June 26, 2026

Washington State Department of Ecology
Climate Pollution Reduction Program Team
300 Desmond Drive SE
Lacey, WA 98503

Re: Seeking Feedback on Carbon Capture, Removal, Utilization, and Storage in the Cap-and-Invest Program (May 21, 2026)

Dear Climate Pollution Reduction Program Team:

The Beyond Alliance welcomes the opportunity to provide feedback on Carbon Capture, Removal, Utilization, and Storage in the Cap-and-Invest Program. We offer the following comments in a constructive and collaborative spirit. The views expressed here reflect the perspectives of Beyond's corporate members, a coalition of companies committed to advancing the scale, integrity, and impact of market-based climate solutions. Our members bring diverse viewpoints, and the positions outlined below summarize areas of broad alignment and, in some cases, present a predominant rather than unanimous perspective.

While we appreciate Ecology's focus on engineered carbon management, we encourage Ecology to ensure that the durability, monitoring, verification, and reversal frameworks it develops are pathway-neutral and performance-based, so that they remain coherent with Washington's existing offset protocols for nature-based removals and can accommodate additional removal pathways as the program matures. To reach its climate goals, Washington should follow the science — and the science requires a portfolio of removal approaches. The IPCC Sixth Assessment Report concluded that limiting warming to 1.5°C or 2°C is unattainable without scaled deployment of carbon dioxide removal across multiple pathways, with no single pathway sufficient to deliver the volumes required.

Clarification of response aims: This submission responds to Questions 6, 8, 9, 10, 11, 12, and 13 of Ecology's request for feedback on Carbon Capture, Removal, Utilization, and Storage in the Cap-and-Invest Program (comment period May 21–June 26, 2026). The three questions presented at the May 28, 2026 public meeting on the Permanent Sequestration Emissions Exemption map to those consultation questions as noted below:

- What other frameworks or models should we be looking at? (Consultation Questions 11 and 13)
- How should potential impacts, harms, and environmental justice be integrated? (Consultation Questions 6 and 12)
- What else should Ecology consider as it works to develop guidance and additional clarity? (Consultation Question 9)

Response content: We have formatted the response into two sections:

1) Permanent sequestration exemption and implementation responses (Questions 8, 9, and 10)

2) Offshore Storage Responses & Report (Questions 6, 11, 12, and 13; report provided as an attachment)
   a) This draft report on dedicated offshore geologic CO_2 storage represents a synthesis of perspectives from the scientific community, regulatory bodies, standard organizations, operators, and buyers.
   b) Though the focus of this report is offshore CO_2 storage, the referenced regulatory frameworks / standards, impacts, and safeguards are often translatable to onshore CO_2 storage.

Context on the attached offshore geologic storage report: As part of our response, we have attached a draft of the report Dedicated Offshore CO_2 Storage in a Decarbonization Context. The Beyond Alliance plans to publish the report before the end of 2026. This report addresses the potential environmental and social impacts of dedicated offshore geologic CO_2 storage and corresponding actionable best practices. This report has been the product of collaboration amongst the scientific community (marine scientists and geoscientists), buyers, and a leading offshore storage operator. Importantly, the report aligns with and builds upon existing regulations and standards for offshore CO_2 storage.

Additional request: We would appreciate the opportunity to meet with Ecology to share our learnings in developing best practices that minimize negative impacts and maximize positive outcomes of offshore geologic CO_2 storage. Many of the best practices in offshore geologic storage can be translated to onshore geologic storage projects. Thank you for your consideration of our response and report.

I. Permanent Sequestration Exemption and Implementation

Question 8: Does the permanent-sequestration definition create barriers?

The definition conditions the permanent-sequestration exemption on a high degree of confidence that substantially 99% of greenhouse gases will remain contained for at least 1,000 years. The barrier risk lies less in that threshold than in how that confidence is operationalized: without clear, science-based criteria for that determination, the definition could exclude geologic or mineralization approaches that can in fact meet a 1,000-year, negligible-reversal-risk standard but lack an established demonstration precedent. We encourage Ecology to publish risk-based criteria for evaluating durability confidence, drawing on emerging international work on negligible risk of reversal (such as under the UNFCCC Article 6.4 mechanism) as a reference point rather than a fixed dependency, since those tools are still in development.

Since the exemption applies to a covered entity's own sequestered emissions rather than to tradeable credits, performance-based and contracted approaches to durability — including for nature-based pathways — are most directly relevant on the offsets and crediting side of the program. We address those mechanisms — and how reversal, compensation, and financial-assurance provisions can broaden participation across pathways without lowering integrity — under Question 9.

Question 9: Monitoring, verification, financial assurance, and reversal provisions

On how monitoring and verification procedures, risk mitigation, compensation, financial assurance, and reversal provisions should be factored into implementation, we offer the following, drawn in part from our comments to the California Air Resources Board on its parallel SB 905 program.

Pathway-neutral integrity standards. Quantification, monitoring, reporting, and verification standards should be calibrated to deliver equivalent confidence in net removal outcomes across pathways, including consistent treatment of leakage, lifecycle emissions accounting (including upstream energy and material flows), and additionality. These standards should apply equally to nature-based, biogenic, geochemical, and engineered removals, so that no pathway is advantaged or disadvantaged by the form its storage takes rather than the integrity of its outcome.

Independent third-party verification through accredited verification bodies and approved registries. Ecology should require independent verification by accredited bodies and recognize credits issued through registries meeting defined regulatory criteria, building on its experience administering the Cap-and-Invest offset program, in which projects list with an approved offset project registry and are verified by an Ecology-accredited verification body. An approved-list approach reduces ambiguity for project developers, lowers buyers' due-diligence burden, and creates clear accountability for verification quality.

Financial responsibility should encompass credit integrity, not only physical remediation. Physical-remediation assurance — corrective action, well plugging, site care, and emergency response — addresses safety but does not, on its own, ensure that if stored carbon is later released, the loss is made whole. Financial-responsibility mechanisms should deliver both physical-remediation assurance and credit-integrity assurance, including compensation for reversals.

Address the post-insolvency liability gap. Notification requirements when an operator or financial-instrument provider enters bankruptcy typically do not specify who then assumes durability and financial-responsibility obligations. Ecology should identify a default disposition of those obligations upon insolvency — a gap that **contracted durability mechanisms**, such as a permanence trust funded at issuance, are designed to address.

Contracted durability as a performance-based approach to reversal risk. Contracted durability refers to the length of time a tonne of CO2 represented by a credit is contractually guaranteed to remain out of the atmosphere, delivered through legal and financial mechanisms that ensure removal performance across the specified time period regardless of pathway. These mechanisms must deliver two core functions across the entire durability threshold: (1) assigning ongoing liability for reversals; and (2) providing tools to compensate for reversals so that the credit delivers the same level of removal. Buffer pools and insurance alone do not satisfy both functions when the durability threshold extends beyond the monitoring period; to serve both, a credit must be paired with either a permanence trust or horizontal stacking after the post-crediting monitoring period. This is especially relevant for nature-based and other pathways whose durability rests on active stewardship rather than geologic confinement:

contracted durability lets these removals deliver durability outcomes equivalent to geologic storage, so they can participate on equal footing rather than being disadvantaged by the form their storage takes.

A **permanence trust** is a risk-transfer approach in which each CDR credit purchase includes a fee, scaled to the credit's risk of reversal, that is deposited into a financial trust managed by an independent entity. The trust assumes liability for monitoring and reversal remediation, likely starting after the monitoring period. **Horizontal stacking** entails a new CDR credit replacing the original credit, likely after the original credit's crediting period and post-crediting monitoring period, or upon reversal. Buffer pools and insurance serve only the compensation function during the crediting and post-crediting monitoring periods.

California adopted a performance-based "Permanent" definition in its Cap-and-Invest program in April 2026,[1] under which the durability threshold can be met either by storage that is not reversible or by contractual mechanisms that compensate for reversals across the threshold. The broader policy environment is converging on this performance-based approach:

- The UNFCCC Paris Agreement Crediting Mechanism (Article 6.4) incorporates principles consistent with contracted durability in its design, including the standard addressing non-permanence and reversals, which calls for insurance or comparable guarantees for avoidable reversals.[2] The Methodology Expert Panel is actively developing reversal-risk assessment tools and guidance on negligible risk of reversal.
- The Integrity Council for the Voluntary Carbon Market's (ICVCM) second Continuous Improvement Work Program (CIWP) on Permanence (launched February 2026) is developing standardized reversal-risk assessment tools, stress-testing protocols for buffer reserves, and novel compensation mechanisms — including permanence trusts and extended insurance.[3]
- The American Forest Foundation and partners have launched a feasibility study and advisory group on the design and governance of a market-level permanence trust.[4]

Because Washington is pursuing linkage with the California-Québec market, aligning with California's performance-based approach would also support compatibility across the linked programs. We encourage Ecology to consider the same operative principle as it strengthens reversal and financial-assurance provisions. The contracted durability mechanisms described above are detailed in Contracted Durability: A Framework for Performance-Based Carbon Removal (RMI, American Forest Foundation, and Beyond Alliance, June 2026), available at

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[1] CARB, Proposed 15-Day Modifications to Proposed Regulation Order, Proposed Amendments to the Regulation for the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms, Attachment A-1, at § 95802(a) (Apr. 14, 2026), https://ww2.arb.ca.gov/rulemaking/2026/cap-and-invest2026.

[2] UNFCCC Article 6.4 Supervisory Body, Standard: Addressing Non-Permanence and Reversals in Mechanism Methodologies (version 01.0), A6.4-STAN-METH-007 (entered into force Oct. 10, 2025), https://unfccc.int/documents/650552.

[3] ICVCM, "Integrity Council launches follow-up work program to refine permanence requirements" (Feb. 18, 2026), https://icvcm.org/integrity-council-launches-follow-up-work-program-to-refine-permanence-requirements/.

[4] American Forest Foundation, "Carbon market stakeholders launch feasibility study and advisory group on new permanence framework" (2025), https://www.forestfoundation.org/why-we-do-it/family-forest-blog/carbon-market-stakeholders-launch-feasibility-study-advisory-group-on-new-permanence-framework/.

https://rmi.org/resources/contracted-durability-a-framework-for-performance-based-carbon-removal.

Question 10: Leveraging Class VI and other federal and state standards

Class VI as a baseline. The EPA Class VI program under 40 CFR Parts 144–146, including the financial-responsibility requirements at 40 CFR § 146.85, provides a well-developed federal baseline for geologic-storage safety that Ecology can leverage. In Washington, Class VI wells are permitted directly by EPA Region 10 — Washington has not sought Class VI primacy — so the Cap-and-Invest program would complement, not replace, a federally administered permitting regime.

Gaps to address. Two gaps are particularly relevant to Washington's permanence objective. First, Class VI requirements are designed primarily to protect underground sources of drinking water; while many provisions also reduce CO2-leakage risk, the program is not built around long-term atmospheric permanence per se. Second, Class VI post-injection site care defaults to a 50-year period, far short of Washington's 1,000-year permanent-sequestration standard — leaving a substantial gap between the federal monitoring framework and the durability the exemption requires. Ecology should consider how monitoring, financial responsibility, and reversal provisions extend across that gap.

II. Offshore Storage Responses

Questions 11 & 13: Other methodologies, protocols, and jurisdictional models

Table 1 provides a summary of regulatory frameworks, with a focus on offshore CO_2 storage (Offshore Storage Report, p.9). The important element is the right-hand column which summarizes the environmental and social safeguards within these regulations. These safeguards can provide a helpful reference baseline as Ecology develops environmental and social safeguards for CO_2 storage.

Table 1: Summary of Offshore Storage Regulatory Frameworks and Associated Environmental and Social Safeguards		
Jurisdiction	**Regulatory Framework Description**	**Environmental and Social Safeguards**
International	• **London Protocol (2006):** Regulates waste materials disposed at sea and allows for the disposal of CO_2 if the following criteria are met: (i) the CO_2 is injected into a geological reservoir, (ii) the CO_2 stream maximizes purity with no threshold provided, and (iii) no additional waste types are injected with the CO_2[3] • **London Protocol Risk Assessment and Management Framework for CO_2 Sequestration in Sub-Seabed Geological Structures (2006):** Provides guidance on meeting the requirements under the London Protocol, including problem formulation, site selection and characterization, exposure assessment, effects assessment, risk characterization, and management[3] • **London Protocol Specific Guidelines for Assessment of Carbon Dioxide Streams into Sub-Seabed Geological Formations:** Guides national authorities in evaluating applications for offshore geologic storage[2]	• **Establishes global operational baseline:** Provides an international, operational baseline that serves as an environmental / social safeguard in countries with developing offshore storage regulations; requirements include waste prevention and management, site-specific environmental characterization and impact assessment, field monitoring and assessment, and mitigation or remediation plans[2, 3]
Australia	• **Offshore Carbon Capture and Storage Regulatory Approvals (2023) and associated legislation:** Provides guidance on the	• **Requires environmental plan and public consultation period:** Specifies that environmental plans must uphold ecologically

	requirements and processes of permitting and environmental approvals established in the Offshore Petroleum and Greenhouse Gas Storage Act 2006, the Environment Protection Act 1981, and the Environment Protection and Biodiversity Conservation Act 1999[5]	sustainable development, minimize environmental impacts, and ensure that seismic surveys and exploration drilling be subject to a public consultation period[5]
European Union	• **European Commission CCS Directive 2009/31/EC (2009) and associated legislation:** Establishes a legal framework for the environmentally safe storage of CO_2 by preventing and eliminating, to the extent possible, negative impacts on the environment and human health within the territory of the member states, their exclusive economic zones, and the continental shelf[1] • Please note: Associated legislation includes EC Monitoring and Reporting Guidelines (2010); CO_2 Storage Life Cycle Risk Management Framework (2011); Characterisation of the Storage Complex, CO_2 Stream Composition, Monitoring and Corrective Measures (2011); Criteria for Transfer of Responsibility to the Competent Authority (2011); and Financial Security and Financial Mechanism (2011)[1, 3]	• **Mandates Environmental Impact Assessment:** Requires that a project conduct an Environmental Impact Assessment inclusive of population and human health, biodiversity, land, soil, water, air, climate, landscape, material assets, and cultural heritage[1] • **Establishes project plan update cadence:** Requires project plan to be updated at a minimum of 5-year intervals to account for changes to CO_2 leakage risk, environment and human health risks, evolving scientific knowledge, and improvements in best available technology[1]
Malaysia	• **CCUS Bill (2025):** Introduced initial federal framework for the entire CCUS value chain, including offshore storage[6, 7]	• **Requires CO_2 plume monitoring but not environmental / social impact assessment and monitoring:** Requires that the operator monitors the storage complex, prepares a geological assessment, and owns responsibility for monitoring and remediation activities; further regulations will increase clarity on monitoring requirements[6, 7]
Norway	• **Royal Decree on 5 December 2014 pursuant to Section 3 of Act No. 12 of 21 June 1963 relating to scientific research and exploration for and exploitation of subsea natural resources other than petroleum resources:** Regulates exploitation, transportation, and storage of CO_2 storage on the continental shelf to counteract climate change[4]	• **Requires a commercial and environmental impact assessment:** Requires that the project assess the environment that may be significantly impacted and related consequences, monitoring, and preventative / mitigating measures[4] • **Compensation for the fishing community:** Requires projects to compensate the fishing community for financial loss associated with the transport and storage of CO_2[4]

Table 1: Summary of Offshore Storage Regulatory Frameworks and Associated Environmental and Social Safeguards

Sources: [1] (2009). Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006. *European Union*.; [2] (2012). 2012 Specific Guidelines for the Assessment of Carbon Dioxide for Disposal into Sub-Seabed Geological Formations. *International Maritime Organization*, *LC34/15, annex 8*.; [3] (2017). Best Management Practices for Offshore Transportation and Sub-Seabed Geologic Storage of Carbon Dioxide. *U.S. Department of the Interior: Bureau of Ocean Energy Management*.; [4] (2017). Regulations relating to exploitation of subsea reservoirs on the continental shelf for storage of CO_2 and relating to transportation of CO_2 on the continental shelf. *Norwegian Offshore Directorate*.; [5] (2023). Offshore Carbon Capture and Storage Regulatory Approvals. *Commonwealth of Australia*.; [6] Nair, K. (2025). Cover Story: Who benefits from CCUS in Malaysia?. *Institute of Strategic and International Studies Malaysia*.; [7] Smith, B. (2025). Thought Leadership: Policy, Legal and Regulatory Review: Mid-2025 Update and Perspective on the IMO's Net Zero Framework. *Global CCS Institute*.

Questions 6 & 12: Potential impacts on communities and Tribes, and mitigation strategies

Table 2 provides a summary of key positive and negative impacts of offshore CO_2 storage projects and associated safeguards to maximize positive and minimize negative outcomes (Offshore Storage Report, p.11-12). Particularly applicable to onshore storage projects are the site-specific risks and the associated recommendations to integrate: (i) a site-specific baseline assessment, (ii) social and environmental impact assessments, (iii) stakeholder engagement, and (iv) continuous improvement.

Table 2: Summary of the Primary Potential Environmental and Social Impacts of Offshore Storage and the Associated Safeguards

Potential Impacts	**Impacted Groups** ✋= social 🌊= environmental	**Description**	**Likelihood of Occurrence**	**Safeguards** *Included in Best Practices Checklist
Potential Positive Impacts of Offshore Storage Projects				
Decarbonization	✋Public and private actors with decarbonization goals	• Offshore storage projects can provide durable, long-term storage aligned with the IEA Sustainable Development Scenario[12]	**High** likelihood of supporting decarbonization goals	• **[Preferred] CO_2 hubs:** Prioritize projects linked to CO_2 hubs to support the efficient development and utilization of CO_2 infrastructure; increased opportunities for regulatory alignment

		• Offshore storage projects can enable economies of scale given significant storage volume capacity		and enforcement; and the scaling of carbon removal and storage pathways
Economic opportunities	✋Local communities and broader carbon sector workforce	• Offshore storage projects can maintain and create local jobs and broader contracting opportunities • Offshore storage projects can support the development of storage hubs and the broader decarbonization economy through shared infrastructure	**High** likelihood of driving local economic opportunities	• **[Preferred] Community Benefits Plan (CBP):** Prioritize projects that integrate a community or social impacts assessment • **[Preferred] Local workforce:** Prioritize projects that maximize hiring of the local workforce, including contractors, where feasible
Energy industry diversification	✋Local and broader energy sector workforce	• Offshore projects can build upon existing knowledge and infrastructure capacity of the energy sector • Offshore projects can aid transition of jobs and skills from oil and gas sector to new roles in carbon management	**High** likelihood of supporting energy industry diversification given the high degree of overlap between offshore storage actors and energy actors	• **[Preferred] Energy sector knowledge:** Prioritize projects that build upon local / regional oil and gas sector knowledge, where feasible
Potential Negative Impacts of Offshore Storage Projects				
Site-specific risks influenced by a distinct composition of onshore and offshore geographic, geological, environmental, and societal parameters	✋Coastal communities and indigenous groups 🌊Coastal and marine flora and fauna	• Offshore projects pose site-specific risks that are based on a suite of contextual measurements for social and environmental parameters. Examples of site-specific risks include (i) conflicts with fishing grounds and other coastal / indigenous community resources and activities and (ii) negative impacts on local biodiversity and endangered species	**Low to High** likelihood of occurrence of site-specific risks that will require site-specific mitigation measures	• **[Mandatory] Site-specific baseline assessment:** Require that projects evaluate the baseline community and ecosystem parameters • **[Mandatory] Social and environmental impact assessments:** Require that projects conduct site-specific social and environmental impact assessments in collaboration with impacted communities (e.g., coastal communities and indigenous groups); the assessment should include plans to mitigate negative impacts • **[Mandatory] Stakeholder engagement:** Require that projects implement recurrent formal and informal stakeholder engagement mechanisms with all impacted communities, notably indigenous communities and vulnerable groups, throughout the project lifetime • **[Mandatory] Continuous improvement:** Require that projects regularly assess for site-specific impacts during the lifetime of the project and update operations accordingly
Earthquakes	✋Communities near CO_2 injection site 🌊Onshore and marine flora and fauna near CO_2 injection site	• Subsurface pressure changes associated with CO_2 injection pose the risk of triggering earthquakes, submarine landslides, and other geohazards[14]	**Low to Medium** likelihood of earthquake events given that the mitigation measures are required by regulatory and standard bodies	• **[Regulatory Requirement] Pressure and microseismic monitoring and management plan:** Require that projects avoid operations in areas that pose a higher risk of seismic activity and integrate pressure and microseismic management programs
CO_2 leakage *(Further reference provided in "Understanding CO_2 Leakage" section below)*	✋Communities in close proximity to CO_2 infrastructure 🌊Onshore and marine flora and fauna	• Surface leaks (i.e., onshore equipment and pipeline leaks), marine leaks (i.e., subsea pipeline leaks), and subsurface leaks (i.e., leakage via compromised caprock) pose the risks of (i) asphyxiation in onshore / marine contexts and (ii) harm to marine flora and fauna sensitive to increased acidification; these risks are related to elevated, localized CO_2 concentration prior to dispersal[2, 9]	**Low to Medium** likelihood of leakage events given that the mitigation measures are required by regulatory and standard bodies	• **[Preferred] Robust safety regulations:** Prioritize projects operating in robust safety regulatory regimes • **[Regulatory Requirement] Site selection:** Require that projects select storage reservoirs overlain by high-integrity seals (laterally continuous, thick, and low permeability) • **[Regulatory Requirement] CO_2 monitoring plan:** Require that projects integrate a site-specific monitoring plan design with best available technologies that effectively monitor prioritised risks concerning the CO_2 plume while minimizing negative environmental and social impacts; additional monitoring should be triggered if certain risk thresholds are exceeded[8] • **[Regulatory Requirement] Maintenance and leakage-response plans:** Require that projects integrate

				provisions to maintain pipelines / equipment and leakage-response plans
Anthropogenic sounds from active seismic geophysical surveys (i.e., legacy subsurface monitoring tool) *(Further reference provided in "Understanding Anthropogenic Noise of Active Seismic Geological Surveys" section below)*	✋Fishing communities whose operational activities coincide with the area of the geophysical survey 🌊Marine life within the water volume (depth and lateral distance) impacted by sounds from the geophysical survey	• Anthropogenic sounds produced during high-resolution geological surveys pose the risks of temporary or permanent physical (e.g., auditory / tissue damage), behavioral (e.g., avoidance of feeding / breeding areas), and physiological (e.g., stress indicators) impacts on marine life, including fish[1, 4]	**High** likelihood of anthropogenic noise generation from active seismic geophysical surveys, given the current reliance on these surveys	• **[Preferred] Risk-optimized monitoring plan:** Prioritize investment in projects that have monitoring and verification plans that appropriately balance the risks with the need for geophysical surveys • **[Preferred] Assessment of anthropogenic sound impacts:** Prioritize projects that integrate an acoustic-biological model with site-specific parameters to assess noise propagation and biological impacts on the species in the affected area and minimize negative impacts on marine life and fishing communities; the model should leverage comprehensive acoustic source data for the specific geophysical survey system[5, 6, 7, 10] • **[Preferred] Recognized limitation of Protected Species Observers (PSOs) personnel or infrared systems on ships and utilize mitigation like the soft-start method:** Prioritize projects that are not solely reliant upon PSOs and soft-start of active seismic geophysical surveys as mitigation strategies; these strategies are not effective at preventing negative impacts to marine life and human communities dependent on marine life • **[Preferred] Emerging monitoring technologies:** Support field trials of emerging CO_2 monitoring approaches that minimize negative environmental and social impacts

Table 2: Summary of the Primary Potential Environmental and Social Impacts of Offshore Storage and the Associated Safeguards

Sources: [1] (2014). Background Document on the Development of Practical Guidance and Toolkits to Minimize and Mitigate the Significant Adverse Impacts of Anthropogenic Underwater Noise on Marine and Coastal Biodiversity. *Convention on Biological Diversity*.; [2] (2015). Sub-seabed CO_2 Storage: Impact on Marine Ecosystems (ECO_2). *European Commission*.; [3] (2024). Ship-mounted camera systems provide real-time detection and increased response time, can reduce the number of whales killed by vessel strikes. *Woods Hole Oceanographic Institution*.; [4] Carroll, A. G., et al. (2017). A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. *Elsevier: Marine Pollution Bulletin*, *114(1)*.; [5] Crocker, S. E., et al. (2019). Measurement of Sounds Emitted by Certain High-Resolution Geophysical Survey Systems. *IEEE Journal of Oceanic Engineering*, *44(3)*.; [6] Ellison, W. T., et al. (2011). A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. *Conservation Biology*, *26(1)*; [7] Fewtrell, J. L., McCauley, R. D. (2012). Impact of air gun noise on the behaviour of marine fish and squid. *Elsevier: Marine Pollution Bulletin*, *64*.; [8] Furre, A., et al. (2016). 20 years of monitoring CO_2-injection at Sleipner. *Energy Procedia*, *114*.; [9] Hall-Spencer, J., et. al. (2008). Volcanic carbon dioxide vents show ecosystem effects of ocean acidification. *Nature*, *454 (96-99)*.; [10] Hovem, J. M., et. al. (2012). Modeling Propagation of Seismic Airgun Sounds and the Effects on Fish Behavior. *IEEE Journal of Oceanic Engineering*, *37(4)*.; [11] Løkkeborg, S., et al. (2012). Sounds from seismic air guns: gear- and species-specific effects on catch rates and distribution. *Canadian Journal of Fisheries and Aquatic Sciences*. 69(8).; [12] Malischek, R., and McCulloch, S. (2021). The world has vast capacity to store CO_2: Net zero means we'll need it. *International Energy Agency*.; [13] McCauley, R. D., et al. (2000). Marine Seismic Surveys - A Study of Environmental Implications. *APPEA Journal*.; [14] Nadim, F. and Kvalstad, T. J. (2007). Risk Assessment and Management for Offshore Geohazards. *First International Symposium on Geotechnical Safety & Risk*.; [15] Streever, B., et. al. (2016). Changes in Fish Catch Rates in the Presence of Air Gun Sounds in Prudhoe Bay, Alaska. *The Arctic Institute of North America*, *69(4)*.

Best practices checklist (supporting Questions 9 and 12)

Table 3 provides the Best Practices Checklist, which is the main deliverable of the Offshore Storage Report (Offshore Storage Report, p.2 & 21). This checklist is aimed to guide the development of sustainable offshore CO_2 storage projects and geologic storage projects more broadly.

Table 3: Offshore Storage Best Practices Checklist		
Categorization	**Best Practice**	**Examples frameworks / references**
Phase I: Site Assessment		
Conduct a baseline assessment	**Did the project assess the reservoir seal integrity?** • Require that projects select storage reservoirs with high-integrity seals that are laterally continuous and which have a low permeability. ★ General regulatory requirement **Did the project conduct a site-specific baseline assessment?** • Require that projects evaluate baseline community and ecosystem parameters, with a strong preference for leveraging a minimum of 1 year of data. Broader datasets can be leveraged in combination with locally collected data. These global data sources include GEOTRACES, International Council for the Exploration of the Sea (ICES), Argo Program, national buoy networks, and fisheries and species databases.	• **Guidance on baseline parameters:** Blackford et al. (2015) recommends a baseline survey that integrates temporal and spatial dynamics.[5] • **Guidance on baseline parameters:** Methratta (2020) recommends a before-and-after gradient design to test parameters at increasing distance from the site of operation before and after development.[12] • **Guidance on detection of threatened mammals:** The Australian Government's Department of Climate Change, Energy, the Environment and Water provides guidance on methods for determining the presence / absence of threatened mammals.[1] • **Examples of critical ecosystems for biodiversity:** Examples of critical ecosystems include whale migratory routes or

	★ General regulatory requirement **Did the project identify and mitigate potential negative impacts to endangered species?** ● Ensure that projects identify endangered species, fisheries taxa, ecosystem engineers and those playing a key role in the community, and species of concern. The project design should alter operations accordingly and/or demonstrate that impacts to critical species are negligible. ★ General regulatory requirement	blue corridors, the U.S. Arctic, the Eastern Pacific, the Southwest Indian Ocean, and the Southwest Pacific and Indonesia.[4, 11]
Evaluate environmental and social impacts	**Does the project integrate stakeholder engagement with all impacted communities?** ● Require that projects implement recurrent formal and informal stakeholder engagement mechanisms with all impacted communities, notably indigenous communities and vulnerable groups, throughout the project lifetime. **Did the project assess environmental and social impacts?** ● Require that projects conduct site-specific social and environmental impact assessments in collaboration with impacted communities (e.g., coastal communities and indigenous groups). The assessment should include plans to mitigate negative impacts. ★ General regulatory requirement **Did the assessment of environmental and social impacts include the impacts of anthropogenic sounds, particularly those associated with CO_2 monitoring technologies?** ● Prioritize projects that (i) integrate an acoustic-biological model with site-specific parameters to assess noise propagation and biological impacts on the species in the affected area and (ii) minimize negative impacts on marine life and fishing communities. The model should leverage comprehensive acoustic source data for the specific geophysical survey system.[6, 7, 8, 10]	● **Guidance on applying an analytical framework to assess the quality of stakeholder engagement:** The United Nations Department of Economic and Social Affairs provides an analytical framework to assess the quality of inclusion, participation, and accountability within stakeholder engagement.[2] ● **Guidance on social and environmental impact assessments:** The Global Carbon Council Environment and Social Safeguard Standard provides a framework and certification process for the assessment and management of environmental and social risks and impacts for CCS projects.[3] ● **Guidance on evaluating behavioral impacts:** Southall et al. (2021) provides guidance on how to evaluate for behavioral impacts on marine mammals from sound exposure. The evaluation integrates variability across species, individuals, situational contexts, and temporal / spatial scales.[14l]
Develop an earthquake monitoring plan	**Does the project integrate a pressure and microseismic monitoring and management plan?** ● Require that projects integrate pressure and microseismic management programs ★ General regulatory requirement	
Develop CO_2 leakage monitoring plan	**Is the project operating within a jurisdiction characterized by robust and enforceable safety regulations for offshore storage?** ● Prioritize projects operating in robust safety regulatory regimes. **Does the project integrate marine life protections beyond the utilization of Protected Species Observers (PSOs) and the soft-start method for active seismic geophysical surveys?** ● Prioritize projects that are not solely reliant upon PSOs and soft-start as mitigation strategies for the negative impacts of active seismic geophysical surveys on marine life. These strategies are not effective at preventing negative impacts to marine life and human communities dependent on marine life. **Does the project integrate a CO_2 monitoring plan?** ● Require that projects integrate a site-specific monitoring plan design with best available technologies that effectively monitor prioritised risks concerning the CO_2 plume while minimizing negative environmental and social impacts. Additional monitoring should be triggered if certain risk thresholds are exceeded.[9] ● Prioritize projects that have monitoring and verification plans that appropriately balance the risks with the need for geophysical surveys. ★ General regulatory requirement	● **Examples of robust and enforceable safety regulations for offshore storage:** Table 1 provides a summary of offshore storage regulatory frameworks and associated environmental and social safeguards. ● **Guidance on a risk-optimized monitoring approach:** Sinha et al. (2024) provides guidance on developing a risk-based or hierarchical monitoring approach which balances continuous and periodic monitoring approaches. Continuous, low-impact approaches are used to detect anomalies in the CO_2 plume and trigger periodic monitoring approaches.[13] ● **Guidance on a risk-optimized monitoring approach:** Furre et al. (2017) provides guidance on optimizing monitoring approaches (i.e., technology, timing, extent) to the project-specific risks.[9] ● **Examples of low-impact monitoring technologies:** Table 7 of the Offshore Storage Report provides examples of technologies with lower-impact potential compared to the potential negative impacts of active seismic geophysical surveys.

	Does the project's CO_2 monitoring plan integrate field trials of emerging monitoring technologies? ● Prioritize projects that integrate field trials of emerging CO_2 monitoring approaches that minimize negative environmental and social impacts. **Does the project integrate maintenance and leakage-response plans?** ● Require that projects integrate provisions to maintain pipelines / equipment and leakage-response plans. ★ General regulatory requirement	
Phase II: CO_2 Injection & Phase III: Post-Injection CO_2 Monitoring **Contextual information regarding leakage risks post injection:** After injection has ceased, leakage risks typically decrease as pressures diminish, leakage pathways are removed (e.g., wells are plugged and abandoned), and more of the CO_2 dissolves or becomes residually trapped in the storage reservoir. Each CO_2 storage project will have its own specific post-injection risks that will need to be assessed and in some cases these residual risks may be deemed high enough for the proponent or regulators to continue monitoring activities. Within regulations globally there is a patchwork of time-based, post-injection monitoring requirements, which may predetermine some of the ongoing monitoring requirements. It is however important to note that monitoring options become more limited once supporting infrastructure and access to the reservoir and overlying geology is removed (e.g., wells are plugged and abandoned). If ongoing monitoring requires this infrastructure, this could actually increase risk over time.		
Implement continuous improvement	**Does the project integrate continuous improvement mechanisms with regards to environmental and social impacts?** ● Require that projects regularly assess for site-specific impacts during the lifetime of the project and update operations accordingly**.** Projects should work with experts and regulators to proactively implement operational and monitoring tactics that manage the various environmental impacts (and related impacts on human communities such as fishing communities). **Does the project regularly assess the effectiveness of its risk-optimized CO_2 monitoring approach?** ● Use dynamic risk assessments to update the risk-optimized CO_2 monitoring approach. Integrate monitoring technologies that reduce negative impacts on marine ecosystems wherever feasible.	● **Guidance on continuous stakeholder engagement:** The Global Carbon Council Environment and Social Safeguard Standard provides a framework and certification process for the identification of impacted stakeholders, continuous and active engagement, and grievance mechanisms.[3]

Table 3: Offshore Storage Best Practices Checklist

Sources: [1] (2024). Survey guidelines for Australia's threatened mammals: Guidelines for detecting mammals listed as threatened under the EPBC Act. *Australian Government: Department of Sustainability, Environment, Water, Population and Communities*.; [2] (2020). What is a "Good Practice?" A Framework to Analyse the Quality of Stakeholder Engagement in Implementation and Follow-up of the 2030 Agenda. *United Nations: Department of Economic and Social Affairs*.; [3] (2025). Environment and Social Safeguard Standard. *Global Carbon Council*. *4(1)*.; [4] (2026). Seascapes: Protecting the places that matter most. World Wildlife Fund.; [5] Blackford, J., et al. (2015). Marine baseline and monitoring strategies for carbon dioxide capture and storage (CCS). *International Journal of Greenhouse Gas Control*. *38*.; [6] Crocker, S. E., et al. (2019). Measurement of Sounds Emitted by Certain High-Resolution Geophysical Survey Systems. *IEEE Journal of Oceanic Engineering*, *44(3)*.; [7] Ellison, W. T., et al. (2011). A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. *Conservation Biology*, *26(1)*; [8] Fewtrell, J. L., McCauley, R. D. (2012). Impact of air gun noise on the behaviour of marine fish and squid. *Elsevier: Marine Pollution Bulletin*, *64*.; [9] Furre, A., et al. (2016). 20 years of monitoring CO_2-injection at Sleipner. *Energy Procedia*, *114*.; [10] Hovem, J. M., et. al. (2012). Modeling Propagation of Seismic Airgun Sounds and the Effects on Fish Behavior. *IEEE Journal of Oceanic Engineering*, *37(4)*.; [11] Johnson, C. M., et al. (2022). Protecting Blue Corridors - Challenges and solutions for migratory whales navigating national and international seas. World Wildlife Fund, *1*.; [12] Methratta, E. T. (2020). Monitoring fisheries resources at offshore wind farms: BACI vs. BAG designs. *ICES Journal of Marine Science*, *77(3)*.; [13] Sinha, M., et al. (2024). Seismic monitoring of CCS with active and passive data: A synthetic feasibility study based on Pelican site, Australia. *International Journal of Greenhouse Gas Control*. *139*.; [14] Southall, B. L., et al. (2021). Marine Mammal Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behavioral Responses to Human Noise. *Aquatic Mammals*, *47(5)*.

Attached Report

All offshore geologic storage responses reference the attachment of the draft report: Dedicated Offshore CO_2 Storage in a Decarbonization Context. We appreciate your consideration of the actionable best practices presented in this report as well as a meeting to discuss the learnings from developing this report.

Sincerely,

Luke Pritchard
Director, Beyond Alliance