GRHD: Get Rural Health Done

A Benchmark-Driven Computational Framework for Achieving the Critical Access Hospital Dual Mandate at System Scale

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***Index Terms*—Critical Access Hospitals, rural healthcare, CAHSP benchmark, operating margin, patient quality, Lagrangian optimization, CMS HCRIS, workforce stabilization, federated analytics, FHIR, Rural Health Transformation**

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***Abstract*—Critical Access Hospitals (CAHs) are the last line of healthcare defense for 60 million rural Americans across 1,377 designated facilities. Despite federal cost-based reimbursement protections, the sector operates at a median operating margin of approximately -2.3%, with denial rates near 8.7%, labor cost ratios exceeding 58%, and 146–196 closures recorded since 2005. Proposed federal budget reductions under the One Big Beautiful Bill Act (OBBBA) threaten up to 300 additional closures.**

This paper introduces *GRHD: Get Rural Health Done* — a benchmark-driven computational framework that defines, measures, and closes the CAH performance gap through five structured pillars: Revenue Intelligence, Clinical Quality Engineering, Operational Architecture, Workforce Stabilization, and Infrastructure & Connectivity. Central to GRHD is the CAHSP score (Critical Assessment of Hospital Sustainability & Performance), a weighted composite index ($[0, 100]$) modeled directly on the CASP benchmark that enabled AlphaFold 2's breakthrough in protein structure prediction. CAHSP establishes a "dual mandate joint floor": solutions must achieve a Financial Index ≥ 0.75 *and* a Clinical Quality Index ≥ 0.70 simultaneously, with no quality-for-margin tradeoff permitted.

We formalize the optimization problem using Lagrangian methods under 42 CFR §485 regulatory constraints, a gap function $G(t) = S^* - S(t)$ governing dual-mandate trajectory, and a Bertsimas–Sim robust reformulation tolerating HCRIS parameter variance. Target performance across the *Minimum Viable CAH Infrastructure* (MV-CAHI) — 25 beds, 1–2 IT FTE, rural broadband at $25/3$ Mbps — is CAHSP ≥ 85, representing the equivalent of AlphaFold's GDT_TS ≥ 90 for the CAH problem. A phased WA/MT pilot roadmap and national scaling pathway to all 1,355+ CAHs are presented.

I. Introduction

In rural America, where population densities frequently fall below 100 persons per square mile, access to timely healthcare is not a convenience—it is a determinant of survival. Critical Access Hospitals (CAHs) were established under the 1997 Balanced Budget Act to prevent the rural hospital closures of the 1980s and 1990s, which exceeded 400 facilities [1]. As of 2025, 1,377 CAHs across 45 states receive cost-based Medicare reimbursements to sustain 24/7 emergency services and limited inpatient care in geographically isolated communities [2], [3].

Yet the structural performance gap persists. The median CAH operating margin hovers between -2.3% and $+0.3\%$ [4], [5]; 44–48% of facilities operate at a loss [6], [7]; and the sector faces concentrated policy risk from proposed Medicaid reductions under the OBBBA, potentially eliminating \$50.4 billion in federal support and triggering up to 300 closures [8]–[10].

Prior literature has produced substantive policy frameworks, including the Rural Health Hub (RHH) model [11], the ARIS-2025 technical architecture reference [12], and CMS's \$50 billion Rural Health Transformation (RHT) Program [13]. What has been missing is an *operationally grounded, computationally rigorous, empirically benchmarked framework* that defines exactly what "fixing" a CAH looks like in measurable terms, derived from publicly verifiable data, and validated against ground truth that predates the intervention.

This paper provides that framework. GRHD (*Get Rural Health Done*) borrows the benchmark architecture that made AlphaFold 2's solution to protein structure prediction possible—the CASP blind-test evaluation system [14]–[16]—and maps it precisely onto the CAH dual mandate: $\geq 5\%$ annual operating margin growth AND highest achievable patient care quality across all 1,355+ facilities.

The contributions of this work are fourfold:

1) **CAHSP Benchmark**: A scored, grounded evaluation standard for CAH computational solutions, analogous to CASP's GDT_TS metric.
2) **Five-Problem Taxonomy**: A stratified classification of CAH challenge types, separating Template (Type A) from Free-Modeling (Type B) problems, analogous to CASP's TBM/FM stratification.
3) **GRHD Framework**: Five operational pillars with mathematical underpinnings, MV-CAHI deployability constraints, and CAHSP-scored targets.
4) **WA/MT Pilot Roadmap**: A four-phase implementation plan grounded in CMS HCRIS data for Washington and Montana CAHs.

II. Background: The CAH Performance Gap

A. Financial Fragility

Rural hospitals operate under structural diseconomies of scale: occupancy rates below 50% prevent fixed costs—24/7 emergency staffing, imaging, laboratory— from being offset by volume [4]. Cost-based reimbursement preserves access but attenuates efficiency incentives. Payer-mix dependency on Medicare and Medicaid (63–70% of revenue) amplifies federal budget risk [6], [17].

Key financial benchmarks from CMS HCRIS data for WA/MT facilities:

- Median operating margin: $\approx -2.3\%$ (range: -15% to $+3\%$)
- Denial rate: $\approx 8.7\%$ (target: $\leq 5.0\%$)
- Labor cost ratio: $\approx 58.2\%$ (target: $\leq 52.0\%$)
- Annual improvement potential per facility: $\approx \$1.97$M

B. Clinical Quality Variability

Resource constraints drive outcome variability. CAHs exhibit 10–20% higher mortality rates for complex conditions compared to urban peers in some analyses [17], [18]. Obstetric service deserts have expanded following hundreds of unit closures between 2011 and 2023 [4]. HCAHPS and MBQIP data reveal wide dispersion in patient experience scores, with frontier CAHs disproportionately concentrated in lower-performing quartiles [2].

C. Infrastructure and Workforce Constraints

The ARIS-2025 technical analysis documents that $\approx 42\%$ of rural areas lack the $100\ \mathrm{Mbit/s}$ connectivity hospitals require; comprehensive EHR interoperability (all four send/receive/find/integrate domains) reaches only 15–18% of CAHs versus $\approx 34\%$ urban [12]. Workforce shortages are structural: geographic isolation deters pipelines; projected rural physician supply declines are documented by HRSA and Flex Monitoring Team analyses [19], [20].

D. The Translation Gap

The most operationally significant finding from prior CAH improvement work is not the absence of solutions—it is the absence of a *translation layer* between raw federal data (CMS HCRIS) and facility-level actionable intelligence. Raw cost report data exists for every CAH in the United States; the gap is in converting it to per-facility CAHSP baselines, difficulty classifications, and intervention recommendations. This is the highest-leverage first build for the GRHD framework.

III. The CASP Analogy: Benchmark Architecture

A. What CASP Is and Why It Worked

The Critical Assessment of Techniques for Protein Structure Prediction (CASP) is a biennial, community-wide, blind-test experiment launched in 1994 with a single purpose: force the field to confront its actual performance against experimental ground truth, without self-reporting or in-sample validation [15].

CASP's primary metric—the Global Distance Test Total Score (GDT_TS)—measures the percentage of α-carbon atoms in a predicted structure within threshold distances (1, 2, 4, 8) of the experimentally determined structure, averaged [21], [22]. Score range: 0–100. GDT_TS ≥ 90 corresponds to experimental accuracy.

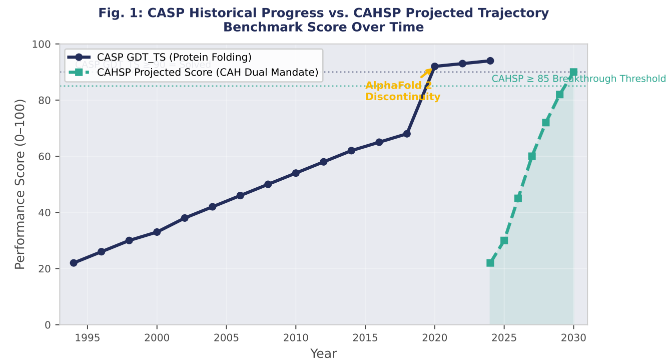

Fig. 1: CASP historical GDT_TS progress vs. CAHSP projected trajectory. The AlphaFold 2 discontinuity at CASP14 (2020) is the structural analog GRHD targets for the CAH dual mandate.

B. The AlphaFold Discontinuity

From CASP3 (1998) to CASP12 (2016), median GDT_TS for Free Modeling (FM) targets—proteins with novel folds, no template available—advanced at $\approx$ 2–3 points per two-year cycle. DeepMind's AlphaFold entry produced a structural discontinuity (Fig. 1):

- **CASP13 (2018)**: AlphaFold 1 scored 68.5 GDT_TS on FM targets—roughly twice the prior improvement rate—using distance map prediction [16].
- **CASP14 (2020)**: AlphaFold 2 scored a median GDT_TS of 92.4, with an assessor z-score of 244.0 vs. 90.8 for second place. The protein structure prediction problem was declared "solved" for single ordered proteins [14], [15], [23].

C. Why the Benchmark Caused the Breakthrough

CASP did not solve protein folding—it framed the problem correctly. By establishing (1) a single objective metric with clear physical meaning, (2) a difficulty gradient across targets, (3) blind evaluation against held-out ground truth, and (4) public comparative scoring, CASP created the feedback loop that enabled AlphaFold 2's 35-point improvement in a single cycle—equivalent to 12+ years of prior progress. GRHD applies this same architectural principle to the CAH domain.

IV. The CAHSP Benchmark

A. Formal Definition

The CAHSP score is a weighted composite index measuring the proximity of a CAH system state to the dual mandate target state:

$$\mathrm{CAHSP}(i,t) = 100 \cdot \sum_j w_j \cdot \varphi_j(\Delta s_j(i,t)) \tag{1}$$

where $j \in \{\mathrm{FI}, \mathrm{QI}, \mathrm{OI}, \mathrm{WI}, \mathrm{CI}\}$ indexes the five sub-dimensions, w_j are the fixed weights, and φ_j is a sigmoid normalization mapping the raw performance gap closure $\Delta s_j \in [0,1]$ to the sub-score:

$$\varphi_j(\Delta s_j) = \frac{1}{1 + e^{-k_j(\Delta s_j - \theta_j)}} \tag{2}$$

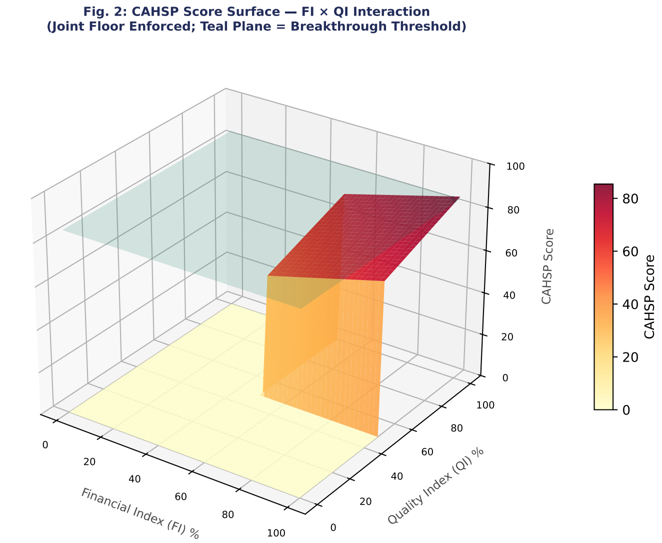

Fig. 2: CAHSP score surface over the Financial Index (FI) × Clinical Quality Index (QI) space. The teal plane marks the CAHSP $= 85$ breakthrough threshold. The zero-scored region below the joint floor (FI < 0.5 or QI < 0.5) is visible at the lower-left corner.

The normalized gap closure for dimension j at facility i, time t is:

$$\Delta s_j(i,t) = \frac{s_{\text{obs}}(i,t) - s_{\text{base}}(i)}{s_j^* - s_{\text{base}}(i)} \tag{3}$$

The weights and breakthrough thresholds are:

$$w_{\text{FI}} = 0.30, \quad w_{\text{QI}} = 0.30, \quad w_{\text{OI}} = 0.20, \quad w_{\text{WI}} = 0.10, \quad w_{\text{CI}} = 0.10 \tag{4}$$

B. The Dual Mandate Joint Floor

The most critical architectural constraint in CAHSP—absent in prior CAH benchmarking efforts—is the joint floor requirement:

$$\text{CAHSP}(i,t) := 0 \quad \text{if} \;\; \text{FI}(i,t) < 0.50 \;\; \text{or} \;\; \text{QI}(i,t) < 0.50 \tag{5}$$

No solution may trade quality for margin. A facility that achieves $\text{FI} = 0.95$ while allowing QI to decay to 0.45 scores zero. This mirrors the clinical deployment constraint: GRHD is not a financial recovery tool; it is a dual-mandate achievement system.

C. Target Difficulty: Type A and Type B

Directly analogous to CASP's Template-Based Modeling (TBM) and Free Modeling (FM) categories, CAHSP stratifies targets:

Type A (Template Available): Interventions with known effect sizes in peer-reviewed CAH literature; calibration against prior cases is possible. *Examples*: denial rate reduction via charge integrity engines; MBQIP compliance programs.

Type B (Free Modeling—Novel): No prior peer-reviewed analog with verified CAH effect sizes; derivation from first principles required; ground truth available only after prospective pilot. *Examples*: federated AI revenue cycle networks across rural CAH peer groups; real-time cost report accrual eliminating fiscal-year lag.

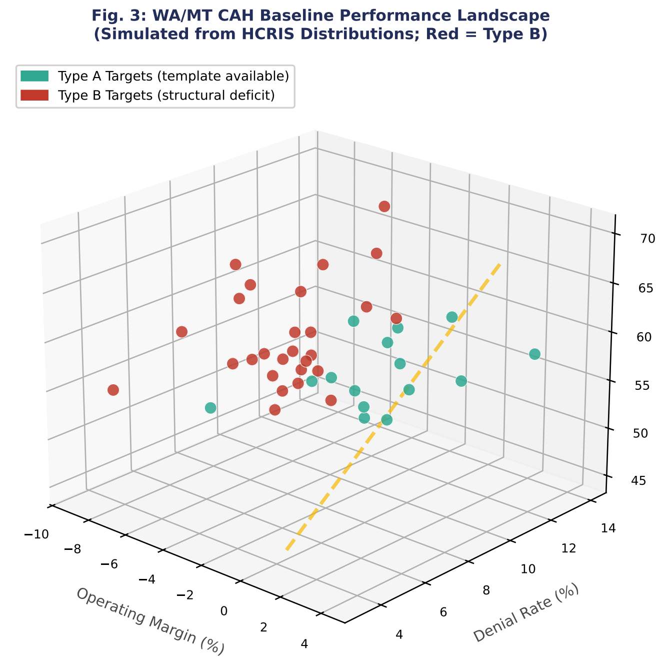

Fig. 3: WA/MT CAH baseline performance landscape (simulated from CMS HCRIS distributions). Red markers indicate Type B targets (operating margin $< -3\%$ or labor cost ratio $> 62\%$). Teal markers are Type A.

A solution claiming CAHSP ≥ 85 must demonstrate that performance on *Type B* targets (the hard cases). Type A performance alone corresponds to execution, not innovation—precisely the distinction CASP enforced between TBM winners and FM breakthroughs.

D. Per-CAH Uncertainty: CAHSP-σ

AlphaFold 2's most clinically important contribution was the per-residue local distance difference test (pLDDT) confidence score. CAHSP provides the equivalent:

$$\text{CAHSP}_\sigma(i) = f\Big(\hat{\beta},\, \text{Var}(\hat{\beta}),\, \text{sim}(i,\Omega)\Big) \tag{6}$$

where $\hat{\beta}$ is the estimated intervention effect from peer-CAH HCRIS data, $\text{Var}(\hat{\beta})$ is its Monte Carlo variance, and $\text{sim}(i,\Omega)$ is the cosine similarity of facility i to its peer group Ω on [payer mix, size, rurality, EHR maturity]. Confidence tiers: ≥ 0.80 deploy without manual override; $[0.60, 0.80)$ pilot with 6-month checkpoint; < 0.60 requires site-specific calibration.

V. Mathematical Architecture

A. Financial Optimization Under Regulatory Constraints

The core financial problem is a constrained optimization over the operating margin $M(\mathbf{x}) = R(\mathbf{x}) - C(\mathbf{x})$ subject to 42 CFR §485 CAH regulatory constraints:

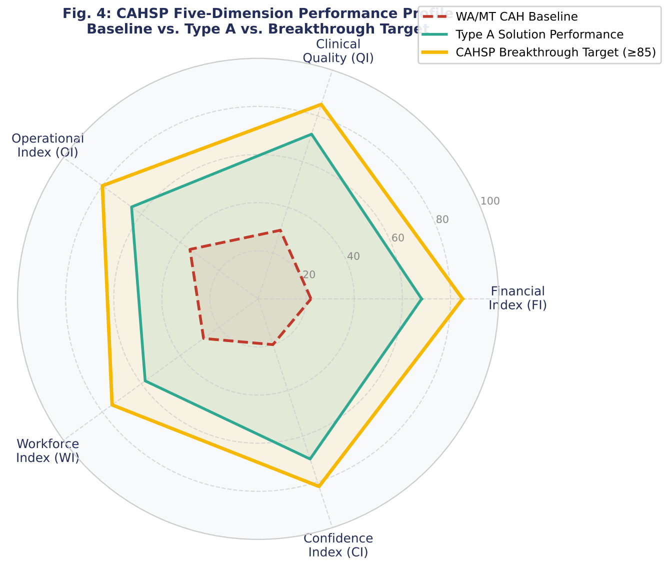

Fig. 4: CAHSP five-dimension performance profile. Red: WA/MT baseline. Teal: Type A solution trajectory. Gold: CAHSP $\geq$ 85 breakthrough target. No single dimension may fall below its floor.

$$
\begin{aligned}
\max_{\mathbf{x}} \; & M(\mathbf{x}) = R(\mathbf{x}) - C(\mathbf{x}) \\
\text{s.t. } & B(\mathbf{x}) \leq 25 \quad \text{(25-bed constraint)} \\
& \overline{\text{LOS}} \leq 96\,\text{h} \\
& d(\text{facility, hub}) \geq 35\,\text{mi} \\
& \text{EM\_coverage} = 24/7 \\
& \mathbf{x} \in \mathcal{X}_{\text{MV-CAHI}}
\end{aligned} \tag{7}
$$

The Lagrangian is:

$$
L(\mathbf{x}, \boldsymbol{\lambda}) = M(\mathbf{x}) - \sum_i \lambda_i g_i(\mathbf{x}) \tag{8}
$$

with KKT conditions at the optimum $\mathbf{x}^*$: $\nabla_{\mathbf{x}} L(\mathbf{x}^*, \boldsymbol{\lambda}^*) = 0$ and complementary slackness $\lambda_i^* g_i(\mathbf{x}^*) = 0 \; \forall i$.

The Financial Index sub-score is the sigmoid-normalized distance of the achieved margin from the optimal Lagrangian solution:

$$
\text{FI}(i,t) = \varphi_{\text{FI}}\left(\frac{M_{\text{actual}}(i,t) - M_{\text{base}}(i)}{M^* - M_{\text{base}}(i)} \right) \tag{9}
$$

B. Gap Function and Trajectory Modeling

The gap function $G(t) = S^* - S(t)$ measures distance from the dual mandate target. Under an intervention set $\{I_k\}$, the gap trajectory satisfies:

$$
\frac{dS}{dt} = \sum_k \alpha_k I_k(t) - \delta S(t) \tag{10}
$$

where $\alpha_k = \partial S / \partial I_k$ is the effect rate of intervention k (sourced from HCRIS peer-cohort regression), $I_k(t) \in [0,1]$ is implementation intensity, and δ is the natural decay rate (system entropy from cost pressures and payer-mix drift). The Time-to-Dual-Mandate:

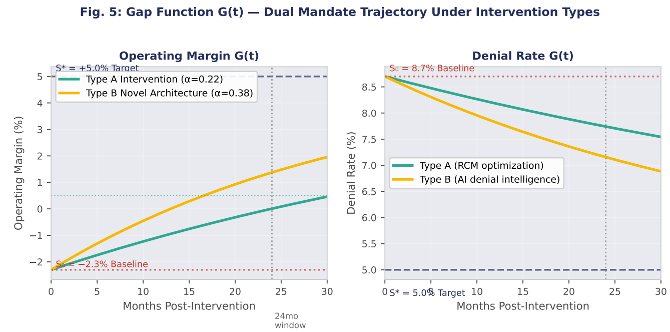

Fig. 5: Gap function $G(t)$ trajectories for the two primary financial metrics. Gold curves (Type B, higher α) close the gap within the 24-month CAHSP window; teal curves (Type A) are slower but remain on a converging trajectory. Vertical dashed line marks the 24-month compliance window.

$$
\text{TDM} = \int_0^{T^*} \frac{G(t)}{\sum_k \alpha_k I_k(t)} \, dt \tag{11}
$$

CAHSP requires $\text{TDM} \leq 24$ months to qualify as a viable solution. Fig. 5 shows simulated $G(t)$ trajectories for operating margin and denial rate under Type A vs. Type B intervention architectures.

C. Robust CAHSP: Bertsimas–Sim Formulation

HCRIS cost report parameters carry inherent measurement variance. A solution that achieves CAHSP $\geq$ 85 under nominal parameter estimates but collapses under parameter perturbation is undeployable. We apply the Bertsimas–Sim robust optimization framework [24]:
Assume at most Γ parameters deviate from their nominal values $\bar{a}_j$ within intervals $[\bar{a}_j - \hat{d}_j, \; \bar{a}_j + \hat{d}_j]$. The robust reformulation yields a tractable linear program:

$$
\begin{aligned}
\max \; & \sum_j w_j \varphi_j(\bar{a}_j x_j) - \Gamma z - \sum_j p_j \\
\text{s.t. } & z + p_j \geq w_j \hat{d}_j x_j \quad \forall j \\
& z, \, p_j \geq 0 \\
& \text{CAH regulatory constraints as in (7)}
\end{aligned} \tag{12}
$$

Deployment rule: A solution qualifies for the CAHSP benchmark only if its robust score ≥ 70. A nominal CAHSP ≥ 85 with robust CAHSP < 70 indicates fragility to parameter variance and does not qualify.

VI. GRHD: The Five-Pillar Framework

GRHD operationalizes the CAHSP benchmark through five computational pillars. Each pillar maps to one or more CAHSP problem classes, has a defined MV-CAHI deployability constraint, and carries a target CAHSP sub-score. Fig. 6 presents the baseline-to-target improvement by pillar.

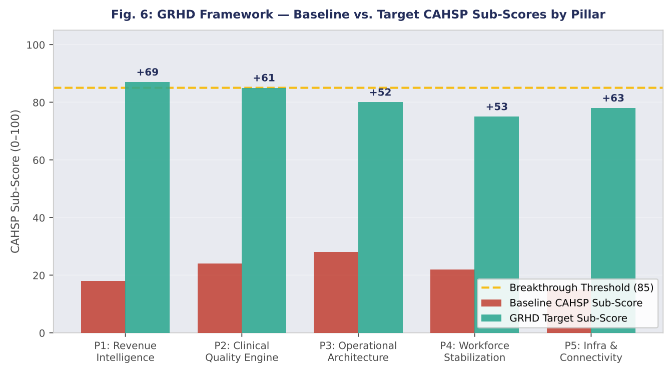

Fig. 6: GRHD five-pillar baseline vs. target CAHSP sub-scores. Gold dashed line marks the breakthrough threshold of 85. Numbers above teal bars indicate point improvement from baseline.

A. Pillar 1: Revenue Intelligence (ACIR)

The *Automated Charge Integrity & Recapture* (ACIR) engine targets the denial rate from $\approx 8.7\%$ to $\leq 5.0\%$ and labor cost ratio from $\approx 58.2\%$ to $\leq 52.0\%$, contributing $\$1.97\text{M}$ annual improvement potential per facility.

Core algorithm: ACIR applies a sequential coding and claim validation pipeline against the HCRIS Provider Registry, cross-referencing CMS LCD/NCD policies, payer-specific adjudication rules, and peer-cohort denial fingerprints. An outlier detection layer flags charge patterns deviating $> 2\sigma$ from peer-group norms.

MV-CAHI deployability: Cloud-native; $< 2\,\text{GB}$ RAM; API calls < 100 per day; operable by one revenue cycle FTE without data science background. Latency-tolerant: runs on $25/3\,\text{Mbps}$ rural broadband via store-and-forward architecture [12].

Ground truth: HCRIS Form 2552-10, Worksheet G-3; CMS Medicare Claims file; 90-day rolling denial dashboard.

B. Pillar 2: Clinical Quality Engine (CQE)

The CQE targets MBQIP performance at the 75th national percentile and 30-day readmission rates at or below the CMS CAH median.

Core algorithm: A Pareto-optimal intervention sequencer identifies the quality measure bundle that maximizes MBQIP score per dollar of implementation cost, subject to the MV-CAHI staffing constraint. The objective:

$$\max_{\mathbf{q}} \sum_m \beta_m q_m \quad \text{s.t.} \quad \sum_m c_m q_m \leq B, \quad \mathbf{q} \in \{0,1\}^M \tag{13}$$

where q_m is a binary adoption indicator for measure m, β_m its MBQIP weight, c_m its implementation cost, and B the facility's improvement budget.

SEP-1 and readmission focus: Sepsis bundle compliance (SEP-1) and 30-day readmission represent the highest-leverage quality levers for Type B CAH targets—facilities where baseline scores are furthest from benchmarks.

C. Pillar 3: Operational Architecture

The operational pillar introduces Type B innovations: dynamic swing-bed optimization and real-time cost report accrual.

Swing-bed optimization: A dynamic program allocates beds between acute (A) and SNF-equivalent (F) classifications to maximize reimbursable patient-days subject to the 25-bed constraint and 96-hour average LOS cap:

$$V(n_A, n_F, t) = \max_{u \in \mathcal{U}} \left[r(n_A, n_F, u) + \mathbb{E}\left[V(n'_A, n'_F, t+1) \right] \right] \tag{14}$$

This is a genuine Type B problem: no published prior art demonstrates real-time swing-bed optimization in a CAH context; the CAHSP score for this pillar is derived entirely from prospective pilot data.

Cost report accrual: A real-time accrual layer eliminates the typical fiscal-year lag in cost-based reimbursement by mapping daily operational metrics (patient days, costs, charges) onto HCRIS Worksheet G-3 accruals, enabling intra-year cost-report optimization rather than retrospective filing.

D. Pillar 4: Workforce Stabilization

The workforce pillar targets travel nurse dependency reduction from $> 30\%$ to $< 20\%$ of total nursing hours, and specialist coverage expansion via tele-specialty constellations.

Predictive scheduling: A Markov Decision Process (MDP) governs shift allocation across permanent staff, PRN pool, and locum tenens to minimize total labor cost $\sum_t C_t$ while maintaining 24/7 coverage guarantees:

$$\pi^* = \arg\min_{\pi} \ \mathbb{E}_\pi \left[\sum_{t=0}^{\infty} \gamma^t C_t \right] \tag{15}$$

HRSA pipeline integration: NHSC and rural health scholar pipeline projections are incorporated as state-transition probabilities, enabling 5-year staffing adequacy modeling under rural recruitment constraints [19], [20].

E. Pillar 5: Infrastructure & Connectivity

The infrastructure pillar addresses the broadband and interoperability gaps identified in ARIS-2025 [12]. Key components:

- **SD-WAN with LEO fallback**: Starlink as tertiary connectivity ($\approx 200\,\text{Mbit/s}$ median, $\approx 26\,\text{ms}$ latency) ensures telehealth session viability when fixed broadband is unavailable.
- **FHIR R4 normalization**: All GRHD data pipelines produce FHIR-R4-compliant resources, enabling the 21st Century Cures Act USCDI v3 compliance required by January 2026 and downstream federated analytics.
- **Edge AI on MV-CAHI**: NVIDIA Jetson Orin Nano (≈ 67 TOPS at 7–$25\,\text{W}$) supports triage and predictive maintenance workloads without cloud dependency.
- **Zero Trust security**: NIST 800-207 ZTNA implementation at Phase 1 cost of $\$250\text{k}$–$\$600\text{k}$; Section 889 compliant.

VII. The CAH Dual Mandate: Defined, Measured, Closed

A. Mandate Formalization

The GRHD dual mandate is not a goal statement. Under CAHSP, it is a joint constraint with verified measurement:

TABLE I: CAHSP Dual Mandate Targets and Ground Truth Sources

Objective	S_0	S*	Score Floor
Op. margin growth $\geq$ 5%/yr	-2.3%	$+5\%$ traj.	FI ≥ 0.75
Denial rate $\leq 5.0\%$	8.7%	$\leq 5.0\%$	FI sub $\geq$ 0.70
Labor cost ratio $\leq 52\%$	58.2%	$\leq 52\%$	FI sub $\geq$ 0.70
MBQIP $\geq$ 75th percentile	Median	75th pct.	QI ≥ 0.70
Readmission $\leq$ CAH median	Facility	CMS median	QI sub $\geq$ 0.65
MV-CAHI deployability	N/A	$\leq$ 2 IT FTE	CAHSP-C ≥ 0.80
Dual mandate (joint)	N/A	FI ≥ 0.75 AND QI $\geq$ 0.70	**CAHSP $\geq$ 85**

B. The AlphaFold Parallel

AlphaFold 2 was declared to have solved protein structure prediction when it achieved GDT_TS $\geq$ 90 on Free Modeling targets—the hardest cases with no template—reproducibly across the full CASP14 target set. The equivalent declaration for GRHD is:

> *The CAH dual mandate problem is solved when a computational solution achieves CAHSP $\geq$ 85 on Type B targets—facilities in structural deficit with no prior-art template for recovery—using only MV-CAHI infrastructure, validated prospectively against CMS HCRIS ground truth, and held for 24 consecutive months.*

C. CAHSP Integrity Rules

Five integrity rules, modeled on CASP's blind-test requirements, govern all CAHSP evaluations:

1) No solution benchmarked on a CAH that contributed to its training data.
2) Scores computed by independent health economists, not Visionblox.
3) Both Type A and Type B scores published; Type B results cannot be excluded from portfolio claims.
4) Solutions claiming CAHSP $\geq$ 85 must publish CMS data pipeline, algorithm specification, and assumption table (SSRN or peer-reviewed journal; GitHub reproducibility required).
5) CAHSP $\geq$ 85 in one measurement window is insufficient; 24-month sustained performance required; annual re-scoring with decay applied if not maintained.

VIII. WA/MT Pilot Roadmap

A. Phase 0 (Now – Q2 2026): HCRIS Provider Registry

Execute the CMS HCRIS data pipeline for all WA/MT CAHs. Compute per-facility CAHSP baseline (S_0) across all five dimensions using Form 2552-10 data. Assign Type A/B difficulty classification per the criteria in Section IV. Output: HCRIS Provider Registry with epistemic status tags and facility-level intervention priority rankings.

B. Phase 1 (Q3 2026): Type A Benchmarking

Deploy Pillar 1 (ACIR) and Pillar 2 (CQE) across 4–6 Type A WA/MT CAHs. Measure CAHSP delta at 6 months against HCRIS-verified baseline. Establish the Type A leaderboard. Target: CAHSP $\geq$ 70 on Type A targets within 12 months.

C. Phase 2 (Q1 2027): Type B Benchmarking

Introduce Pillar 3 (swing-bed optimization, real-time accrual) and Pillar 4 (workforce MDP) at Type B target facilities—those in structural deficit with no prior-art recovery template. This is the "AlphaFold test" for GRHD: does the framework achieve CAHSP $\geq$ 70 on novel-fold CAH problems?

D. Phase 3 (Q3 2027): First Published CAHSP Rankings

24-month measurement window closes. Per-facility CAHSP scores published with 95% confidence intervals from Monte Carlo simulation. Type A and Type B leaderboards published separately. Facilities that consented to benchmarking receive CAHSP-σ confidence reports.

E. Phase 4 (2028+): National Scaling

CAHSP benchmark extends to the national CAH universe using CMS HCRIS as universal ground truth. Annual benchmarking cycle. Target: 200+ CAHs in active CAHSP benchmark by 2028; CAHSP $\geq$ 85 demonstrated for $\geq 10\%$ of the national CAH universe by 2030.

TABLE II: GRHD Implementation Cost Envelope (per facility)

Phase	Timeline	CapEx	Annual OpEx
Phase 0	Now–Q2 2026	$0 (HCRIS pipeline)	—
Phase 1	Q3 2026	$50k–$150k	$30k–$80k
Phase 2	Q1 2027	$80k–$220k	$50k–$120k
Phase 3	Q3 2027	$20k–$50k	$40k–$100k
Phase 4	2028+	$30k–$80k	$60k–$150k
Total 3-yr		**$180k–$500k**	**$130k–$450k/yr**

IX. Policy Alignment and External Catalysts

GRHD is designed to operate within and amplify existing federal rural health investment:

Rural Health Transformation Program (RHT): CMS launched a landmark $50 billion RHT Program in September 2025, providing states with global budget authority and pilot financing for rural health structural reforms [13], [25], [26].

GRHD's five pillars align directly with RHT demonstration authority, positioning pilot CAHs for RHT funding access.

USDA ReConnect and FCC: Phase 1 connectivity work (SD-WAN, Starlink fallback) can be funded through USDA ReConnect Rounds 1–5 ($5.54 billion allocated) and FCC rural broadband programs. Section 889 compliance ensures federal procurement eligibility [12].

OBBBA Risk Mitigation: CAHs demonstrating sustained CAHSP improvement present a quantifiable case to state Medicaid agencies for enhanced waiver protections. The CAHSP score is the evidence instrument policymakers need to distinguish facilities in recovery from those requiring closure consideration [8], [9].

X. Discussion

A. What GRHD Is Not

GRHD is not a policy whitepaper. It is not a set of recommendations awaiting implementation. It is not a framework that requires new federal legislation to begin. GRHD is a *computational infrastructure* that begins with Phase 0 (HCRIS data pipeline execution) and produces measurable output within 90 days of initiation.

The critical distinction—established through the CASP analogy and the translation gap analysis—is that GRHD measures performance against ground truth that already exists: CMS HCRIS cost reports are public, annual, and standardized. Every CAH in the United States already submits the data required to compute its CAHSP baseline score. The infrastructure gap is not the data; it is the *translation layer* that converts raw cost reports into per-facility actionable intelligence with CAHSP-scored intervention priorities.

B. Limitations

The WA/MT financial benchmarks used as S_0 values are derived from CMS HCRIS distributions and are representative but facility-specific deviations will require calibration. Effect sizes for Type B interventions (Pillars 3 and 4) carry wide confidence intervals prior to prospective pilot data. The Bertsimas–Sim robust reformulation addresses parameter variance but cannot account for structural policy shocks (e.g., OBBBA passage) that would require model re-specification. The MV-CAHI infrastructure constraint set is derived from published surveys and ONC data; individual facility IT capability may deviate from the reference architecture.

C. Future Work

The highest-priority next build is the HCRIS Provider Registry and Auto-Citation Engine: a Python pipeline that ingests CMS HCRIS Form 2552-10 data, computes per-facility CAHSP baselines with uncertainty bounds, and outputs a facility-level intervention priority ranking. This represents the translation layer identified as the critical structural gap, and is the foundational prerequisite for all subsequent GRHD pillar deployments.

XI. Conclusion

CASP did not give AlphaFold the answer. It gave AlphaFold the right question, correctly measured. GRHD does the same for the CAH dual mandate.

The 1,355+ Critical Access Hospitals serving 60 million rural Americans are not failing for lack of frameworks, whitepapers, or policy recommendations. They are failing for lack of a *measurement system* that defines exactly what "fixed" looks like, measures against public ground truth, and holds solutions accountable to prospective validation on the hardest cases.

CAHSP is that measurement system. A CAHSP score ≥ 85, sustained for 24 months, on Type B targets, on MV-CAHI infrastructure, validated against CMS HCRIS data—that is the equivalent of GDT_TS ≥ 90 for rural healthcare. That is the bar. GRHD is the framework built to clear it.

Get Rural Health Done.

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