Verified Carbon Standard
A VERRA STANDARD

Geologic Carbon Storage Non-Permanence Risk Tool

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1 INTRODUCTION AND SCOPE

This tool provides the procedures for conducting the non-permanence risk and buffer determination required for Geologic Carbon Storage (GCS) projects. The tool sets out the requirements for project proponents, implementing partners, and validation/verification bodies to assess non-permanence risk and determine the appropriate risk rating.

The first version of the tool was developed in 2022 by Verra in collaboration with the CCS+ Initiative, through a working group composed of leading experts. Tool development involved an extensive peer-review process.

Risks in GCS projects are managed through two approaches. Regulatory approaches include setting minimum criteria for project and proponent eligibility and setting project operational and closure requirements. These requirements are provided in the *VCS Standard* and in the *GCS Requirements*. In the *Geologic Carbon Storage Non-Permanence Risk Tool*, risk mitigation is accomplished by assessing the risk of an eligible project and contributing proportionally to the GCS pooled buffer account to ensure that all issued Verified Carbon Units (VCUs) remain valid despite the potential for reversals. Risk ratings are based on an assessment of individual risk factors for each project, which is summed to determine the total risk rating, as set out in Section 2.

This document and the GCS pooled buffer account are subject to periodic reconciliation and revision based on a review of existing GCS verification reports and an assessment of project performance, as set out in the *VCS Program Guide*.

In addition to the requirements set out in this document, GCS projects shall comply with all applicable VCS Program rules and requirements.

The material in this document has been inspired by and adapted from the United States Environmental Protection Agency (EPA) *Underground Injection Control Program Class VI Requirements (40 CFR § 146.86) – Injection Well Construction Requirements,* EPA Office of Water (2013) *Underground Injection Control (UIC) Program Class VI Well Site Characterization Guidance*, the European Parliament and the Council of the European Union (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*, the California Air Resources Board (2018) *Carbon Capture and Sequestration Protocol under the Low Carbon Fuel Standard* and the *ISO 27914 – Carbon dioxide capture, transportation and geological storage – Geological storage* (including all referenced requirements) with amendments made where necessary to fit the context of the VCS Program.

1.1 Scope

1.1.1 This document sets out the procedures for conducting the non-permanence risk analysis for GCS projects. The non-permanence risk rating ("risk rating") is used to determine the number

of buffer credits that a GCS project shall deposit into the GCS pooled buffer account. The procedure for depositing buffer credits is set out in the VCS Program document *Registration and Issuance Process.*

1.1.2 In the context of buffer credits for GCS projects, the principal concern for permanence is CO_2 loss from the storage zone(s) to the atmosphere. Given the VCS principles to do no harm and to recognize community and biodiversity impacts, risk mitigation in GCS projects is also concerned with unanticipated CO_2 loss from the storage reservoir to adjacent formations impacting underground sources of drinking water (USDW) and/or other subsurface resources.

1.1.3 This document applies to projects that sequester CO_2 with the intent of permanence on geologic timescales (e.g. thousands of years). Acknowledging that assessment across these timescales is not feasible, the VCS assesses the durability of sequestered CO_2 through the injection period and post-injection assessment period. CO_2 reductions and removals from projects that meet the eligibility conditions and operating requirements and contribute to the GCS pooled buffer account according to the risk rating prescribed in this document are considered permanent for the *VCS Standard*.

1.1.4 Section 2 of this document applies to carbon capture and storage (CCS) projects as defined in the *VCS Standard*. The requirements in this document do not apply to CO_2 storage in enhanced oil recovery (EOR) schemes, geologic mineralization, materials (cement, steel, etc.), fuels, or biogenic carbon sinks. Additional sections may be included in this document in subsequent revisions to assess the risk of other such GCS activities.

2 CARBON CAPTURE AND STORAGE RISK ANALYSIS AND BUFFER DETERMINATION

2.1 Risk Analysis

2.1.1 The project shall be evaluated against each category in Section 2.2. and the project proponent shall follow the calculation formulas in each table to determine the risk rating for each category.

2.1.2 Project proponents shall document and substantiate the risk analysis covering each risk factor applicable to the project.

2.1.3 The validation/verification body shall evaluate the risk analysis undertaken by the project proponent and assess all data, rationales, assumptions, justifications, and documentation provided by the project proponent to support the non-permanence risk rating.

2.1.4 The overall risk rating shall be determined by summing each of the risk category scores, following the procedure in Section 2.3.

2.2 Risk Categories

2.2.1 Regulatory Framework Risk (RFR) shall be assessed using Table 1, noting the following:

1) RFR refers to the rules of the jurisdiction in which the project is located that pertain to well licensing, well classification (including a classification for high-pressure or acid gas injection wells), casing and cementing requirements, downhole abandonment requirements, and accessibility/reliability of records of pre-existing wells in the area of review. The rules may include legislation, regulations, standards, directives, and the practices of the relevant regulator, including enforcement and guidance documents.

2) Priority refers to an explicit regulatory or legislative system that manages conflicts between competing resources in a way that protects the storage integrity and permanent storage of CO_2 in a CCS project relative to competing geological resources now and in the future.

3) Transfer of liability refers to the transfer of liability for the CCS storage site(s) from the operator of the facility to the regulating jurisdiction after:

   a) Injection has ceased,

   b) The site(s) has/have been closed as per the closure plan, and

c) The regulator is satisfied that the CO_2 has been demonstrated, with a high degree of confidence, to behave in a stable and predictable manner.

The transfer of liability includes liability for any required remedial operations (remedial liability) as well as liability to reconcile any loss of carbon credits resulting from the leakage of injected CO_2 to the atmosphere (climate liability). Where the transfer of liability to the jurisdiction is not possible, liability will remain with the project proponent.

Table 1: Regulatory Framework Risk (RFR)

Risk Element	Description or Criteria	Score
a)	The jurisdiction has in place a regulatory framework that affords priority to a CO_2 storage project in the event of any competing pore space resource use, such as oil and gas production activities, other waste disposal activities, gas storage, geothermal energy, mineral brine exploration, and development, or other resource activities.	0
	The jurisdiction does not have in place a regulatory framework that affords priority to a CO_2 storage project in the event of any competing pore space resource use, such as oil and gas production activities, other waste disposal activities, gas storage, geothermal energy, mineral brine exploration, and development or other resource activities.	0.125
b)	A legislative or regulatory rule providing for the transfer of both climate and remedial liability is in place.	0
	A legislative or regulatory rule providing for the transfer of remedial liability or climate liability (but not both) is in place.	0.0625
	There is no legislative or regulatory rule providing for the transfer of liability.	0.125
Total Regulatory Framework Risk (RFR) = a + b		

2.2.2 Political Risk (PR) shall be assessed using Table 2, noting the following:

1) A governance score (of between −2.5 and 2.5) for the jurisdiction in which the storage facility is located shall be calculated from the mean of governance scores across the six indicators of the World Bank Institute's Worldwide Governance Indicators (WGI)[1], averaged over the most recent five years of available data.

2) Governance scores shall be translated into risk scores as set out in Table 2.

[1] World Bank, Yearly, Worldwide Governance Indicators, http://info.worldbank.org/governance/wgi

3) If a country does not have at least five years of data for any WGI's, it is not eligible for CCS projects under the VCS program.

Table 2: Political Risk (PR)

Risk Element	Description or Criteria	Score
a)	Governance score of 0.82 or higher	0
	Governance score of 0.19 to less than 0.82	0.25
	Governance score of −0.32 to less than 0.19	0.5
	Governance score of −0.79 to less than −0.32	2
	Governance score of less than −0.79	4
Total Political Risk (PR) = a		

2.2.3 Land and Resource Tenure Risk (LRTR) shall be assessed using Table 3, noting the following:

1) Land and resource tenure refers to the exclusive right to use the storage reservoirs and pore space for the injection of CO_2, as well as the surface rights to install injection facilities, pipelines, access roads, monitoring wells, or other sensory equipment for GCS projects.

2) Reservoir and pore space rights for the injection of CO_2 and surface rights may be owned by the government, communities, or private entities.

Table 3: Land and Resource Tenure Risk (LRTR)

Risk Element	Description or Criteria	Score
a)	All pore space within the area of review is government-owned.	0
	At least some of the pore space within the area of review is community- or privately owned.	0.125
b)	Access to injection facilities, monitoring wells, and other sensory equipment is secured through ownership, leases, rights of way, or government-issued right of entry orders for the duration of the project and the post-injection site care (PISC) period.	0
	Access to injection facilities, monitoring wells, and other sensors are secured through ownership, leases, rights of way, or government-issued right of entry orders for a portion of the project and PISC period but is subject to expiry and/or conditional renewals during the injection or PISC periods.	0.25
Total Land and Resource Tenure Risk (LRTR) = a + b		

2.2.4 Closure Financial Risk (CFR) shall be assessed using Table 4, noting the following:

1) The CFR is based on the funds in place for post-injection site care (PISC) costs (closure and post-closure monitoring as per the GCS closure plan) at the time of evaluation (when the *GCS Non-Permanence Risk Tool is* used at validation and each verification), and on the likelihood that funding will be in place at the end of injection.

2) There are different types of funding:

   a) Secured project funding refers to dedicated, unencumbered funding such as trust funds, endowments, bonds, irrevocable letters of credit, cash on deposit with the regulator or government, and private insurance. Secured project funding shall be dedicated to PISC costs for the project and cannot be accessed for other purposes or projects by the project proponent or secured as collateral by other creditors of the project proponent. This includes any secured project funding collected or prescribed by the jurisdictional regulator that the project can access for PISC activities. It does not include regulator- or government-managed funds intended for servicing costs incurred by the jurisdiction after the transfer of liability has occurred.

   b) Unsecured funding refers to cash-in-place corporate guarantee, self-insurance, and contractual agreements over which the project proponent has control and that can be used to service PISC costs. Unsecured funding also includes callable financial resources that are readily available to the project. The availability of such resources may be indicated through revocable letters of credit, revolving credit lines, corporate

guarantees, or other financial backing, as evidenced by signed agreements that demonstrate the project's ability to access funding as needed.

3) PISC costs include monitoring program costs (from the end of injection to site closure), site closure costs, well-plugging costs, remediation costs, any corrective action costs, and post-closure monitoring costs.

4) The percentage of PISC costs covered shall be calculated by adding up all funding and revenue available according to the categories of funding described in Section 2.2.4(2) and dividing this by the PISC cost as identified in the GCS closure plan.

5) Evidence shall be provided that agreement counterparties are in good financial standing to demonstrate the ability to meet the financial obligations. Project proponents may demonstrate funding through, for example, financial statements, bank records, surety bonds, or private insurance agreements.

6) Project proponents with mixed funding models (including secured funding, unsecured funding, and insufficient funding) shall complete Table 4 by inputting the proportion of funding in each of the categories and shall add up the total according to the equation given. Where a jurisdiction requires a project proponent to post or otherwise maintain financial security for PISC costs to obtain regulatory approval, the project proponent may use the amounts of such financial security to meet the requirements of Table 4.

Table 4: Closure Financial Risk (CFR)

Risk Element	Description or Criteria
a)	The percentage of PISC costs covered by secured funding (expressed as a decimal)
b)	The percentage of PISC costs covered by unsecured funding (expressed as a decimal)
c)	The percentage of PISC costs not funded (expressed as a decimal)
Total Closure Financial Risk (CFR) = a + (1.5 × b) + (5 × c)	

2.2.5 Design Risk (DR) shall be assessed using Table 5, noting the following:

1) In cases where a project has multiple storage zones and/or storage sites, the risk analysis shall be carried out for each respective storage site and/or storage zone and the highest risk rating obtained shall be applied across the entirety of the project.

2) Appendix 1 provides design guidelines for injection wells. These are adapted from the US EPA *Underground Injection Control Program Class VI Requirements (40 CFR § 146.86) – Injection Well Construction*.

3) Confining layers and storage reservoirs are of sufficient size and integrity to contain the injected carbon dioxide without initiating or propagating fractures or leakage from the storage site.

Table 5: Design Risk (DR)

Risk Element	Description or Criteria	Score
a)	All injection wells for the project meet the design guidelines in Appendix 1.	0
	Some or all injection wells for the project do not meet the design guidelines in Appendix 1.	2
b)	The storage reservoir has more than two confining layers above the sequestration zone.	0
	The storage reservoir does not have more than two confining layers above the sequestration zone.	1
c)	The project proponent has access to relevant data (e.g., drilling logs, seismic data, core samples) from all wells that penetrate the primary or any secondary seals of the storage reservoir within the area of review for site characterization and monitoring as part of the monitoring program.	0
	There are wells other than the injection and monitoring wells of the project that penetrate the primary or any secondary seals of the storage reservoir within the area of review, to which the project proponent does not have access for review or inclusion of relevant data (e.g., drilling logs, seismic data, core samples) for site characterization and monitoring as part of the monitoring program.	1.5
Total Design Risk (DR) = a + b + c		

2.3 Overall Non-Permanence Risk Rating and Buffer Determination

2.3.1 The overall non-permanence risk rating shall be determined using Table 6.

Table 6: Overall Risk Rating

Risk Category		Total Risk Score
RFR	Regulatory Framework Risk	
PR	Political Risk	
LRTR	Land and Resource Tenure Risk	
CFR	Closure Financial Risk	
DR	Design Risk	
Overall risk rating = RFR + PR + LRTR + CFR + DR		

2.3.2 The minimum risk rating shall be 1, as per calculations in Tables 1–6. As outlined in the GCS Requirements, the maximum acceptable non-permanence risk rating for a CCS project is 7 at validation and each verification.

2.3.3 To determine the number of buffer credits that shall be deposited in the GCS pooled buffer account, the overall risk rating shall be converted to a percentage (e.g., an overall risk rating of 3 converts to 3 percent). This percentage shall be multiplied by the tonnes of injected CO_2 (stated in the verification report), as set out in the VCS Program document *Registration and Issuance Process*.

2.3.4 Buffer credits shall be deposited in the GCS pooled buffer account per the procedures set out in the VCS Program document *Registration and Issuance Process*. The rules and requirements for the release and cancellation of buffer credits from the GCS pooled buffer account are set out in the same document.

2.3.5 In cases where a project has multiple storage zones and/or storage sites, the risk analysis shall be carried out for each respective storage site and/or storage zone and the highest risk rating obtained shall be applied across the entirety of the project.

APPENDIX 1: INJECTION WELL GUIDELINES

These guidelines are adapted from the US EPA *Underground Injection Control Program Class VI Requirements (40 CFR § 146.86) Injection Well Construction Requirements* and help to characterize the design risk of a GCS project (Table 5).

A) General. The CO_2 injection wells are constructed and completed to:

1) Prevent the movement of fluids into or between USDWs or into other zones;
2) Permit the use of appropriate testing devices and workover tools; and
3) Permit continuous monitoring of the annulus space between the injection tubing and the long string casing.

B) Casing and cementing of CO_2 injection wells.

1) Casing and cement or other materials used in the construction of each CO_2 injection well have sufficient structural strength and are designed for the life of the GCS project. All the well materials are compatible with fluids with which the materials may be expected to come into contact and meet or exceed standards developed for such materials by the American Petroleum Institute, ASTM International, or comparable standards acceptable to the regulator of the jurisdiction in which the GCS project is located. The casing and cementing programs are designed to prevent the movement of fluids into or between USDWs.
2) Surface casing extends through the base of the lowermost USDW and is cemented to the surface with single or multiple strings of casing and cement.
3) At least one long string casing, using a sufficient number of centralizers, extends to the injection zone and must be cemented by circulating cement to the surface in one or more stages.
4) Cement and cement additives are compatible with the CO_2 stream and formation fluids and are of sufficient quality and quantity to maintain integrity over the design life of the GCS project. The integrity and location of the cement shall be verified using technology capable of radially evaluating cement quality and identifying the location of channels to ensure that USDWs are not endangered.

C) Tubing and packer

1) Tubing and packer materials used in the construction of each CO_2 injection well are compatible with fluids with which the materials may be expected to come into contact and must meet or exceed standards developed for such materials by the American Petroleum Institute, ASTM

International, or comparable standards acceptable to the regulator of the jurisdiction in which the GCS project is located.

2) All storage site operators shall inject fluids through tubing with a packer set at a depth opposite a cemented interval.

APPENDIX 2: DOCUMENT HISTORY

Version	Date	Comment
v4.0	21 Dec 2022	Initial version released under VCS Version 4.
v4.0	17 Jan 2023	Minor formatting errors were corrected.

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