6] Dobbin KB, Fencl AL. Institutional diversity and safe drinking water provision in the United States. *Utilities Policy*. 2021;73:101306. doi:10.1016/j.jup.2021.101306.

[7] Gallaher S, Heikkila T. Challenges and opportunities for collecting and sharing data on water governance institutions. *Journal of Contemporary Water Research & Education*. 2014;153(1):66–78. doi:10.1111/j.1936-704X.2014.03181.x.

[8] Kumpel E, MacLeod C, Stuart K, et al. From data to decisions: understanding information flows within regulatory water quality monitoring programs. *npj Clean Water*. 2020;3:38. doi:10.1038/s41545-020-00084-0.

[9] Pace C, Fencl A, Baehner L, Lukacs H, Cushing LJ, Morello-Frosch R. The Drinking Water Tool: A Community-Driven Data Visualization Tool for Policy Implementation. *International Journal of Environmental Research and Public Health*. 2022;19(3):1419. doi:10.3390/ijerph19031419.

[10] Andres LA, Garrido J, Gonzalez J, Marques RC. Assessing regulatory governance for the water and sanitation agencies in Brazil. *Utilities Policy*. 2024;90:101802. doi:10.1016/j.jup.2024.101802.

[11] U.S. Environmental Protection Agency. *SDWARS 5 Flat File Upload Specification*. Draft Version 3.0, July 2023. Retained in EPA FOIA 2026-EPA-06825.

[12] U.S. Environmental Protection Agency. *UCMR 5 Final Data Elements Table*. Retained in EPA FOIA 2026-EPA-06825.

[13] U.S. Environmental Protection Agency. *SDWARS 5 Relationship Diagram*. Retained in EPA FOIA 2026-EPA-06825.

[14] U.S. Environmental Protection Agency. *Occurrence Data from the Unregulated Contaminant Monitoring Rule*. Updated 28 August 2026. Accessed 24 September 2026. `https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule`.

[15] U.S. Environmental Protection Agency. *Concepts and Definitions for STOrage and RETrieval and Water Quality Exchange*. Updated 30 June 2026. Accessed 24 September 2026. `https://www.epa.gov/waterdata/concepts-and-definitions-storage-and-retrieval-and-water-quality-exchange`.

[16] Data.gov / GSA. *DCAT-US Schema v3.0*. 2026. Accessed 24 September 2026. `https://resources.data.gov/resources/dcat-us3/`.

[17] U.S. Environmental Protection Agency. *Environmental Information Exchange Network*. Updated 31 July 2026. Accessed 24 September 2026. https://www.epa.gov/exchangenetwork.

[18] U.S. Environmental Protection Agency. *Cross-Media Electronic Reporting Rule*. Updated 10 June 2026. Accessed 24 September 2026. https://www.epa.gov/cromerr.

[19] U.S. Environmental Protection Agency. *Drinking Water State Revolving Fund — Statutory Authority and Program Regulation*. Updated 28 October 2025. Accessed 24 September 2026. https://www.epa.gov/dwsrf/drinking-water-state-revolving-fund-statutory-authority-and-program-regulation.

[20] U.S. Environmental Protection Agency. *State Revolving Fund Public Portal*. Accessed 24 September 2026. https://sdwis.epa.gov/ords/sfdw_pub/r/sfdw/owsrf_public/home.

[21] U.S. Environmental Protection Agency. *Funding Assistance for Territories under the Drinking Water State Revolving Fund*. Updated 26 May 2026. Accessed 24 September 2026. https://www.epa.gov/dwsrf/funding-assistance-territories-under-drinking-water-state-revolving-fund.

[22] U.S. Environmental Protection Agency. *Tribal Environmental Information Resources*. Updated 9 September 2025. Accessed 24 September 2026. https://www.epa.gov/tribal/tribal-environmental-information-resources.

[23] Carroll SR, et al. The CARE Principles for Indigenous Data Governance. *Data Science Journal*. 2020;19:43. doi:10.5334/dsj-2020-043.

[24] German RR, et al. Updated Guidelines for Evaluating Public Health Surveillance Systems. *MMWR Recommendations and Reports*. 2001;50(RR-13):1–35.

[25] Wang RY, Strong DM. Beyond Accuracy: What Data Quality Means to Data Consumers. *Journal of Management Information Systems*. 1996;12(4):5–33. doi:10.1080/07421222.1996.11518099.

[26] Pipino LL, Lee YW, Wang RY. Data Quality Assessment. *Communications of the ACM*. 2002;45(4):211–218. doi:10.1145/505248.506010.

[27] Proctor E, et al. Outcomes for Implementation Research: Conceptual Distinctions, Measurement Challenges, and Research Agenda. *Administration and Policy in Mental Health*. 2011;38:65–76. doi:10.1007/s10488-010-0319-7.

[28] Kindling M, et al. Dataset Versioning: A Data Science Practice Perspective. *Data Science Journal*. 2021;20:12. doi:10.5334/dsj-2021-012.

[29] Michener WK, et al. DataONE: Data Observation Network for Earth. *Ecological Informatics*. 2012. doi:10.1016/j.ecoinf.2011.08.007.

[30] Larsen SG, Young D. WaDE: An Interoperable Data Exchange Network for Sharing Water Planning and Use Data. *Journal of Contemporary Water Research & Education*. 2014;153:33–41. doi:10.1111/j.1936-704X.2014.03177.x.

[31] U.S. Government Accountability Office. *Water Infrastructure Resilience: Agencies Could Better Assess Efforts to Assist Communities Vulnerable to Natural Disasters*. GAO-25-107013, 2025. Accessed 24 September 2026. https://files.gao.gov/reports/GAO-25-107013/index.html.

[32] Siame T, Willis AB, Nyarko AJ, Karimi S, et al. Addressing contaminants of emerging concern in the United States public water systems. *Environmental Science and Pollution Research*. 2026;33:8209–8228. doi:10.1007/s11356-026-37822-9.

[33] U.S. Environmental Protection Agency. *Economic Analysis for the Final PFAS National Primary Drinking Water Regulation*. 2024. Accessed 24 September 2026. https://www.epa.gov/system/files/documents/2024-04/pfas-npdwr_final-rule_ea.pdf.

Supplementary methods and audit record for the 51-jurisdiction handoff audit

Gustavo Pedro Ricou

24 September 2026

1 Audit frame and evidence classes

This supplement records the evidence structure, classification rules, robustness material, and conditional technical design that support the main audit. It functions as an appendix to the 51-jurisdiction public-record analysis. The main manuscript reports the empirical finding; this document supplies enough detail for a reader to inspect its frame, rules, and stated limits.

The historical packet covers 50 states and the District of Columbia. It contains 612 jurisdiction–stage cells, four historical adjacent-handoff contracts, 204 historical handoff opportunities, 121 direct-evidence cells, and a separately classified post-treatment-verification extension. The acquisition frame is registered and versioned. It is neither a probability sample nor an exhaustive inventory of agency files, projects, applications, actions, or current websites. A failed factor means only that the stated public relationship cannot be reconstructed from that packet.

Table 1: Evidence classes used throughout the audit and conditional design.

Evidence class	Permitted use
Observed repository data	Describe a source-defined record in the frozen packet.
Derived observed result	Report an audited count or rule-based classification from that packet.
External authoritative precedent	Identify a bounded reporting, exchange, governance, or workflow practice.
Synthetic contract test	Show how the proposed validation logic behaves under declared inputs.
Normative decision rule	State a policy trade-off without representing it as a measured effect.
Prospective protocol	Define what a later implementation study would measure and when.
External review pending	Mark a question that requires an authorised legal, governance, security, or stakeholder process.

The denominator ladder is shown in Table 2. Its objects must not be combined into a single jurisdictional rate. The direct cell count concerns source-defined components. The historical and extended handoff counts concern separate relationships. The intensive extraction-and-reconciliation band is omitted from the main display because its denominator is an acquisition effort, not a meaningful measure of jurisdictional capacity.

The Minnesota and UCMR5/SDWARS materials were received after the historical packet was frozen. They are retained as post-freeze implementation-context checks. They are not added cells, and they do not change the 51-jurisdiction frame, any stated denominator, or the primary result. The public record is therefore kept distinct from later source-adapter compatibility work.

Table 2: Denominator ladder for the frozen public-record audit.

Analytic object	Count	Permitted interpretation
Jurisdictions	51	Fixed historical frame: 50 states and the District of Columbia.
Jurisdiction–stage cells	612	Whether a registered source directly establishes a source-defined component.
Historical handoff opportunities	204	Whether four adjacent relations can be evaluated under the frozen direct-evidence rule.
Extended handoff opportunities	255	Whether five adjacent public questions pass the all-factor rule.

2 Factor and classification record

2.1 Public-handoff factors

Table 3 gives the full reader-facing explanation of the seven-factor rule. A factor is required only when the declared question would otherwise invite an unsupported substitution. The complete factor calculations, removals, and question-scope record are available through the stable repository locator in the main manuscript.

Table 3: Factor-by-factor public-handoff record.

Factor	Guarded distinction	Record needed
Identity	Separate systems, facilities, projects, awards, and results.	Stable identifier or source-owned bridge.
Semantics	"Eligible," "priority," "awarded," and "implemented."	Status code, record family, and codebook version.
Denominator	Visible rows and the stated cycle universe.	Universe, inclusion rule, and period.
Timing	Later release and earlier event.	Event date plus relevant update or release date.
Disposition	Support, refusal, ineligibility, withdrawal, deferral, and pending status.	Dated decision, disposition, and status history.
Version lineage	Corrected release and prior public meaning.	Version identifier, manifest, and correction or supersession relation.
Mature follow-up	Award, contract, construction, and verified outcome.	Dated attributable post-action verification record.

Complete-relay questions require all seven factors; narrower questions may require fewer. The stable repository locator provides the factor calculations, removal analyses, and illustrative declared cases that support the audit record.

2.2 Historical classification and release lineage

Historical materials are not discarded merely because they predate a future profile, and they are not promoted because a name appears plausible. Table 4 records the classification rule used in the audit.

The release-lineage comparison uses an archived Massachusetts construction to show why a current page or export cannot automatically stand for an earlier public answer. It classifies old-only, new-only, and identity-paired records separately, because their meanings differ. The detailed counterfactual windows and numerical sensitivity outputs are retained in the technical repository; the reader-facing result is

Table 4: Historical-source classification and permitted analytic use.

Classification	Permitted use
Prospective native package	A source-owned package that may be assessed against a future profile after ordinary conformance gates.
Deterministic historical evidence	Official, readable, semantically mapped, stable-identifier, explicit-relationship, timed or intervalled, and versioned record.
Source-only evidence	Bounded component record with an unresolved bridge, relationship, time, or lineage; it cannot be reconstructed as a relay.
Excluded	Lacks an official, readable, or interpretable basis for the declared claim.

the classification principle: a reproducible claim preserves its relevant earlier release, correction, or supersession path.

3 Robustness and version lineage

The audit is organised around eight independent public questions: interpretation of a reported PFAS result; a stated programme-entry universe; a recorded disposition; an executed or amended agreement; an attributable implementation milestone; attributable post-treatment verification; reproducibility after supersession; and correction of a stale relationship. The questions were specified before factor assignment. Their source locators, factor needs, and prohibited substitutions are retained in the repository. The main rule is simple: a package can answer one question without being described as a complete relay.

Eight competing event structures were evaluated in synthetic adversarial tests. The selected conditional six-role structure keeps monitoring, entry, decision, agreement, implementation, and verification distinct where the public question requires that distinction. Source-local splits remain possible, and a linear route is not imposed on a record that documents withdrawal, resubmission, carry-forward, inapplicability, amendment, or multiple implementation phases. The full adversarial grid and counterexamples are technical validation materials, not a claim that every jurisdiction uses the same workflow.

The audit also preserves a distinction between event time, source-update time, public-release time, and correction or supersession visibility. A date retains the precision actually supplied by the source rather than being converted into a fictional timestamp. Official timing anchors are treated as source- and event-specific context. They do not impose one national cadence. The same principle applies to notification: a changed, public, source-defined status may be a future controlled notification event, while an unchanged release, raw concentration, inferred exceedance, or absent row is not.

4 Conditional technical design and future evaluation

4.1 Source-faithful profile

The conditional profile retains six evidence roles–monitoring, programme entry, decision, agreement, implementation, and post-treatment verification–without requiring every source to use a uniform linear path. It preserves a source universe, event or episode, typed relationship, source-defined codebook, relevant timing, version relation, and public, controlled, or unavailable access class. A validator may report structural validity, disclosure completeness, and claim sufficiency separately. A monitoring-only source can therefore remain valid for a monitoring question while being insufficient for a lifecycle claim.

The UCMR5/SDWARS materials supply an important compatibility precedent. They show a federal reporting workflow with persistent water-system, facility, and sample-point identifiers; controlled data

elements; relation rules; validation; rejection; correction; and resubmission. They support preservation of native identifiers and meaning during exchange. They do not establish universal DWSRF law, a national field mandate, a public application-to-response bridge, or a universal interface.

4.2 Governance, access, and future evidence

The profile distinguishes public sources, source owners, public metadata, controlled records, and unavailable or uncollected information. A public catalogue can expose provenance and an access route without asserting custody over every native record. A field-level design must be reviewed by the source owner and applicable authority before a field is public, coarsened, controlled, or excluded. A technical schema is not a privacy, security, records-retention, or Indigenous-data-governance certification.

States and the District of Columbia, Puerto Rico, other territories, and federally recognised Tribal or direct-implementation contexts remain distinct routes. Tribal participation, consent, co-design, disclosure preferences, and governance authority are not inferred; a Tribal or direct-implementation context is not a proxy state category. A partner-governed process is a candidate institutional arrangement, not an existing mandate, charter, or delegation of authority.

Table 5 identifies the evidence a later implementation decision would require. It keeps desk design, external precedent, and observed implementation separate.

Table 5: Evidence required for a future implementation or policy decision.

Question	Evidence required before a stronger claim
Legal and records authority	Field-specific legal analysis, lawful instrument, and source-owner decision.
Privacy, security, and access	Threat model, access design, security review, incident rules, and controlled workflow.
Format and workflow portability	Participating systems, documented mappings, correction history, and measured fidelity.
Administrative burden and cost	Measured work, rework, cost, and burden distribution by actor.
Equity and participation	Predeclared strata, lawful permissions, participation denominators, and distributional analysis.
Adoption and implementation	Recruitment, governance, adaptation, technical failures, fidelity, and feasibility records.
Effectiveness and outcomes	Credible comparison, predeclared endpoint, and attributable outcome record.

No pilot has been conducted; future implementation evaluation requires lawful governance, a frozen protocol, credible comparison, and observed outcome records.

Sources, data, code, and supporting audit material are available through the main repository locator.