Applying Monitoring Architecture: A Failure-Mode Stress Mapping of West Newton A

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Series Note

This paper is the second in a three-part series examining the architecture of environmental monitoring and assurance within UK onshore hydrocarbon regulation. It applies the monitoring framework developed in the companion paper, Monitoring, Threshold Governance, and the Architecture of Assurance in UK Onshore Hydrocarbon Regulation, to the West Newton A planning application as a structured stress-mapping exercise.

Rather than assessing environmental outcome or regulatory performance, this paper examines how the submitted monitoring architecture is structured to detect, interpret, and respond to departures from expected system behaviour. Its purpose is to illustrate how monitoring architecture can be analysed independently of any subsequent operational outcome.

Together, the series forms part of a broader body of work examining how evidence becomes visible, recognised, and acted upon within environmental governance systems, and whether existing observations and evidence have, in some circumstances, already reached thresholds that should reasonably have prompted further investigation.

Executive Summary

This paper applies a structured monitoring-architecture framework to the West Newton A application. The analysis is prospective and architectural. It does not assess environmental impact, operational outcome, regulatory adequacy, or likelihood of failure. It examines how the submitted governance and monitoring design is structured to detect and respond to deviation from predicted behaviour.

The application presents multiple assurance layers, including subsurface modelling, operational controls, environmental monitoring, defined thresholds, and regulatory oversight. Together, these elements form a detectability envelope – the range of system behaviour the architecture is structurally capable of observing and escalating.

The stress mapping identifies the following structural characteristics:

- Monitoring placement is aligned with predicted subsurface geometry and assumed domain separation.
- Operational parameters are monitored continuously, while environmental domains are monitored at defined intervals.
- Escalation is primarily threshold-based, with clearly defined responses to exceedance events.
- Cross-domain reassessment appears partially interpretive rather than fully automatic.
- Review clauses and adaptive mechanisms are present, though some escalation pathways depend on professional judgement rather than predefined triggers.
- Detection and action are not identical: measurable signals that remain within defined tolerability limits do not automatically trigger reassessment.

These features are typical of threshold-governed regulatory systems. Their identification does not imply malfunction, breach, or harm. "Failure mode activation" in this document refers to structural exposure within the monitoring design, not evidence of operational failure.

In summary, the West Newton A architecture demonstrates clear response mechanisms for defined exceedance events and includes adaptive capacity. Where potential deviation manifests as distributed, sub-threshold, or cross-domain signals, recognition would in some cases depend on interpretive synthesis rather than automatic escalation.

This document is descriptive. It maps governance structure as presented. It does not determine adequacy, risk, or outcome.

Table of Contents

1. Introduction

1.1 Context

This paper applies a previously defined monitoring-architecture failure-mode framework to the West Newton A application as currently submitted.

The application is live. No retrospective operational failure is under review within this document. The focus is prospective: to examine how the monitoring and governance design presented within the application is structured to detect, classify, and respond to system behaviour should deviation from prediction arise.

The analysis is architectural rather than outcome-based.

1.2 Purpose

The purpose of this paper is to provide a structured and transparent stress-mapping of monitoring and escalation architecture.

Subsurface operations rely upon layered systems of prediction, monitoring, threshold control, and regulatory oversight. These systems can be evaluated not only in terms of outcome but also in terms of structural design. This paper undertakes the latter.

It does not seek to:

• determine whether failure will occur,
• assess environmental impact,
• assign causation,
• advocate for approval or refusal,
• or evaluate regulatory adequacy.

It examines architecture.

1.3 Rationale for Architectural Review

In live applications, decision-making relies not only on predicted behaviour but also on the capacity of governance systems to recognise and respond to deviation if it occurs.

Monitoring placement, sampling cadence, escalation thresholds, cross-domain routing, and revision clauses together define the system's detectability envelope.

Understanding that envelope provides clarity regarding:

• what behaviour is structurally observable,
• how signals transition from observation to action,
• whether cross-domain reassessment is automatic or interpretive,
• and how conceptual models would be revised if contradicted.

This analysis therefore complements technical modelling by examining how governance structure would manage unexpected system behaviour.

1.4 Analytical Discipline

The failure-mode framework applied in this paper is fixed and previously defined. It is not expanded or modified here. Activation of a failure mode denotes structural exposure within monitoring or governance design. It does not imply harm, malfunction, or regulatory failure.

All observations are evidence-bounded and confined to documentation available within the West Newton A application and associated governance materials.

1.5 Architectural Position Statement

This paper applies a previously defined monitoring-architecture failure-mode framework (FM-A-1 through FM-A-7; FM-B-1 through FM-B-3) to the West Newton A planning and regulatory artefact. The failure-mode set is fixed. It is not redefined, merged, expanded, or reinterpreted within this document. The framework is treated as analytically frozen for the purposes of comparative stress-mapping.

The purpose of this paper is diagnostic. It examines governance and monitoring architecture as structured in the application and supporting materials. It does not determine environmental outcome, regulatory breach, operator intent, or causal mechanism. Activation of a failure mode denotes structural exposure within the monitoring or governance design. It does not imply harm, non-compliance, or system malfunction.

"Failure mode activation" is used in a technical sense. It indicates that, under the stated architecture, a particular class of detectability limit, escalation dependency, interpretive constraint, or domain segmentation is structurally present. It does not assert that the condition occurred in practice, nor that it produced measurable consequence. Activation reflects architectural possibility under defined conditions, not outcome attribution.

This paper distinguishes between outcome evidence and architectural structure. The focus is on what the monitoring and governance design makes structurally observable, indirectly observable, conditionally observable, or structurally filtered. Where detectability depends upon model assumptions, threshold triggers, discretionary interpretation, or cross-domain escalation, those dependencies are documented descriptively.

The concept of a "detectability envelope" is used to describe the total domain of phenomena that the monitoring architecture is structurally capable of observing within its stated cadence, spatial distribution, threshold logic, and integration rules. The paper does not assume that phenomena outside that envelope occurred. It identifies only whether the architecture provides a defined mechanism for their recognition.

All analysis is bounded by available primary documentation and explicitly referenced evidence classes. No new failure modes are introduced or integrated. Where candidate extensions are mentioned, they are flagged as non-integrated and remain external to the locked framework.

This document does not synthesise, prioritise, rank, or reconcile activated modes. It does not convert structural exposure into normative judgement. It does not assess proportionality of policy or determine acceptability of risk. It maps architecture.

Where uncertainty is identified, it is treated as a property of system design rather than as proof of impact. The presence of bounded uncertainty does not constitute evidence of failure. It constitutes an architectural feature that may condition how observations are interpreted and escalated.

This paper therefore operates within a defined analytical boundary: it evaluates the structural properties of monitoring and governance design as presented, and the classes of detectability and escalation that logically follow from that design. It does not extend beyond that boundary.

2. Methodological Frame

2.1 Analytical Orientation

This paper applies a structured failure-mode stress-mapping framework to the West Newton A application as a governance artefact. The objective is to assess monitoring and escalation architecture.

The framework treats monitoring systems, modelling assumptions, threshold logic, and cross-domain routing rules as design components that can be examined independently of whether adverse events occurred. The analysis is therefore architectural rather than empirical-outcome based.

The question addressed is not "Will failure occur?" but rather:
What classes of detectability, escalation dependency, and interpretive constraint are structurally present within the stated governance design?

2.2 Framework Integrity

The failure-mode set (FM-A-1 through FM-A-7; FM-B-1 through FM-B-3) is fixed and previously defined. It is not modified in this paper. No renaming, merging, expansion, or reinterpretation of the modes is undertaken.

Where structural conditions are identified that resemble additional modes, these are flagged separately as candidate observations and are not incorporated into the formal matrix.

This ensures comparability across applications and prevents analytical drift.

2.3 Activation Criteria

Failure mode activation occurs when documentary evidence demonstrates that the structural condition described by a mode is:

- explicitly present in design logic,
- implicitly embedded within monitoring cadence or thresholds,
- contingent upon interpretive recognition, or
- structurally dependent on model stability or domain segmentation.

Activation does not require outcome evidence.
Activation does not imply malfunction.
Activation reflects architectural exposure under defined conditions.

Each activation is bounded by:

• its evidentiary basis,
• its detectability posture,
• the monitoring class involved (procedural, design-based, or outcome-based), and
• identifiable boundary conditions under which the mode would not apply.

2.4 Evidence Handling

Primary evidence comprises planning documentation, regulatory statements, operator submissions, monitoring descriptions, and supporting technical materials forming part of the application record.

The analysis does not infer beyond the stated architecture of those documents.
Where assumptions are made within the application, they are treated descriptively.
Where monitoring systems are described, they are assessed in terms of spatial distribution, cadence, threshold logic, and escalation triggers.

No synthesis across domains is performed unless explicitly supported by the architecture itself.

2.5 Detectability Envelope

The concept of a detectability envelope is central to this analysis.

The detectability envelope represents the domain of phenomena that the monitoring and governance system is structurally capable of observing, recognising, and escalating under its stated design.

Phenomena may fall into one of four categories:

• Structurally observable
• Indirectly observable
• Conditionally observable (dependent on thresholds or interpretation)
• Structurally filtered

This classification does not imply that filtered phenomena occurred. It identifies whether the architecture provides a defined recognition pathway.

2.6 Escalation and Propagation

Where monitoring in one domain (e.g. seismicity, groundwater, surface stability) does not automatically trigger reassessment in another domain, this is treated as a routing characteristic of the governance architecture.

The presence of segmentation does not imply oversight failure. It indicates that escalation depends upon discretionary recognition rather than automatic propagation.

2.7 Treatment of Uncertainty

Uncertainty is treated as a structural property of system design.

Where models rely upon assumptions regarding fault behaviour, permeability distribution, detectability thresholds, or temporal response, these are documented without adjudicating their accuracy.

The analysis distinguishes between:

• bounded uncertainty (acknowledged within the architecture), and
• unbounded uncertainty (not structurally constrained within the monitoring design).

The presence of uncertainty does not imply inadequacy. It conditions interpretive robustness.

2.8 Analytical Limits

This paper does not:

• attribute causation,
• assess proportionality of policy,
• determine acceptability of risk,
• infer environmental impact,
• evaluate regulatory competence, or
• reconcile activated modes into a unified judgement.

It maps structure.

Subsequent sections apply this methodological frame to the West Newton A application as presented.

Section 3 – The West Newton A Application as Governance Artefact

3.1 Analytical Framing

West Newton A is treated in this paper as a governance artefact rather than an operational site history. The focus is on the structure of the application as submitted: its monitoring design, modelling assumptions, escalation mechanisms, and domain segmentation.

Because the application is live, the analysis is prospective rather than retrospective. The relevant question is not whether failure will occur, but whether the governance architecture, as structured, defines and bounds the classes of system behaviour it may encounter.

3.2 Design Assurance Layers

The application presents multiple assurance layers, typically including:

• subsurface modelling and structural interpretation,
• well integrity design and verification,
• operational monitoring (e.g. seismic, pressure, fluid volumes),
• environmental monitoring (e.g. groundwater, surface water, emissions),
• threshold-based operational controls, and
• regulatory oversight and reporting mechanisms.

Each layer is described as contributing to risk management through prediction, detection, or control. This paper does not evaluate the sufficiency of any layer in isolation. Instead, it examines how the layers interact structurally.

3.3 Monitoring Architecture

Monitoring within the application is structured around defined parameters, spatial distributions, and temporal cadences.

Key characteristics include:

- the spatial placement of sensors or sampling points,
- the frequency of data acquisition or reporting,
- the thresholds triggering operational response,
- the extent to which monitoring is confirmatory versus hypothesis-testing,
- the routing of data between operational and regulatory domains.

Where monitoring is designed primarily to validate predicted behaviour, the detectability envelope is shaped by those predictions. Where monitoring includes mechanisms to detect deviation from baseline or unexpected pathways, the envelope may be broader.

This section does not adjudicate which posture is preferable. It documents the structural characteristics as presented.

3.4 Threshold and Escalation Logic

The application typically defines thresholds (e.g. seismic magnitude limits, pressure parameters, chemical concentrations) that trigger staged responses.

Threshold systems perform two functions:

- operational control (e.g. pause, reduce rate, modify injection),
- regulatory notification or review.

The structural question addressed in this paper is:

Are escalation pathways automatic across domains, or do they depend upon discretionary interpretation?

For example, does exceedance in one monitoring domain trigger reassessment in adjacent domains, or is escalation compartmentalised?

This is not an evaluation of competence. It is a mapping of routing logic.

3.5 Domain Segmentation

Applications of this type frequently treat subsurface geomechanics, hydrogeology, surface water, and structural stability as analytically distinct domains.

Segmentation allows technical clarity but may condition how signals propagate. Where remits are compartmentalised, cross-domain reassessment may depend upon interpretive recognition rather than predefined triggers.

The presence of segmentation does not imply vulnerability. It defines structural propagation rules.

3.6 Model Stability and Review Clauses

Planning-stage conceptual models underpin operational design and monitoring placement. These models define:

• expected fracture geometry or subsurface behaviour,
• assumed fault isolation or connectivity,
• anticipated hydraulic separation between domains.

The application may contain review clauses, adaptive provisions, or contingency mechanisms.

This paper assesses whether such mechanisms are:

• automatically triggered by defined conditions, or
• dependent upon interpretive reassessment by operators or regulators.

3.7 Governance Posture

Taken as a whole, the application presents a governance posture that may be characterised structurally as:

• threshold-dominant,
• model-confirmatory,
• review-dependent,
• or adaptive by design.

These terms are descriptive, not evaluative. They describe how the architecture appears structured to handle deviation from prediction.

Subsequent sections apply the failure-mode framework to these structural characteristics.

Section 4 – Detectability and Escalation Architecture

4.1 Spatial Detectability Structures

4.1.1 Structural Orientation

Spatial detectability refers to the geographic distribution and placement of monitoring instruments, sampling locations, and observational controls relative to the domains of potential system behaviour described within the application.

The West Newton A application presents monitoring systems distributed across defined domains, typically including:

• subsurface seismic monitoring arrays,
• pressure and operational monitoring within the well-bore,
• groundwater monitoring boreholes,
• surface water sampling locations where applicable,
• and site-level environmental monitoring points.

Each of these systems defines a spatial envelope within which phenomena are directly observable.

4.1.2 Pathway Definition and Sensor Placement

Monitoring placement is typically informed by conceptual models of expected subsurface geometry and hydraulic behaviour. Where models assume:

• contained fracture propagation,
• defined separation between operational depth and shallow aquifers,
• limited fault connectivity,
• or predictable stress fields,

sensor placement will be optimised to observe behaviour within those predicted domains.

In such cases, monitoring design is structurally pathway-bound: it detects what it is designed to spatially intersect.

This is not a critique. It reflects standard engineering logic.

The structural question is therefore whether the application defines monitoring in a manner that:

• tests model boundaries, or
• assumes model stability and places sensors accordingly.

4.1.3 Lateral and Vertical Coverage

Spatial detectability has both horizontal and vertical dimensions.

Horizontally, monitoring density and distribution determine whether phenomena occurring outside predicted lateral extents would be observed.

Vertically, separation between operational horizons and protected groundwater units is typically inferred through stratigraphic modelling and well integrity design. Monitoring may therefore focus on:

• well integrity confirmation,
• pressure containment within defined intervals,
• and compliance-based groundwater sampling at selected boreholes.

If groundwater monitoring points are limited in number and positioned according to assumed hydraulic separation, detectability is strongest where assumptions hold and weaker where lateral heterogeneity or unexpected connectivity exists.

Again, this reflects structural design rather than demonstrated deficiency.

4.1.4 Boundary Sensitivity

Where faults or structural discontinuities are acknowledged within the application, their treatment influences spatial detectability.

If faults are treated as:

- sealed,
- hydraulically isolated,
- or non-conductive under anticipated stress conditions,

then monitoring may not be spatially extended to test fault-mediated connectivity beyond predicted zones.

Where faults are considered potentially transmissive, monitoring density and placement may expand accordingly.

The application's spatial architecture therefore defines whether fault-bounded or fault-extended behaviour would fall inside or outside the detectability envelope.

4.1.5 Structural Filtering

A phenomenon may be:

- directly observable if it occurs within sensor range,
- indirectly inferable through pressure or seismic response,
- or structurally filtered if it occurs outside the spatial monitoring geometry.

The presence of filtering does not imply that filtered phenomena will occur. It identifies that recognition would depend upon secondary signals or model reassessment rather than direct detection.

4.1.6 Prospective Framing

Because the application is live, this section assesses structural exposure rather than historical omission.

The question is:

If system behaviour were to deviate laterally or vertically from predicted extents, does the current spatial monitoring architecture provide a defined mechanism for recognition?

4.1.7 Failure Modes Structurally Engaged

Within this theme, the following failure modes are structurally engaged where pathway-bound placement and domain segmentation are present:

FM-A-1 – Spatial Detectability Constraint (Spatial_Blind_Spot)
FM-A-4 – Cross-domain non-propagation of significance
FM-B-3 - Resolution Compression Under Bounded Uncertainty

Activation reflects architectural exposure, not outcome.

Section 4.2 – Temporal and Cadence Constraints

4.2.1 Structural Orientation

Temporal detectability refers to the relationship between monitoring frequency, reporting intervals, and the timescales on which system behaviour may evolve.

The West Newton A application defines monitoring cadence across several domains, typically including:

- real-time operational data (e.g. injection rate, pressure, seismic monitoring where applicable),
- periodic groundwater sampling,
- scheduled environmental surveys,
- and threshold-triggered reporting requirements.

Each of these operates on a defined temporal interval. That interval forms part of the detectability envelope.

4.2.2 Continuous vs Periodic Monitoring

Certain parameters are monitored continuously during active operations (e.g. well pressure, seismic magnitude within Traffic Light frameworks). These systems are structurally capable of identifying exceedances within minutes or seconds.

Other domains – particularly groundwater chemistry and environmental sampling – are typically monitored at defined intervals (e.g. quarterly, monthly, or event-based).

Where monitoring is periodic, signals that arise and dissipate between intervals may not be directly recorded. Detection would depend on:

- persistence of the signal beyond the sampling interval,
- secondary indicators, or
- discretionary reassessment triggered by other domains.

This does not imply that transient signals will occur. It describes the structural condition under which recognition would be interval-dependent.

4.2.3 Between-Interval Invisibility

In systems governed by scheduled sampling, there exists a structural window during which:

- short-lived deviations,
- transient hydraulic responses,
- or time-limited chemical fluctuations

may not be directly captured.

This condition is inherent to periodic monitoring architecture.

FM-A-2 – Temporal Resolution Constraint (Temporal_Blind_Spot)

The relevant prospective question is whether the cadence aligns with the shortest plausible timescale of system response as defined by the conceptual model.

4.2.4 Operational Pause and Post-Event Windows

Threshold-based systems typically include pause conditions (e.g. injection halt upon seismic exceedance) followed by defined monitoring windows.

Where post-event monitoring duration is fixed, recognition of delayed responses depends upon:

- the sufficiency of that window relative to subsurface diffusion timescales,
- and the assumption that delayed behaviour will manifest within defined monitoring intervals.

If system response times exceed pause or review windows, escalation may depend upon subsequent scheduled review rather than immediate detection.

Again, this is structural description, not outcome inference.

4.2.5 Adaptive Monitoring Lag

Where monitoring networks are densified or expanded in response to observed behaviour, early operational phases may have structurally lower detectability than later phases.

This condition reflects adaptive monitoring logic rather than failure. However, it defines a temporal asymmetry:

- early-phase detectability may be narrower,
- later-phase detectability broader following revision or expansion.

For a live application, this raises a prospective architectural question:

Does the monitoring framework incorporate predefined adaptive triggers, or does densification depend upon discretionary interpretation after observation?

4.2.6 Persistence Thresholds and Escalation Timing

Escalation often depends not only on magnitude but on persistence or recurrence. For example:

- repeated threshold exceedance,
- sustained deviation from baseline,
- or cumulative pattern recognition.

Where escalation requires persistence, single short-duration anomalies may not trigger formal reassessment.

This is a design choice. It influences whether distributed low-magnitude signals are recognised as system behaviour or treated as isolated noise.

4.2.7 Prospective Framing

The live status of the application shifts the analytical emphasis from “was something missed?” to:

If system behaviour were to manifest over shorter timescales than defined monitoring intervals, does the architecture provide a defined pathway for recognition?

The answer depends upon cadence alignment, persistence criteria, and adaptive triggers.

4.2.8 Failure Modes Structurally Engaged

Within this theme, the following failure modes are structurally engaged where periodic monitoring, persistence thresholds, or adaptive lag are present:

FM-A-2 – Between-interval invisibility
FM-A-3 – Threshold-safe drift (where distributed signals remain below escalation triggers)
FM-B-2 - Adaptive monitoring lag
FM-B-3 - Uncertainty compression (where temporal bounds are assumed within modelling constraints)

Activation reflects architectural exposure, not projected outcome.

Section 4.3 – Threshold and Escalation Logic

4.3.1 Structural Orientation

Threshold systems define the conditions under which monitoring signals transition from observation to action. Within the West Newton A application, thresholds typically govern:

• seismic magnitude limits (where applicable),
• injection pressure or operational parameters,
• environmental concentration limits,
• regulatory notification triggers,
• and pause or review requirements.

These thresholds convert continuous variability into discrete escalation events.

4.3.2 Threshold-Dominant Architecture

In threshold-based governance systems, escalation is structurally contingent upon exceedance.

Below threshold, behaviour is treated as operationally tolerable or compliant.
At or above threshold, defined actions are triggered.

This binary structure provides clarity and operational certainty. It also defines a detectability-tolerability interface:

• detectability refers to whether a signal is measured;
• tolerability refers to whether that signal crosses the predefined escalation boundary.

Where thresholds are set conservatively, escalation may occur early.
Where thresholds are set near anticipated operational bounds, escalation may occur only at more pronounced deviations.

This paper does not assess proportionality of threshold setting. It examines structural implications.

4.3.3 – Distributed Sub-Threshold Signals

A system may exhibit distributed signals that individually remain below escalation triggers but collectively represent deviation from predicted behaviour.

In threshold-dominant systems, recognition of distributed sub-threshold behaviour depends upon:

• pattern recognition outside formal triggers,
• discretionary review,
• cumulative criteria explicitly defined in the application, or
• interpretive synthesis across monitoring domains.

Where escalation logic is strictly instrument-bound and magnitude-defined, distributed low-amplitude signals – whether arising within instrumented networks or through other observational channels – may remain operationally invisible in structural terms.

This condition does not imply that such signals will occur. It identifies the structural relationship between magnitude, admissibility, and action.

In architectures where escalation is contingent upon predefined numeric or persistence criteria, signals that fall outside instrumented pathways or below escalation thresholds may be recorded administratively without entering the formal escalation hierarchy. Recognition of such signals therefore depends upon interpretive integration rather than automatic routing.

This exposure represents a composite interaction of pathway-bound observability, cadence limitation, and interpretive dependency within escalation logic.

4.3.4 Escalation Routing

Threshold exceedance may trigger:

• operational pause or modification,
• internal technical review,
• regulatory notification,
• or independent oversight assessment.

The architecture determines whether escalation remains within a single domain or propagates across domains.

For example:

• Does a seismic exceedance trigger hydrogeological reassessment?
• Does pressure anomaly prompt groundwater sampling revision?
• Are cross-domain reviews automatic or discretionary?

The application's routing logic defines whether significance propagates structurally or depends upon interpretive judgement.

4.3.5 Persistence and Re-Entry Conditions

Threshold systems often define not only exceedance conditions but also re-entry criteria:

• duration of monitoring pause,
• criteria for restart,
• acceptable post-event signal decay.

If re-entry conditions assume bounded system response within defined windows, delayed or cumulative effects may not structurally trigger re-evaluation unless explicitly incorporated.

This again reflects design logic rather than demonstrated inadequacy.

4.3.6 Detectability-Tolerability Interface

The detectability-tolerability interface arises where:

• signals are measurable,
• but escalation is conditional on predefined magnitude or persistence thresholds.

A system may therefore detect behaviour that is formally classified as acceptable.

The structural question is whether the application explicitly couples detectability limits with acceptability logic. Where detection capability exceeds threshold sensitivity, the architecture may recognise more than it is required to act upon.

Conversely, where detection capability is limited relative to threshold logic, the tolerability classification may operate within a partially defined detectability envelope.

4.3.7 Prospective Framing

For a live application, the relevant question is:

If deviation from predicted behaviour were to manifest in distributed, sub-threshold, or cross-domain form, does the threshold architecture provide a defined mechanism for recognition and escalation?

The answer depends upon whether escalation relies solely on numeric exceedance or incorporates pattern-based reassessment.

4.3.8 Failure Modes Structurally Engaged

Within this theme, the following failure modes are structurally engaged where threshold-dominant and domain-segmented logic is present:

FM-A-3 – Threshold-safe drift
FM-A-4 – Cross-domain non-propagation of significance
FM-A-7 - Detectability-tolerability decoupling
FM-B-3 - Uncertainty compression (where thresholds operationalise bounded uncertainty as precision)

In addition, distributed sub-threshold behaviour – including signals arising outside instrumented detection pathways – may manifest as a composite interaction of:

FM-A-1 – Pathway-bound observability failure
FM-A-2 – Between-interval invisibility

This composite manifestation does not constitute a new failure mode. It reflects layered interaction at the observational interface between detectability limits and discretionary escalation logic.

Activation denotes structural exposure, not projected outcome.

In stress-mapping terms, the question is not the validity of such signals, but their procedural status within escalation design.

Where escalation is strictly threshold-triggered and instrument-bound:

• Non-instrumented anomaly signals may be logged without structural escalation.
• Observations may be processed administratively rather than diagnostically.
• Cross-domain review may not be automatically initiated.
• Conceptual model reassessment may not be triggered absent quantitative exceedance.

This produces a structurally identifiable interface condition:

A circumstance in which signals are present within the monitored environment but are not eligible for automatic integration into the escalation hierarchy.

Under low-stress conditions, such separation may be inconsequential. Under elevated stress conditions – particularly where early perturbations fall below calibrated thresholds - distributed anomaly signals may function as weak indicators of deviation while remaining outside formal review mechanisms.

This composite exposure is characterised by:

• Admissibility asymmetry (instrumented vs non-instrumented signals),
• Escalation dependency on quantitative exceedance,
• Absence of defined protocols for model reassessment triggered by qualitative anomaly clustering,
• Discretionary rather than mandatory cross-domain consultation.

The stress-mapping implication is not that distributed signals are determinative, but that the architecture's capacity to interrogate uncertainty may be bounded by its admissibility rules.

In systems where conceptual models are assumed stable until threshold exceedance, distributed anomaly signals remain supplementary rather than structurally catalytic.

Section 4.4 – Domain Segmentation and Cross-Domain Routing

4.4.1 Structural Orientation

Complex subsurface operations are typically assessed across multiple technical domains, including:

• geomechanics and induced seismicity,
• hydrogeology and groundwater protection,
• well integrity engineering,
• surface water and drainage behaviour,
• environmental emissions and compliance.

Each domain is governed by its own monitoring framework, technical standards, reporting structures, and regulatory remit.

Domain segmentation provides clarity and technical depth. It also defines how signals propagate between domains.

4.4.2 Parallel Oversight Structures

In segmented governance architectures, each domain may operate under:

• distinct regulatory bodies or sub-units,
• different threshold criteria,
• separate reporting chains,
• and independent review cycles.

Under such arrangements, signals arising in one domain do not automatically trigger reassessment in another unless a defined routing rule exists.

For example:

• Seismic exceedance may trigger operational pause without automatically triggering hydrogeological model reassessment.
• Groundwater anomaly may prompt sampling review without necessarily prompting structural geomechanical re-evaluation.

The architecture determines whether routing is predefined or discretionary.

4.4.3 Triggered vs Interpretive Propagation

Cross-domain propagation may occur in two principal ways:

1. Triggered propagation – where formal rules require reassessment in adjacent domains upon defined events.
2. Interpretive propagation – where technical judgement determines whether a signal in one domain is relevant to another.

Triggered propagation produces automatic structural coupling.
Interpretive propagation depends upon professional recognition.

Neither is inherently superior. Each reflects governance design choice.

The architectural question is whether the application defines explicit cross-domain triggers or relies upon interpretive linkage.

4.4.4 Compartmentalised Assurance

Applications frequently describe each assurance layer as independently robust. While this may strengthen domain-specific confidence, it may also create a condition in which:

• each domain validates itself within its own assumptions,
• without formal requirement to re-test adjacent assumptions.

This does not imply oversight deficiency. It describes a structural characteristic of compartmentalised governance.

Where conceptual models assume separation (e.g. mechanical isolation from hydrogeological systems), cross-domain reassessment may not be automatically embedded.

4.4.5 Cumulative Pattern Recognition

System-level behaviour may emerge across domains at low amplitude:

• minor seismicity,
• small pressure variations,
• marginal chemical changes,
• subtle surface responses.

If each domain evaluates signals independently against its own thresholds, cumulative pattern recognition depends upon integrative review mechanisms.

The structural question is whether integrative review is:

• formally embedded within the architecture,
• periodically scheduled,
• triggered by defined cross-domain criteria,
• or discretionary.

4.4.6 Prospective Framing

For a live application, the relevant question becomes:

If deviation from predicted behaviour were to manifest as low-magnitude signals across multiple domains, does the governance architecture structurally integrate those signals, or would recognition depend upon interpretive synthesis?

The answer defines the extent to which the system is integrated versus parallel.

4.4.7 Failure Modes Structurally Engaged

Within this theme, the following failure modes are structurally engaged where segmentation and interpretive routing are present:

FM-A-4 – Cross-domain non-propagation of significance
FM-A-5 – Assumption-locked interpretation (where cross-domain revision depends on model stability)
FM-A-6 - Audit-completeness illusion (where procedural compliance within domains may mask integrative gaps)
FM-B-3 - Uncertainty compression (where bounded uncertainty is operationalised within domain silos)

Activation reflects architectural exposure, not evidence of segmentation malfunction.

Section 4.5 – Model Stability and Revision Pathways

4.5.1 Structural Orientation

Monitoring architecture is not independent of conceptual modelling. Sensor placement, threshold selection, and escalation routing are all informed by prior assumptions regarding:

- subsurface stratigraphy,
- fault geometry and behaviour,
- hydraulic separation between operational depth and protected aquifers,
- stress field orientation and fracture propagation limits,
- and expected system response times.

These assumptions form the conceptual model underpinning the application.

The structural question addressed in this section is not whether those assumptions are correct. It is how the architecture handles potential contradiction or refinement of them.

4.5.2 Model-Confirmatory Monitoring

Where monitoring systems are primarily designed to validate predicted behaviour, the architecture may be described as model-confirmatory.

In such systems:

- sensors are placed where behaviour is expected,
- thresholds are calibrated to predicted magnitudes,
- and deviation is defined relative to model outputs.

This is standard engineering practice.

However, model-confirmatory systems differ structurally from model-testing systems.

Model-testing systems intentionally place instrumentation or review triggers at conceptual boundaries in order to detect unexpected pathways.

The application may include elements of both. This section identifies which posture predominates.

4.5.3 Assumption Locking

Assumption locking occurs structurally where:

- monitoring design presumes model stability, and
- model revision depends upon discretionary interpretation rather than predefined triggers.

In such cases, conceptual reassessment is reactive rather than structurally embedded.

This does not imply that revision would not occur. It identifies whether the architecture defines explicit revision pathways.

4.5.4 Boundary Testing Mechanisms

A model may be challenged by:

• exceedance of predicted spatial extent,
• unexpected fault activation patterns,
• anomalous hydraulic responses,
• distributed sub-threshold behaviour inconsistent with predicted geometry.

The structural question is:

Are such boundary conditions explicitly defined as triggers for conceptual review within the application?

Where boundary testing is predefined, the system is structurally adaptive.
Where boundary testing depends upon interpretive judgement, adaptation remains possible but is not automatic.

4.5.5 Revision Clauses and Escalation Hierarchy

Applications may contain clauses allowing for:

• review of monitoring networks,
• densification of sensors,
• modification of injection protocols,
• updated modelling submissions.

The presence of such clauses demonstrates capacity for adaptation.

The architectural distinction lies in whether these mechanisms are:

• triggered by predefined objective criteria, or
• initiated through professional interpretation after observation.

The former embeds revision structurally.
The latter preserves flexibility but relies on recognition.

4.5.6 Prospective Framing

Because the application is live, this section evaluates preparedness for deviation rather than documented contradiction.

The relevant question is:

If behaviour were to extend beyond predicted model bounds, does the architecture provide a defined, objective pathway for conceptual reassessment?

4.5.7 Failure Modes Structurally Engaged

Within this theme, the following failure modes are structurally engaged where model-confirmatory posture and discretionary revision are present:

FM-A-5 – Assumption-locked interpretation
FM-A-1 – Pathway-bound observability (where sensor placement reflects predicted geometry)
FM-A-6 - Audit-completeness illusion (where internal consistency may reinforce model stability)
FM-B-3 - Uncertainty compression (where bounded uncertainty is operationalised as definitional precision)

Activation reflects architectural exposure, not prediction of contradiction.

Section 4.6 – Review Clauses and Discretionary Escalation

4.6.1 Structural Orientation

Governance architectures typically contain provisions for reassessment, modification, or pause in response to emerging information. These provisions function as adaptive safeguards – the structural equivalent of "Plan B."

Within the West Newton A application, such provisions may include:

• operational pause mechanisms,
• monitoring network review clauses,
• regulatory reporting triggers,
• technical review panels or independent oversight provisions,
• submission of revised models or mitigation plans.

The structural question is not whether these mechanisms exist. It is how they are activated.

4.6.2 Automatic vs Discretionary Review

Review pathways may be triggered in two principal ways:

1. Automatic activation – where predefined numeric thresholds or objective criteria compel reassessment.
2. Discretionary activation – where technical judgement determines whether observed behaviour warrants revision.

Automatic review produces structural predictability.
Discretionary review preserves flexibility and contextual judgement.

Both are legitimate governance designs. The distinction lies in escalation dependency.

4.6.3 Defined Contingency Conditions

Applications may define contingency scenarios, such as:

• exceedance of seismic magnitude thresholds,
• sustained operational anomalies,
• environmental concentration exceedance,
• equipment malfunction or integrity concern.

Where contingency conditions are clearly specified, the pathway from signal to review is formalised.

However, if the defined contingencies correspond primarily to threshold exceedance, then distributed or ambiguous behaviour may not automatically trigger revision unless classified as anomalous through interpretation.

4.6.4 Escalation Hierarchy

Escalation pathways may follow a tiered structure:

- operator-level review,
- regulator notification,
- independent technical assessment,
- potential modification of consent conditions.

The architecture determines whether each tier is sequentially mandatory or conditionally invoked.

If escalation beyond operator-level review depends upon interpretation rather than defined cross-domain triggers, higher-tier reassessment becomes discretionary.

4.6.5 Adaptive Capacity

The presence of review clauses demonstrates adaptive capacity.

The structural distinction lies in whether:

- adaptation is embedded as a rule-based response to defined boundary conditions, or
- adaptation relies upon professional recognition of deviation from expectation.

The latter does not imply deficiency. It reflects reliance on expert judgement as a stabilising mechanism.

4.6.6 Prospective Framing

For a live application, the relevant architectural question is:

If system behaviour were to deviate in a manner not anticipated by predefined contingencies, would review be structurally compelled, or would it depend upon discretionary interpretation?

The answer defines how robust “Plan B” is under non-standard deviation.

4.6.7 Failure Modes Structurally Engaged

Within this theme, the following failure modes are structurally engaged where review relies upon discretionary escalation:

FM-A-5 – Assumption-locked interpretation
FM-A-4 – Cross-domain non-propagation of significance
FM-A-6 - Audit-completeness illusion (where procedural sufficiency may mask interpretive dependency)
FM-B-2 - Adaptive monitoring lag

Activation reflects structural reliance on interpretive recognition, not evidence of review failure.

Section 4.7 – Detectability-Tolerability Interface

4.7.1 Structural Orientation

Monitoring architecture does not merely determine what can be observed. It also determines how observed signals are classified within governance logic.

The detectability-tolerability interface describes the relationship between:

• what the system is capable of measuring, and
• what the system is required to act upon.

These two domains are not identical.

4.7.2 Detection Without Escalation

A monitoring system may detect variability that remains below defined escalation thresholds.

In such cases:

• the signal is observable,
• the signal is recorded,
• but the signal is classified as operationally acceptable.

This is inherent to threshold-based governance design. Detection does not automatically imply intervention.

The architectural question is not whether tolerability is correctly defined. It is whether detectability limits are explicitly coupled to tolerability logic.

4.7.3 Defined Acceptability

Acceptability may be defined through:

• numeric thresholds,
• regulatory standards,
• baseline deviation criteria,
• or persistence conditions.

Where tolerability is defined numerically, the architecture produces clarity. However, if detection capability is coarser than tolerability thresholds, signals may fall into an interpretive margin.

Conversely, if detection capability exceeds escalation sensitivity, the system may record behaviour that is structurally deemed acceptable without review.

The relationship between detection precision and escalation criteria defines the tightness of the interface.

4.7.4 Sub-Threshold Persistence

Distributed, low-magnitude, or slowly evolving signals may remain within tolerable bounds while cumulatively altering system conditions.

If tolerability logic evaluates signals independently rather than cumulatively, such behaviour may not trigger escalation.

This does not imply that cumulative deviation will occur. It identifies the structural condition under which recognition depends upon pattern synthesis rather than threshold exceedance.

4.7.5 Tolerability Assumptions and Model Coupling

Tolerability thresholds are typically derived from conceptual modelling, historical precedent, or regulatory policy.

Where tolerability limits assume bounded system response within defined envelopes, the architecture implicitly couples detectability to model stability.

If deviation remains within the numeric tolerability window but extends conceptually beyond predicted geometry or interaction pathways, recognition depends upon interpretive reassessment rather than numeric trigger.

4.7.6 Prospective Framing

For a live application, the relevant architectural question is:

If system behaviour were to remain detectable yet within predefined tolerability limits, does the governance framework provide a defined mechanism for cumulative reassessment?

Where cumulative reassessment is predefined, the interface is structurally integrated.
Where reassessment depends upon discretionary recognition, the interface is interpretive.

4.7.7 Failure Modes Structurally Engaged

Within this theme, the following failure modes are structurally engaged where detectability and tolerability are partially decoupled:

FM-A-7 – Detectability-tolerability decoupling
FM-A-3 – Threshold-safe drift
FM-A-6 - Audit-completeness illusion
FM-B-3 - Uncertainty compression

Activation reflects architectural exposure, not prediction of unacceptable behaviour.

Section 5 – Detectability Envelope of West Newton A

5.1 Purpose of Consolidation

This section consolidates the structural observations identified in Section 4 into a defined detectability envelope for West Newton A.

The detectability envelope describes the domain of system behaviour the monitoring and governance architecture is structurally capable of:

- observing,
- classifying,
- escalating, and
- revising.

This section does not synthesise outcomes or rank activated failure modes. It consolidates structural characteristics.

5.2 Structurally Observable Domains

The architecture provides defined mechanisms for observing:

- operational parameters within the well bore and injection system,
- seismic magnitude within defined detection sensitivity and threshold frameworks,
- groundwater chemistry at specified monitoring locations and intervals,
- environmental compliance parameters within scheduled sampling regimes.

Within predicted spatial extents and defined temporal cadence, behaviour inside these domains is structurally observable.

Where thresholds are clearly defined, escalation within those domains is procedurally specified.

5.3 Indirectly Observable Behaviour

Certain classes of system behaviour may not be directly measured but may be indirectly inferred through secondary indicators, including:

- pressure response patterns,
- seismic clustering or spatial migration trends,
- deviation from established baselines.

Recognition of indirectly observable behaviour depends upon interpretive synthesis rather than single-parameter exceedance.

The architecture allows such recognition but does not compel it absent threshold triggers.

5.4 Conditionally Observable Behaviour

Some behaviours are conditionally observable – meaning detection depends upon alignment between monitoring cadence, spatial placement, and the timescale or geometry of deviation.

Examples include:

- transient sub-threshold seismicity,
- short-duration hydraulic anomalies between sampling intervals,
- distributed low-amplitude changes across domains.

Where such behaviour does not intersect these parameters, escalation relies upon the interpretive mechanisms described in Section 4.

Conditional observability is inherent to periodic and pathway-bound monitoring systems.

5.5 Structurally Filtered Behaviour

Behaviour occurring:

- outside predicted spatial geometry,
- between sampling intervals,
- below numeric escalation thresholds,
- or across segmented domains without predefined cross-domain triggers

may fall partially or fully outside the defined detectability envelope.

Structural filtering does not imply that such behaviour will occur. It indicates that recognition would depend upon intersection with existing monitoring placement, cadence, and threshold design.

Where such behaviour does not intersect these parameters, escalation would rely upon the same interpretive and discretionary mechanisms described in Section 4.

5.6 Escalation Dependency

Within the architecture, escalation may be:

- automatic within domain upon threshold exceedance,
- conditional upon persistence criteria,
- or discretionary where cross-domain propagation is interpretive.

The detectability envelope therefore contains zones of:

- mandatory escalation,
- discretionary reassessment,
- and observational tolerance.

The distribution of these zones defines governance posture.

5.7 Adaptive Capacity

The application contains review and modification mechanisms that allow for:

- densification of monitoring networks,
- operational modification,
- model revision,
- regulatory review.

Adaptive capacity exists structurally.

The degree to which adaptation is automatically triggered versus interpretively initiated defines responsiveness to deviation.

5.8 Envelope Characterisation

Taken together, the detectability envelope of West Newton A is characterised as:

• spatially defined by predicted geometry and monitoring placement,
• temporally defined by a combination of continuous and periodic cadence,
• threshold-dominant in escalation logic,
• segmented across technical domains with interpretive routing,
• adaptive but partially dependent on discretionary recognition for cross-domain synthesis.

These descriptors are architectural, not evaluative.

5.9 Analytical Boundary

This consolidation does not determine whether behaviour falls within or outside the envelope.

It defines only what the architecture is structured to recognise, escalate, and revise under its current design.

Section 6 – Cross-Domain Routing and Escalation Architecture

6.1 Structural Orientation

Section 4 identified the presence of domain segmentation and threshold-based escalation within individual monitoring categories. Section 5 consolidated the detectability envelope.

This section examines how signals move across domains once detected – that is, whether escalation architecture operates as:

• integrated and automatically propagating, or
• segmented and interpretively routed.

The focus remains structural.

6.2 Domain-Level Escalation

Within-domain escalation is typically governed by predefined thresholds. For example:

• seismic magnitude exceedance triggers pause or modification,
• chemical concentration exceedance triggers regulatory reporting,
• operational pressure exceedance triggers system adjustment.

These pathways are generally formalised and procedural.

Within-domain routing is therefore structurally predictable.

6.3 Cross-Domain Escalation

Cross-domain escalation concerns whether an event in one domain compels reassessment in another.

Examples include:

• Does seismic exceedance require hydrogeological model reassessment?
• Does repeated low-magnitude seismic clustering prompt review of fault connectivity assumptions?
• Does operational anomaly trigger revision of groundwater sampling placement or cadence?

The architecture may specify explicit cross-domain triggers, or it may rely on technical interpretation to determine relevance.

Where cross-domain triggers are explicitly defined, propagation is automatic.
Where triggers are not defined, propagation depends on recognition.

6.4 Integrative Review Mechanisms

Applications may include integrative oversight mechanisms such as:

• periodic multidisciplinary review meetings,
• independent technical panels,
• structured reporting cycles incorporating multiple domains.

The presence of such mechanisms increases the probability of cross-domain synthesis.

The structural distinction lies in whether these mechanisms are:

• scheduled irrespective of threshold exceedance, or
• invoked conditionally following discrete events.

Scheduled integrative review embeds cross-domain synthesis structurally.
Conditional review remains event-driven.

6.5 Escalation Hierarchy

Escalation may occur across multiple tiers:

• operational response,
• operator-level technical review,
• regulator notification,
• independent oversight.

The routing architecture determines whether higher tiers are:

• automatically engaged upon defined criteria, or
• engaged following interpretive recommendation from lower tiers.

Tiered systems can be robust. They can also centralise interpretive discretion at early stages.

This section does not evaluate which approach is preferable. It documents structural routing characteristics.

6.6 Prospective Framing

For a live application, the relevant question becomes:

If deviation were to manifest across domains at low magnitude or sub-threshold level, does the escalation architecture compel cross-domain reassessment, or would synthesis depend upon discretionary judgement?

The answer defines the structural integration of the system.

6.7 Structural Characteristics Observed

Based on the architecture described in preceding sections, the West Newton A application exhibits:

• formalised within-domain escalation pathways,
• threshold-dominant routing within individual monitoring categories,
• review clauses permitting cross-domain reassessment,
• cross-domain propagation that is at least partially interpretive rather than fully automatic.

These are descriptive characteristics of governance design.

6.8 Failure Modes Structurally Engaged

Within this cross-domain routing architecture, the following failure modes are structurally engaged where interpretive propagation is present:

FM-A-4 – Cross-domain non-propagation of significance
FM-A-5 – Assumption-locked interpretation
FM-A-6 - Audit-completeness illusion
FM-B-2 - Adaptive monitoring lag

Activation reflects architectural dependency on interpretive synthesis rather than predefined cross-domain triggers.

Section 7 – Governance Posture Observed

7.1 Purpose of Characterisation

Having mapped spatial detectability, temporal cadence, threshold logic, domain segmentation, model stability, review clauses, and cross-domain routing, this section characterises the overall governance posture of the West Newton A application.

This characterisation is structural rather than evaluative. It does not determine adequacy or insufficiency. It describes how the architecture appears configured to manage deviation from prediction.

7.2 Threshold-Dominant Structure

The application exhibits a threshold-dominant structure within key operational and environmental domains.

Escalation pathways are clearly defined for:

• numeric exceedance events,
• parameter-specific limits,
• operational pause conditions.

This produces clarity in governance response to discrete and measurable deviations.

Threshold dominance implies that behaviour below defined triggers remains operationally tolerable unless persistence or cumulative criteria are defined.

7.3 Model-Confirmatory Orientation

Monitoring placement and escalation logic appear aligned with planning-stage conceptual models.

Sensors, sampling points, and thresholds are structured around predicted geometry and bounded system behaviour.

This reflects a model-confirmatory orientation, where monitoring validates predicted stability rather than actively stress-testing boundary assumptions.

Such posture is common in regulated subsurface operations.

7.4 Review-Dependent Adaptivity

The architecture includes adaptive capacity through review clauses and discretionary escalation pathways.

However, cross-domain synthesis and conceptual reassessment appear at least partially review-dependent rather than fully trigger-based.

Adaptation is therefore available, but in some instances contingent upon recognition rather than automatically compelled.

7.5 Segmented Technical Domains

Governance is organised across segmented technical domains, each with defined monitoring parameters and escalation logic.

Segmentation allows technical clarity and accountability. It also means that integration depends on routing rules or interpretive synthesis.

FM-A-4 – Cross-Domain Non-Propagation

The architecture does not appear fully integrated through automatic cross-domain propagation triggers.

7.6 Detectability-Tolerability Coupling

The system demonstrates structured detectability within defined parameters.

Tolerability is largely threshold-bound.

Where distributed or cumulative deviation does not cross numeric triggers, reassessment appears interpretive rather than mandatory.

This is a design feature of threshold-dominant systems rather than an identified deficiency.

FM-A-7 – Detectability-Tolerability Decoupling

Escalation eligibility is defined not only by signal magnitude, but by the admissibility pathways through which signals enter formal review structures.

7.7 Prospective Stability

Because the application is live, the relevant framing is prospective.

The governance posture observed suggests that:

- clear response mechanisms exist for defined exceedance events,
- adaptive capacity is present,
- cross-domain integration may depend on interpretive recognition in certain scenarios,
- model stability is assumed unless contradicted by threshold-defined deviation.

These characteristics define how the system would respond if deviation were to occur.

7.8 Analytical Boundary

This characterisation does not rank posture as strong or weak. It does not assert vulnerability.

It describes the structural configuration through which signals would be:

- detected,
- classified,
- escalated,
- and potentially integrated.

Subsequent sections reaffirm evidentiary limits and boundary conditions.

Section 8 – Boundary Conditions and Evidentiary Limits

8.1 Purpose of This Section

This section reaffirms the analytical limits of this paper and clarifies what cannot be inferred from the preceding stress-mapping.

The purpose is to ensure that architectural observations are not mischaracterised as outcome claims.

8.2 No Outcome Determination

This paper does not determine:

• whether failure will occur,
• whether environmental impact is likely,
• whether thresholds are appropriately calibrated,
• whether monitoring density is sufficient,
• whether conceptual models are correct.

It evaluates governance architecture as presented.

Activation of a failure mode does not imply malfunction, breach, or harm. It denotes structural exposure under defined conditions.

8.3 No Causal Attribution

No causal mechanism is asserted in this document.

Where model stability, spatial detectability, or cross-domain routing are discussed, the analysis remains confined to structural design characteristics.

The paper does not infer subsurface behaviour, hydrogeological connectivity, or mechanical instability.

8.4 Documentation Boundaries

The analysis is bounded by the documentation available within the West Newton A application and associated governance materials.

If additional cross-domain triggers, adaptive clauses, or integrative review mechanisms exist outside the reviewed documentation, they may alter the mapping.

This paper does not assume absence beyond the documented architecture.

8.5 Unobserved Behaviour

Where structural filtering or conditional observability is identified, this does not imply that filtered behaviour exists.

It identifies that, if such behaviour were to arise, recognition would depend on defined pathways or discretionary review.

The absence of evidence is not treated as evidence of absence.
Nor is structural exposure treated as evidence of occurrence.

8.6 Temporal Limitation

Because the application is live, governance posture and detectability envelope may evolve.

Subsequent modifications, monitoring densification, regulatory clarification, or model revision may alter structural characteristics identified herein.

This paper reflects architecture at the time of review.

8.7 Scope Limitation

This document does not:

• recommend approval or refusal,
• propose policy change,
• advocate regulatory reform,
• rank risk,
• or synthesise activated modes into a unified judgement.

It performs architectural stress-mapping only.

8.8 Conditions That Would Alter the Mapping

The structural characterisation presented would materially change if:

• automatic cross-domain propagation triggers were explicitly defined,
• adaptive monitoring densification were rule-based rather than discretionary,
• cumulative pattern recognition criteria were formally embedded,
• model boundary testing were predefined within escalation logic.

Absent such structural mechanisms, routing and adaptation remain partially interpretive.

This statement is descriptive, not prescriptive.

Section 9 – Conclusion

9.1 Structural Characterisation

This paper has applied a failure-mode stress mapping framework to the West Newton A monitoring and governance architecture.

The analysis has not evaluated environmental outcome or operational performance. It has examined structural design.

The mapping identifies how the architecture is configured to:
• detect,
• classify,
• escalate, and
• revise deviation from predicted behaviour.

The resulting characterisation is architectural rather than evidentiary.

9.2 Detectability Envelope

The detectability envelope is spatially bounded by predicted geometry and monitoring placement.

It is temporally bounded by a combination of continuous and periodic cadence.

Escalation logic is threshold-dominant, with discretionary pathways for cross-domain interpretation.

Adaptive capacity is structurally present but partially dependent on interpretive recognition.

The envelope defines what the system is configured to recognise and escalate under its current design.

9.3 Escalation Architecture

Escalation pathways are clearly defined for discrete exceedance events within individual domains.

Where behaviour does not cross predefined thresholds, escalation may depend upon interpretive synthesis rather than automatic routing.

Escalation eligibility is defined not only by signal magnitude, but by the admissibility pathways through which signals enter formal review structures.

This is a structural property of threshold-governed systems.

9.4 Prospective Framing

Because the application is live, the relevant framing is prospective.

The architecture demonstrates:
• defined response mechanisms for threshold exceedance,
• conditional pathways for cumulative or distributed deviation,
• review clauses enabling modification and model reassessment,
• cross-domain integration dependent in some instances on interpretive recognition.

These characteristics describe how the system would respond to deviation under its current configuration.

9.5 Analytical Boundary

This analysis does not assert that deviation will occur.

It does not assert that the architecture is insufficient.

It identifies the structural conditions under which detection, escalation, and reassessment are configured to operate.

The purpose of this stress mapping exercise is descriptive.

Interpretation of adequacy, risk, or regulatory posture lies outside the scope of this document.

Appendix A – Failure-Mode Architecture (Canonical List)

Table 1 — Canonical Failure Mode Architecture (Version 1.0 — Locked)

FM Code	FM Label	Short Name	Primary Domain	Core Description	Architecture Paper	Detectability & Burden Paper	Stress Mapping Paper	Consistency Notes
FM-A-1	Spatial Detectability Constraint	Spatial_Blind_Spot	Detectability	Monitoring geometry excludes relevant spatial pathways (coverage and placement limits).	Yes	Yes	Yes	Stable and consistently applied
FM-A-2	Temporal Resolution Constraint	Temporal_Blind_Spot	Detectability	Signals occur between sampling windows, reporting cycles, or inspection intervals.	Yes	Yes	Yes	Historical note: labelled "Between-Interval Invisibility" in applied drafts
FM-A-3	Threshold-Safe Drift	Sub_Threshold_Accumulation	Threshold Logic	Distributed, cumulative, or low-magnitude behaviour remains below escalation thresholds.	Yes	Yes	Yes	Explicit in Architecture; occasionally implicit elsewhere
FM-A-4	Cross-Domain Non-Propagation	Domain_Non_Propagation	Governance	Signals in one regulatory domain do not trigger reassessment or escalation in another absent explicit propagation rules.	Yes	Yes	Yes	Previously labelled "Cross-Domain Fragmentation" in earlier matrix
FM-A-5	Assumption-Locked Interpretation	Model_Lock	Interpretation	Monitoring outputs are interpreted through stable conceptual models unless explicit revision triggers are activated.	Yes	Yes	Yes	Historical note: mis-numbered as FM-A-4 in earlier matrix
FM-A-6	Audit-Completeness Illusion	Procedural_Completeness	Governance	Procedural compliance and documented reporting are treated as epistemic completeness despite bounded detection envelopes.	Yes	Yes	Partial	Previously mis-filed as FM-C-2
FM-A-7	Detectability–Tolerability Decoupling	DetTol_Decoupling	Threshold Governance	Tolerability judgments operate within the detection envelope; behaviour outside detectability does not reliably enter threshold or escalation logic.	Yes	Yes	Yes	Must remain explicitly present across documents
FM-B-1	Algorithm-Shaped Observability	Processing_Filtering	Detection Pipeline	Data processing, filtering, or classification rules determine which signals become formally visible.	Yes	Yes	Partial	Most explicit in Detectability paper
FM-B-2	Adaptive Monitoring Lag	Governance_Window_Lag	Detection Pipeline	Monitoring scope or sensitivity increases only after recognised events, creating temporal asymmetry in detectability.	Yes	Yes	Yes	Clear in seismic and hydro examples
FM-B-3	Resolution Compression Under Bounded Uncertainty	Resolution_Compression	Detection Pipeline	Bounded-but-imprecise signals are administratively compressed into stable categories without formal model revision.	Yes	Yes	Partial	Historicall note: shortened to "Resolution Compression"

This appendix reproduces the canonical failure-mode architecture used as fixed analytical infrastructure in this paper. The set is treated as complete for the purposes of cross-document comparability. The modes are defined in systems-engineering terms. They describe structural conditions under which monitoring and governance architectures may remain procedurally coherent while epistemically bounded. They function as analytical lenses for examining architectural properties rather than as outcome claims.

Appendix B – References

Peer-Reviewed / Scientific

Davies, R.J., Almond, S., Ward, R.S., Jackson, R.B., Adams, C., Worrall, F., Herringshaw, L.G., Gluyas, J.G. and Whitehead, M.A. (2014). Oil and gas wells and their integrity: Implications for shale and unconventional resource exploitation. *Marine and Petroleum Geology*, 56, pp.239-254. https://doi.org/10.1016/j.marpetgeo.2014.03.001

Haszeldine, R.S. (2015). Cautionary comments on groundwater contamination relating to high volume fracking. *Environmental Earth Sciences*, 74, pp.1565-1568. https://doi.org/10.1007/s12665-015-4156-6

Llewellyn, G.T., Dorman, F., Westland, J.L., Yoxtheimer, D., Grieve, P., Sowers, T., Humston-Fulmer, E. and Brantley, S.L. (2015). Evaluating a groundwater supply contamination incident attributed to Marcellus shale gas development. *Proceedings of the National Academy of Sciences*, 112(20), pp.6325-6330. https://doi.org/10.1073/pnas.1420279112

Lei, Q., Latham, J.-P. and Tsang, C.-F. (2017). The use of discrete fracture networks for modelling coupled geomechanical and hydrological behaviour of fractured rocks. *Computers and Geotechnics*, 85, pp.151-176. https://doi.org/10.1016/j.compgeo.2016.12.024

Westaway, R. (2016). Importance of characterizing uncertainty in controversial geoscience applications. *Earth System Dynamics*, 7, pp.1-15. https://doi.org/10.5194/esd-7-1-2016

Government / Policy / Regulatory

Department of Energy & Climate Change (DECC) (2011). *The hydrocarbon prospectivity of Britain's onshore basins*. London: DECC.

Department of Energy & Climate Change (DECC) (2012). *Shale gas and fracking: Planning permission and climate change*. London: DECC.

Department of Energy & Climate Change (DECC) (2014a). *Understanding earthquake risks associated with shale gas*. London: DECC.

Department of Energy & Climate Change (DECC) (2014b). *Shale gas regulation and monitoring*. London: DECC.

Department of Energy & Climate Change (DECC) (2014c). *Shale gas well design and integrity (safety design)*. London: DECC.

UK Government (2013). *Developing onshore shale gas and oil: Facts about fracking*. London: HM Government.

UK Government (2019). *Shale gas and fracking: Policy update (moratorium statement)*. London: HM Government.

Concerned Health Professionals of New York (CHPNY) (2018). *Compendium of scientific, medical, and media findings demonstrating risks and harms of fracking (unconventional gas and oil extraction), version 5*. New York: CHPNY.

Air Quality Expert Group (AQEG) (2018). *Potential air quality impacts of shale gas extraction in the UK* (PB14504). London: Department for Environment, Food and Rural Affairs (Defra). (Report compiled 2015; published 2018.)

Parliamentary / Institutional

Environment Agency (2013). *Written evidence submitted by the Environment Agency (ISG 34)*. House of Commons Energy and Climate Change Committee, April 2013.

Royal Society and Royal Academy of Engineering (2012). *Shale gas extraction in the UK: A review of hydraulic fracturing*. London: The Royal Society and The Royal Academy of Engineering.

Professional / Technical Submissions

Geological Society of London and Petroleum Exploration Society of Great Britain (PESGB) (2012). *Submission to the Royal Society / Royal Academy of Engineering Inquiry into Shale Gas*, 11 April 2012.

Smythe, D.K. (2014). *Preston New Road objection* (Version 1.3). September 2014.

Permanent Peoples' Tribunal (2018). *Preliminary statement on fracking and climate change*. Rome: Permanent Peoples' Tribunal.