BioCarbon Standard

METHODOLOGICAL DOCUMENT

Carbon Dioxide Removal (CDR)

BCR0017
Soil Carbon Removal through Agricultural Management and Mineral Weathering

BIOCARBON CERT®

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Credits

This document has been prepared by BioCarbon Cert as part of the BioCarbon Standard (BCS).

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Acronyms and abbreviations

ADC	Avoiding Double Counting
AFOLU	Agriculture, Forestry and Other Land Use
BAT	Baseline and Additionality Tool
BD	Bulk Density
C	Carbon
CAB	Conformity Assessment Body
CDR	Carbon Dioxide Removal
CFF	Coarse Fragment Fraction
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DIC	Dissolved Inorganic Carbon
DOC	Dissolved Organic Carbon
EF	Emission Factor
GCDR	Gross Carbon Dioxide Removal
GHG	Greenhouse gas
GIS	Geographic Information System
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LE	Leakage Emissions
MRV	Monitoring, Reporting and Verification
N_2O	Nitrous oxide
N_2O-N	Nitrous oxide expressed as nitrogen
NCDR	Net Carbon Dioxide Removal
PE	Project Emissions
PSD	Particle Size Distribution
QA/QC	Quality Assurance and Quality Control
SDGs	Sustainable Development Goals
SDSs	Sustainable Development Safeguards
SIC	Soil Inorganic Carbon
SOC	Soil Organic Carbon
tC	Metric tonne of carbon
tCO_2	Metric tonne of carbon dioxide
tCO_2e	Metric tonne of carbon dioxide equivalent
UNFCCC	United Nations Framework Convention on Climate Change
VCC	Verified Carbon Credit

1 Introduction

Managed agricultural soils may contribute to climate change mitigation through carbon dioxide removal (CDR), provided that removals are additional, measurable, attributable, durable, conservatively quantified, and independently verified.

This methodology establishes requirements for quantifying net anthropogenic carbon dioxide removals in agricultural soils through soil organic carbon (SOC) enhancement and soil inorganic carbon (SIC) formation. These pathways are treated as distinct but complementary forms of carbon storage, reflecting their different mechanisms, monitoring requirements, uncertainty profiles, and permanence characteristics.

The methodology is designed to address carbon removal pathways that are not fully covered by agricultural land management methodologies focused on general agronomic practices or soil organic carbon enhancement alone. Its purpose is to provide a transparent, conservative, and replicable framework for quantifying net removals associated with SOC enhancement, SIC formation, and mineral weathering processes in managed agricultural systems.

This methodology is not intended to credit general regenerative agriculture practices as standalone mitigation activities. Agricultural management practices, biological inputs, mineral amendments, organic amendments, or other soil interventions are eligible only where they result in measurable and verifiable net carbon dioxide removals in SOC and/or SIC pools, relative to a conservative baseline scenario.

This methodology does not apply to biochar production or application, forest carbon activities, afforestation, reforestation, REDD+, peatland restoration, wetland conservation, direct air capture, bioenergy with carbon capture and storage, or other carbon dioxide removal pathways covered by separate methodologies.

2 Objectives

The objectives of this methodology are to:

(a) Establish a conservative, transparent, and replicable framework for quantifying net anthropogenic carbon dioxide removals in managed agricultural soils through soil organic carbon (SOC) enhancement and soil inorganic carbon (SIC) formation or accumulation;
(b) Provide activity-specific requirements for project activities that seek to increase durable carbon storage in agricultural soils through eligible soil management interventions, mineral amendments, biological inputs, organic amendments, or other practices that can be demonstrated to result in measurable and verifiable carbon dioxide removals;
(c) Distinguish clearly between the agricultural or soil management practices implemented by the project and the carbon dioxide removal outcomes credited under

the BioCarbon Standard, ensuring that practices, inputs, or technologies are not credited as such, but only to the extent that they generate quantified net removals in eligible SOC and/or SIC pools;

(d) Establish separate accounting requirements for SOC and SIC, recognizing their different formation mechanisms, monitoring requirements, uncertainty profiles, and permanence characteristics;

(e) Provide a methodological basis for quantifying carbon dioxide removals associated with mineral weathering processes in agricultural soils, including the formation or accumulation of stable soil inorganic carbon;

(f) Ensure that baseline determination, additionality, monitoring, leakage, uncertainty, permanence, safeguards, sustainable development contributions, and double counting avoidance are addressed through the applicable BioCarbon Tools, as part of the modular architecture of this methodology;

(g) Support consistency with recognized scientific guidance for land-based carbon accounting and carbon dioxide removal, including IPCC-based approaches for soil carbon and anthropogenic removals;

(h) Reduce the risk of over-crediting through conservative baseline setting, separate pool accounting, uncertainty management, leakage assessment, and independent verification;

(i) Ensure that project activities applying this methodology are distinct from general agricultural land management activities and are eligible only where measurable and verifiable net carbon dioxide removals in SOC and/or SIC pools can be demonstrated.

This methodology shall ensure that all credited mitigation outcomes are measurable, additional, conservative, and verifiable, and aligned with the integrity requirements of the BioCarbon Standard.

3 Scope

This methodology applies to project activities implemented in managed agricultural soils that are designed to generate and quantify net anthropogenic carbon dioxide removals through one or both of the following pathways:

(a) measurable enhancement of soil organic carbon (SOC) stocks; and

(b) measurable formation or accumulation of soil inorganic carbon (SIC), including SIC associated with mineral weathering processes.

This methodology is a Carbon Dioxide Removal (CDR) methodology for agricultural soils. It applies only to project activities that result in measurable, attributable, conservatively quantified, and independently verified net carbon dioxide removals in eligible soil carbon pools.

Eligible project activities under this methodology may include, but are not limited to:

(a) application of eligible silicate minerals or other approved mineral amendments that promote mineral weathering and SIC formation;
(b) application of biological inputs, microbial inoculants, enzymes, or other soil biological products that support SOC stabilization, SIC formation, or mineral weathering processes;
(c) application of organic amendments, excluding biochar, that contribute to SOC accumulation or stabilization;
(d) soil management interventions that improve soil structure, aggregation, biological activity, or chemical conditions relevant to SOC accumulation or SIC formation;
(e) practices aimed at restoring degraded agricultural soils where such restoration results in measurable SOC and/or SIC removals;
(f) integrated soil management systems that combine mineral, biological, organic, and agronomic interventions, provided that the resulting SOC and/or SIC removals can be quantified in accordance with this methodology.

The methodology is designed to be applicable across a range of agricultural and environmental contexts, including:

(a) different climatic zones;
(b) varying soil types and mineralogical conditions;
(c) different land-use histories and baseline management conditions;
(d) heterogeneous agricultural landscapes;
(e) systems with different levels of management intensity and technical capacity;
(f) regions where SOC and/or SIC changes can be monitored through appropriate sampling, laboratory analysis, modelling where applicable, and uncertainty management procedures.

This methodology focuses on outcome-driven carbon dioxide removal rather than reliance on a specific proprietary technology, input, product, or agronomic package. Project activities shall not be credited on the basis of the use of a specific product, practice, or input. Crediting shall be based only on quantified and verified net carbon dioxide removals in eligible SOC and/or SIC pools.

This methodology adopts a net CDR accounting approach. Gross SOC and/or SIC removals shall be adjusted for:

(a) project emissions;
(b) leakage;
(c) uncertainty;
(d) reversals, where applicable;
(e) applicable reserve contributions; and

(f) any other deductions required under the BioCarbon Standard and the applicable BioCarbon Tools.

Only absolute net carbon dioxide removals shall be eligible for crediting. Improvements in emission intensity, crop productivity, soil fertility, soil health, or agronomic performance alone shall not be sufficient for crediting unless they result in quantified and verified net carbon dioxide removals.

This methodology is distinct from BioCarbon methodologies addressing general agricultural land management, improved agricultural practices, or soil organic carbon enhancement alone. A project activity shall not apply this methodology where it only implements general improved agricultural practices without demonstrating quantified and verified net carbon dioxide removals in SOC and/or SIC pools in accordance with the accounting, monitoring, and verification requirements of this methodology.

This methodology shall not apply to:

(a) biochar production or application;
(b) afforestation, reforestation, REDD+, or forest management activities;
(c) peatland restoration, wetland conservation, mangrove restoration, or other blue carbon activities;
(d) direct air capture, bioenergy with carbon capture and storage, or geological carbon storage activities;
(e) activities that only improve agricultural productivity, soil fertility, or soil health without quantified and verified net carbon dioxide removals;
(f) activities where project boundaries, land tenure or use rights, carbon rights, baseline conditions, or monitoring arrangements cannot be demonstrated in accordance with the BioCarbon Standard and the applicable BioCarbon Tools.

The methodology is applicable only where the project holder can demonstrate that the data required for SOC and/or SIC quantification are available, reliable, traceable, and sufficient to support validation, monitoring, verification, and issuance under the BioCarbon Standard.

4 Version

This document constitutes the Version for Public Consultation of the methodology BCR0017 – Soil Carbon Removal through Agricultural Management and Mineral Weathering: Carbon Dioxide Removal (CDR) Methodology for Agricultural Soils.

This version has been prepared for stakeholder review, technical assessment, and public consultation under the BioCarbon Standard. The publication of this document for public consultation does not constitute final approval of the methodology, nor does it authorize the

registration, validation, verification, or issuance of Verified Carbon Credits (VCCs) under this methodology.

Comments, technical recommendations, and stakeholder inputs received during the public consultation process may result in substantive or editorial revisions to this document. BioCarbon may modify, clarify, expand, or remove methodological provisions prior to final approval, including provisions related to scope, applicability conditions, baseline determination, quantification, monitoring, uncertainty management, permanence, leakage, safeguards, and double counting avoidance.

Project holders, Conformity Assessment Bodies, and other intended users shall not apply this methodology for validation, verification, or credit issuance until BioCarbon has formally approved and published a final version of the methodology.

Once approved, the final version of this methodology will specify its effective date, applicable transition provisions, and any version-control rules governing its use. Intended users shall ensure that they apply the most recent approved version of the methodology and all applicable BioCarbon Standard tools in force at the time of validation or verification, as applicable.

5 Applicability conditions

All project activities under this methodology shall meet the following conditions:

(a) The project activity shall be implemented on eligible managed agricultural land and mineral soils in accordance with the applicability conditions of this methodology.
(b) The project activity shall result in measurable and verifiable net carbon dioxide removals in SOC and/or SIC pools.
(c) SOC and SIC shall be quantified separately where both pools are included.
(d) The project activity shall apply a conservative baseline scenario consistent with the BioCarbon Baseline and Additionality Tool.
(e) The project activity shall include a monitoring design capable of detecting SOC and/or SIC changes with adequate statistical confidence.
(f) All inputs used to support credited removals shall be traceable from origin to field application.
(g) All material project emissions, leakage, uncertainty, and reversal risks shall be assessed and accounted for in accordance with the applicable BioCarbon Tools.
(h) The project activity shall not cause conversion of natural ecosystems, deforestation, forest degradation, wetland degradation, biodiversity loss, or significant adverse environmental or social impacts.

(i) The project holder shall demonstrate the right to implement the activity, access the land, apply relevant inputs, monitor the project area, and claim the resulting carbon dioxide removals.
(j) The project activity shall comply with all applicable legal, environmental, social, safeguards, and double counting requirements under the BioCarbon Standard.

5.1 Additional requirement for mineral amendments

Where mineral amendments are applied, the project holder shall demonstrate that such amendments meet documented mineralogical, chemical, contaminant, leachability, dust, occupational safety, legal sourcing, and chain-of-custody requirements. Materials that present unacceptable risks to soil, water, biodiversity, workers, or communities shall be ineligible, regardless of their theoretical CO_2 uptake potential. Evidence demonstrating compliance with this requirement shall be documented in the Project Document and monitored in accordance with Sections 15.6, 15.7, and 17.3.

6 Methodology type and modular architecture

This methodology is a modular methodology under the BioCarbon Standard. It defines activity-specific requirements for carbon dioxide removal in agricultural soils through soil organic carbon enhancement and soil inorganic carbon formation, and shall be applied together with the applicable BioCarbon Standard requirements and the mandatory BioCarbon Tools in force at the time of validation or verification, as applicable.

The most recent version in force of each of the following BioCarbon Tools shall be applied in full, according to the scope, risks, and characteristics of the project activity:

(a) Baseline and Additionality Tool;
(b) Monitoring, Reporting and Verification Tool;
(c) Leakage Management Tool;
(d) Conservative Approach and Uncertainty Management Tool;
(e) Permanence and Risk Management Tool;
(f) Avoiding Double Counting Tool;
(g) Sustainable Development Safeguards Tool; and
(h) Sustainable Development Goals Contribution Tool.

The requirements contained in these Tools are normative and mandatory. Where requirements related to baseline determination, additionality, monitoring, reporting, verification, leakage, uncertainty, permanence, safeguards, sustainable development contributions, or double counting avoidance are addressed through an applicable BioCarbon Tool, the provisions of that Tool shall prevail.

This methodology shall not duplicate, replace, or modify the requirements established in those instruments. Its role is to define the eligible activity, carbon pools, project boundary,

quantification approach, soil-specific monitoring requirements, and activity-specific conditions necessary to quantify carbon dioxide removals in agricultural soils.

Failure to comply with any applicable BioCarbon Tool shall render the project activity ineligible for registration, verification, or issuance under this methodology.

All references shall be applied in a manner that ensures consistency, transparency, and conservativeness in the quantification of greenhouse gas emission reductions and removals.

7 Relationship with other BioCarbon methodologies

This methodology is distinct from BioCarbon methodologies addressing general agricultural land management, improved agricultural practices, or soil organic carbon enhancement alone.

The methodology applies only where the project activity is designed to generate and quantify net carbon dioxide removals in agricultural soils through measurable enhancement of soil organic carbon stocks, measurable formation or accumulation of soil inorganic carbon associated with mineral weathering processes, or both.

Agricultural management practices, biological inputs, mineral amendments, organic amendments, or other soil interventions are not credited as standalone activities. They are eligible only to the extent that they contribute to quantified and verified net carbon dioxide removals in SOC and/or SIC pools.

Where a project activity only implements improved agricultural practices without quantifying net carbon dioxide removals in SOC and/or SIC pools in accordance with this methodology, the project shall not apply this methodology and shall use the applicable agricultural land management methodology under the BioCarbon Standard.

8 Normative references / Methodological basis

8.1 General

This methodology shall be applied in conjunction with the BioCarbon Standard, the applicable BioCarbon Tools, the BioCarbon validation and verification requirements, and the methodology-specific provisions contained herein.

The project holder shall apply the most recent version in force of each applicable BioCarbon Standard document, tool, procedure, template, and guidance document, unless BioCarbon expressly requires a specific version.

External standards, IPCC guidance, UNFCCC/CDM documents, ISO standards, and other technical sources may be used to support methodological consistency, scientific robustness, and internationally recognized accounting principles. They shall not override BioCarbon Standard requirements.

8.2 BioCarbon Standard documents and tools

The following BioCarbon Standard documents shall be applied, as applicable, in their most recent versions in force:

(a) BioCarbon Standard;
(b) BioCarbon Standard Operating Procedures;
(c) BioCarbon Validation and Verification Manual;
(d) applicable BioCarbon Tools listed in Section 6 of this methodology;
(e) applicable BioCarbon templates for Project Documents, Monitoring Reports, validation reports, verification reports, and supporting documentation;
(f) any additional BioCarbon rules, procedures, modules, or guidance documents formally issued by BioCarbon and applicable to the project activity.

Where the BioCarbon Standard, a BioCarbon Tool, or an applicable BioCarbon procedure establishes a requirement related to eligibility, validation, verification, issuance, registry operation, safeguards, or accounting integrity, such requirement shall be considered mandatory under this methodology.

8.3 IPCC guidance

This methodology is designed to be consistent with the principles and accounting logic of the IPCC Guidelines for National Greenhouse Gas Inventories and the 2019 Refinement to the 2006 IPCC Guidelines, particularly for land representation, cropland and grassland classification, soil carbon stock changes, managed agricultural soils, and non-CO_2 emissions from managed soils.

The following IPCC sources shall be used as methodological references, where applicable:

(a) 2006 IPCC Guidelines, Volume 4, Chapter 2: Generic Methodologies Applicable to Multiple Land-Use Categories;
(b) 2006 IPCC Guidelines, Volume 4, Chapter 3: Consistent Representation of Lands;
(c) 2006 IPCC Guidelines, Volume 4, Chapter 5: Cropland;
(d) 2006 IPCC Guidelines, Volume 4, Chapter 6: Grassland;
(e) 2006 IPCC Guidelines, Volume 4, Chapter 10: Emissions from Livestock and Manure Management, where relevant;
(f) 2006 IPCC Guidelines, Volume 4, Chapter 11: N_2O Emissions from Managed Soils, and CO_2 Emissions from Lime and Urea Application;
(g) 2019 Refinement to the 2006 IPCC Guidelines, Volume 4, including relevant refinements to the chapters listed above.

For SOC, this methodology follows the general IPCC stock-change logic for mineral soils. For SIC and enhanced mineral weathering, this methodology recognizes that IPCC includes SIC within the soil carbon accounting framework, but does not provide a complete project-level crediting procedure for attributing newly formed SIC to enhanced mineral weathering.

Therefore, this methodology establishes methodology-specific requirements for SIC quantification, attribution, exclusion of lithogenic and exogenous inorganic carbon, uncertainty management, and conservative crediting.

8.4 UNFCCC/CDM and ISO references

The following UNFCCC/CDM sources may be used as supporting references where technically relevant and consistent with the BioCarbon Standard:

(a) UNFCCC Clean Development Mechanism Glossary of CDM Terms;
(b) UNFCCC CDM Executive Board, EB23, Annex 18: Definition of Renewable Biomass;
(c) applicable CDM methodological tools or approved methodologies where expressly referenced by this methodology or an applicable BioCarbon Tool.

The CDM definition of renewable biomass may be used as supporting guidance for assessing the sustainable origin of biomass residues, organic amendments, or biogenic inputs. Such materials shall not be sourced in a manner that results in a decrease of carbon pools in the source area.

The following ISO standards provide supporting requirements and principles for project-level GHG accounting, monitoring, reporting, validation, and verification:

(a) ISO 14064-2:2019;
(b) ISO 14064-3:2019;
(c) ISO 14065:2020;
(d) ISO/IEC 17029:2019.

In case of inconsistency between ISO standards and BioCarbon requirements, the BioCarbon Standard shall prevail.

8.5 Documentation and traceability

The project holder shall document in the Project Document and Monitoring Reports how the applicable BioCarbon documents, IPCC guidance, external references, and methodology-specific procedures have been applied.

All data sources, assumptions, models, laboratory methods, calculation files, and supporting evidence shall be retained and made available for validation and verification in accordance with the BioCarbon Monitoring, Reporting and Verification Tool.

9 Terms and definitions

For terms not defined herein, the definitions contained in the BioCarbon Standard, and the applicable BioCarbon Tools shall apply. Certain terms are defined specifically for the purposes of SOC, SIC, and mineral weathering accounting under this methodology.

Additionality

The condition whereby greenhouse gas (GHG) emission reductions or removals would not have occurred in the absence of the project activity, as demonstrated in accordance with the BioCarbon Baseline and Additionality Tool (BAT).

Agricultural soil

Soil located within managed agricultural land, including cropland, managed grassland, or managed pasture, where agricultural production, grazing, or soil management activities are implemented and where SOC and/or SIC stocks may be monitored and quantified.

Baseline scenario

The most plausible and conservative counterfactual scenario of land management, soil carbon dynamics, GHG emissions, and GHG removals that would occur in the absence of the project activity, as determined in accordance with the BioCarbon Baseline and Additionality Tool and the requirements of this methodology.

Biological input

A soil input containing living or biologically active components, including microbial inoculants, consortia of microorganisms, enzymes, metabolites, or other biological products intended to influence soil biological activity, soil aggregation, SOC stabilization, mineral weathering, or SIC formation.

Carbon Dioxide Removal (CDR)

The anthropogenic withdrawal of carbon dioxide (CO_2) from the atmosphere and its durable storage in an eligible carbon pool. Under this methodology, removals are eligible only where they are quantified as net carbon dioxide removals in SOC and/or SIC pools.

Carbon stock

The quantity of carbon stored in a defined carbon pool at a specific point in time, expressed in mass of carbon per unit area or as total mass of carbon within a defined project area or stratum.

Carbonate amendment

A soil amendment composed partly or entirely of carbonate, bicarbonate, lime, limestone, dolomite, or other material that directly adds inorganic carbon or alkalinity to soil. Carbonate amendments are not eligible as mineral weathering inputs for credited SIC removals unless exogenous inorganic carbon is conservatively deducted in accordance with the SIC quantification requirements of this methodology.

Chain of custody

The documented process by which inputs, materials, and associated information are tracked from their origin through transport, storage, handling, and final application within the project area. Under this methodology, chain of custody applies to mineral amendments, biological inputs, organic amendments, biomass residues, and any other soil inputs used to support credited removals.

Cropland

Managed land used for the production of annual or perennial crops, including temporary crops, permanent crops, fallow areas within crop rotations, and other cultivated agricultural systems, as defined by the applicable national land-use classification or relevant IPCC land-use category.

Eligible carbon pool

A carbon reservoir eligible for crediting under this methodology. Eligible carbon pools are limited to soil organic carbon (SOC) and soil inorganic carbon (SIC). Aboveground biomass, belowground biomass, dead wood, litter, harvested products, and biochar carbon are not eligible carbon pools under this methodology.

Eligible mineral amendment

A mineral material applied to agricultural soils that is approved under this methodology and that may contribute to mineral weathering, alkalinity generation, atmospheric CO_2 uptake, or SIC formation, subject to the eligibility, traceability, contaminant, and quantification requirements of this methodology.

Emission intensity

Greenhouse gas emissions per unit of agricultural output, such as per unit of crop yield, fiber, biomass, or livestock product. Improvements in emission intensity alone shall not be sufficient for crediting under this methodology.

Enhanced mineral weathering

Project-induced acceleration of mineral weathering processes through the application of eligible silicate mineral amendments or other approved interventions that increase mineral dissolution and associated atmospheric CO_2 uptake. Under this methodology, enhanced mineral weathering may be credited only where it results in quantified and verified net carbon dioxide removals in eligible SOC and/or SIC pools.

Exogenous inorganic carbon

Inorganic carbon introduced into the project area through external inputs, including carbonate minerals, bicarbonates, lime, limestone, dolomite, industrial residues, or any other input containing inorganic carbon. Exogenous inorganic carbon shall not be credited as atmospheric carbon dioxide removal and shall be conservatively deducted where relevant.

Greenhouse gas (GHG)

Gases that contribute to the greenhouse effect, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

Gross carbon dioxide removal

The quantity of carbon dioxide removals attributable to the project activity and stored in eligible SOC and/or SIC pools after baseline adjustment and pool-specific attribution deductions, but before deduction of project emissions, leakage, uncertainty adjustments, reversal compensation, reserve contributions, or any other applicable deductions.

Leakage

The net increase in GHG emissions or decrease in carbon stocks outside the project boundary that occurs as a result of the project activity and is measurable and attributable to the project activity, as assessed in accordance with the BioCarbon Leakage Management Tool.

Lithogenic carbonate

Carbonate material inherited from the soil parent material or geological substrate, or otherwise present in the soil independently of the project activity. Lithogenic carbonate shall not be credited as carbon dioxide removal under this methodology.

Managed agricultural land

Land subject to human management for agricultural production, grazing, soil improvement, or related agricultural purposes. Under this methodology, managed agricultural land is limited to cropland, managed grassland, and managed pasture.

Managed grassland or managed pasture

Managed agricultural land dominated by herbaceous vegetation, grasses, or forage species and used for grazing, hay production, forage production, or other agricultural purposes. Natural grasslands not under agricultural management and grasslands converted from natural ecosystems for the purpose of generating credits are not eligible under this methodology.

Mineral soil

Soil that is not classified as organic soil or peat soil and where carbon dynamics are governed primarily by mineral-organic interactions, mineral weathering, carbonate chemistry, and soil management processes. This methodology applies only to mineral soils.

Mineral weathering

The chemical dissolution or transformation of minerals in soil, resulting in the release of cations, changes in alkalinity, and potential uptake of atmospheric CO_2 through bicarbonate formation, carbonate precipitation, or other stable inorganic carbon pathways.

Monitoring

The systematic collection, recording, archiving, and management of all data necessary to quantify baseline conditions, project emissions, leakage, SOC and/or SIC removals, uncertainty, and compliance with this methodology and the applicable BioCarbon Tools.

Net carbon dioxide removal

The quantity of carbon dioxide removal eligible for crediting after gross SOC and/or SIC removals have been adjusted for project emissions, leakage, uncertainty, reversals where applicable, reserve contributions, and any other deductions required under the BioCarbon Standard, applicable BioCarbon Tools, and this methodology.

Net GHG balance

The total balance of GHG emissions and removals under the project activity, accounting for all relevant sources, sinks, pools, leakage, uncertainty deductions, and applicable adjustments.

Organic amendment

A non-carbonized organic material applied to soil to improve soil properties or contribute to SOC accumulation or stabilization, including compost, manure, crop residues, digestate, or other organic materials that meet the eligibility, sourcing, traceability, and safeguards requirements of this methodology. Biochar is not an eligible organic amendment under this methodology.

Organic soil

Soil that meets the applicable national, IPCC, or methodological criteria for organic soils, including peat soils and other soils with high organic matter content formed under wet or anaerobic conditions. Organic soils are not eligible under this methodology.

Pedogenic carbonate

Carbonate formed in soil through soil-forming processes. Under this methodology, pedogenic carbonate may be credited only where the project holder demonstrates that it is newly formed or accumulated as a result of the project activity and represents atmospheric CO_2 removal, after conservative exclusion of lithogenic carbonate, exogenous inorganic carbon, and non-attributable carbonate redistribution.

Permanence

The condition whereby credited carbon dioxide removals are maintained over time and are protected from material risk of reversal, in accordance with the BioCarbon Permanence and Risk Management Tool.

Project activity

The specific set of interventions implemented by the project holder to alter baseline soil carbon dynamics and generate measurable net carbon dioxide removals in eligible SOC and/or SIC pools under this methodology.

Project boundary

The spatial, temporal, and operational limits within which project activities, eligible soil carbon pools, project emissions, leakage, monitoring parameters, and accounting procedures are defined for the purposes of this methodology.

Project emissions

GHG emissions that occur as a result of implementing the project activity, including emissions associated with input production, extraction, processing, transport, storage, field application, fuel use, electricity use, irrigation changes, nutrient management, and other relevant sources identified under this methodology and the applicable BioCarbon Tools.

Project scenario

The scenario that reflects the actual conditions, interventions, management practices, inputs, soil carbon dynamics, emissions, and removals occurring as a result of implementing the project activity.

Regenerative agricultural practices

Agricultural practices that aim to improve soil function, biological activity, soil structure, nutrient cycling, water retention, or ecosystem processes. The designation of a practice as regenerative shall not, in itself, constitute evidence of GHG emission reductions, carbon dioxide removals, or additionality under this methodology.

Removal

A process by which carbon dioxide is withdrawn from the atmosphere and stored in a carbon pool. Under this methodology, removals are eligible only where they are quantified as net carbon dioxide removals in SOC and/or SIC pools.

Reversal

The release, loss, or reduction of previously credited carbon stored in eligible SOC and/or SIC pools, resulting in partial or total loss of credited carbon dioxide removals.

Silicate mineral

A mineral composed primarily of silicate structures that may undergo chemical weathering and release cations capable of contributing to alkalinity generation, bicarbonate formation, carbonate precipitation, or other processes associated with atmospheric CO_2 uptake.

Soil inorganic carbon (SIC)

Carbon present in soil in inorganic forms, including carbonates, bicarbonates, and other inorganic carbon species. Under this methodology, SIC may be credited only where it represents measurable and attributable carbon dioxide removal associated with project-induced mineral weathering or other eligible SIC formation processes, after conservative exclusion of lithogenic carbonate, exogenous inorganic carbon, and non-attributable carbonate redistribution.

Soil organic carbon (SOC)

Carbon contained in soil organic matter, including decomposed plant, animal, and microbial residues, microbial biomass, and organic compounds stabilized through physical, chemical, or biological mechanisms.

SOC stock change

The measurable difference in soil organic carbon stocks between two points in time within a defined project area, stratum, or sampling unit, expressed as a net increase or decrease.

SIC stock change

The measurable difference in soil inorganic carbon stocks between two points in time within a defined project area, stratum, or sampling unit, expressed as a net increase or decrease and adjusted, where applicable, to exclude lithogenic carbonate, exogenous inorganic carbon, carbonate redistribution, or non-attributable inorganic carbon.

Soil carbon stock change

The measurable change in SOC and/or SIC stocks between two points in time. Under this methodology, SOC stock change and SIC stock change shall be quantified separately.

Stratification

The division of the project area into relatively homogeneous units based on factors influencing SOC and/or SIC stocks, GHG emissions, and removals, including soil type, mineralogy, carbonate content, climate, topography, land-use history, management practices, amendment application, and baseline carbon stock conditions.

Uncertainty

The degree of variability, lack of precision, or incomplete knowledge associated with the estimation of GHG emissions, removals, carbon stock changes, project emissions, leakage, or monitoring parameters, as assessed in accordance with the BioCarbon Conservative Approach and Uncertainty Management Tool.

10 Project boundaries

The project boundary defines the spatial, temporal, operational, and accounting limits within which carbon dioxide removals, project emissions, leakage, monitoring parameters, and eligible soil carbon pools are identified, quantified, monitored, reported, and verified.

The project boundary shall include the managed agricultural land where eligible project interventions are implemented and where SOC and/or SIC removals are quantified. It shall also include all relevant upstream, on-site, and downstream activities that are directly attributable to the project activity and that may result in material GHG emissions or affect the quantification of net carbon dioxide removals.

10.1 Spatial boundary

The spatial boundary shall include all agricultural land parcels, fields, strata, or management units where eligible interventions are implemented and where SOC and/or SIC stock changes are quantified under this methodology.

The project holder shall define the spatial boundary using georeferenced polygons, maps, cadastral information where available, and a clear description of all included land units. The spatial boundary shall be fixed at validation and shall remain traceable throughout the quantification period.

The project area may include one or more non-contiguous parcels, provided that each parcel meets the applicability conditions of this methodology and is included in the validated monitoring design. Any addition, removal, or modification of land units after validation shall

be documented, justified, and subject to the applicable BioCarbon rules for project updates, monitoring, and verification.

The spatial boundary for crediting shall be limited to the soil volume and depth included in the validated sampling and quantification design. SOC and/or SIC changes occurring outside the monitored soil depth or outside the validated project area shall not be credited.

10.2 Temporal boundary

The temporal boundary shall include the period during which eligible project interventions are implemented, monitored, and quantified for the purpose of credit issuance under this methodology.

The project start date shall correspond to the date on which the project holder begins implementation of eligible interventions that are expected to generate SOC and/or SIC removals, unless otherwise defined by the BioCarbon Standard or applicable BioCarbon Tools.

The quantification period, monitoring periods, verification events, and any applicable renewal or reassessment requirements shall be defined in accordance with the BioCarbon Standard, the Monitoring, Reporting and Verification Tool, the Baseline and Additionality Tool, and the applicable version rules in force.

Carbon dioxide removals shall be credited only ex post, after they have been monitored, quantified, adjusted for applicable deductions, and independently verified.

10.3 Operational boundary

The operational boundary shall include all project activities and associated processes that are necessary to implement the project and that may materially affect net carbon dioxide removals.

The operational boundary shall include, where applicable:

(a) production, extraction, processing, crushing, grinding, screening, storage, and handling of mineral amendments;
(b) production, formulation, storage, and handling of biological inputs, microbial inoculants, enzymes, or other biological products;
(c) production, collection, processing, composting, storage, handling, and application of eligible organic amendments, excluding biochar;
(d) transport of mineral amendments, biological inputs, organic amendments, biomass residues, and other relevant inputs from source to project area;
(e) field application of eligible amendments or inputs;
(f) soil preparation, crop or pasture management, residue management, irrigation, nutrient management, and other field operations directly associated with the project activity;

(g) soil sampling, laboratory analysis, data management, monitoring, and verification activities, where emissions from these activities are material;
(h) any additional activity that is directly attributable to project implementation and may result in material GHG emissions or affect the quantification of SOC and/or SIC removals.

10.4 Carbon pools and emission sources

The project boundary shall include all eligible carbon pools and all GHG emission sources that are expected to be materially affected by the project activity. The inclusion or exclusion of any carbon pool, source, sink, or reservoir shall be justified in the Project Document and assessed during validation and verification.

This methodology credits only net carbon dioxide removals stored in eligible soil carbon pools. Emission reductions associated with reduced fertilizer use, reduced fuel consumption, improved production efficiency, or other changes in agricultural management shall not be credited as standalone mitigation outcomes under this methodology. However, any material increase in GHG emissions caused by the project activity shall be quantified and deducted from gross carbon dioxide removals.

10.4.1 Carbon pools

Eligible carbon pools under this methodology are limited to soil organic carbon (SOC) and soil inorganic carbon (SIC). These pools shall be accounted for separately, recognizing their different formation mechanisms, monitoring requirements, uncertainty profiles, and permanence characteristics.

At least one eligible soil carbon pool shall be included for crediting. Where both SOC and SIC are included, the project holder shall demonstrate that the two pools are separately measured or modelled, and that no double counting occurs between organic and inorganic carbon fractions.

Carbon pools shall be excluded where changes are not eligible under this methodology, are not attributable to project activities, are not measurable with sufficient confidence, or where their inclusion would create a risk of double counting or over-crediting.

Table 1. Carbon pools included in the project boundary

Carbon pool	Baseline scenario	Project scenario	Included?	Justification
Soil organic carbon (SOC)	Yes	Yes	Conditional	Included where SOC removals are claimed or where project activities may materially affect SOC stocks. SOC represents one of the eligible soil carbon pools under this methodology and shall be quantified separately from SIC.
Soil inorganic carbon (SIC)	Yes	Yes	Conditional	Included where SIC removals are claimed, where mineral weathering processes are

Carbon pool	Baseline scenario	Project scenario	Included?	Justification
				implemented, or where project activities may materially affect SIC stocks. SIC shall be quantified separately from SOC and shall exclude lithogenic carbonate, exogenous inorganic carbon, and non-attributable carbonate redistribution.
Aboveground biomass	No	No	No	Not an eligible carbon pool under this methodology. Changes in crop biomass, cover crops, agroforestry biomass, or other aboveground vegetation shall not be credited.
Belowground biomass	No	No	No	Not an eligible carbon pool under this methodology. Root biomass changes may influence SOC dynamics but shall not be credited as a separate biomass pool.
Dead organic matter – dead wood	No	No	No	Not an eligible carbon pool under this methodology and generally not material in managed agricultural soil CDR accounting.
Litter	No	No	No	Not an eligible carbon pool under this methodology. Litter inputs may influence SOC formation but shall not be credited as a separate pool.
Harvested biomass products	No	No	No	Carbon stored in harvested agricultural products is outside the scope of this methodology and shall not be credited.
Biochar	No	No	No	Biochar production and application are excluded from this methodology and shall be addressed under a separate methodology.
Dissolved organic carbon (DOC) and dissolved inorganic carbon (DIC) exported outside the monitored soil profile	No	No	No for crediting	DOC and DIC exported below the monitored soil depth or outside the project boundary shall not be credited under this methodology unless an approved module explicitly provides accounting procedures. Where material, dissolved carbon transfers shall be assessed conservatively for leakage, uncertainty, or loss of attributable soil carbon.

Where a project holder claims removals in SOC, SIC, or both, the selected pools shall be included consistently in the baseline and project scenarios. A pool may not be selectively included only in the project scenario or selectively excluded from the baseline where such treatment would overestimate net removals.

Where a non-credited carbon pool may experience a material loss as a result of the project activity, the project holder shall assess whether such loss affects net carbon dioxide removals, leakage, reversal risk, or uncertainty. Such effects shall be conservatively accounted for in accordance with this methodology and the applicable BioCarbon Tools.

10.4.2 GHG emission sources

The project boundary shall include all material GHG emission sources attributable to the project activity. Emissions shall be accounted for on an incremental basis relative to the baseline where the source exists in both scenarios, and on a project-attributable basis where the source is introduced by the project activity.

The following GHG emission sources shall be included where relevant and material.

Table 2. GHG emission sources included in the project boundary

Source category	Gas	Baseline scenario	Project scenario	Included?	Justification
Mineral extraction, crushing, grinding, screening, processing, or preparation	CO_2	No, unless occurring in baseline	Yes, where mineral amendments are applied	Conditional / Yes where material	Mineral amendment preparation may be a material emission source in enhanced mineral weathering activities and shall be quantified where attributable to the project.
Production or formulation of biological inputs, microbial inoculants, enzymes, or other biological products	CO_2	No, unless occurring in baseline	Yes, where such inputs are applied	Conditional	Included where biological inputs are used and associated production or formulation emissions are material.
Production, processing, composting, storage, or handling of organic amendments	CO_2/ CH_4/ N_2O	Yes, if occurring in baseline	Yes, where organic amendments are applied	Conditional	Included where project activities introduce or materially change organic amendment use, storage, or handling and such changes affect emissions.
Transport of mineral, biological, or organic inputs	CO_2	Yes, if occurring in baseline	Yes	Conditional	Included where transport is attributable to the project activity and emissions are material, particularly for high-volume mineral amendments.
Field application of mineral, biological, or organic inputs	CO_2	No, unless occurring in baseline	Yes	Conditional	Included where field application requires fuel, electricity, machinery, or other energy use that is material.
Fossil fuel use in agricultural operations directly attributable to the project activity	CO_2	Yes, if occurring in baseline	Yes	Conditional	Included where project interventions materially change machinery use, soil preparation, spreading, irrigation, transport, or

Source category	Gas	Baseline scenario	Project scenario	Included?	Justification
					other fuel-consuming operations.
Electricity consumption attributable to the project activity	CO_2	Yes, if occurring in baseline	Yes	Conditional	Included where electricity is used for input processing, irrigation, pumping, storage, monitoring, or other project-related operations and is material.
Soil nitrogen processes associated with fertilizer use, organic amendments, crop residues, biological nitrogen fixation, or changes in nutrient management	N_2O	Yes	Yes	Conditional / Yes where nitrogen inputs change	N_2O emissions are material in many agricultural systems and shall be included where project activities affect nitrogen inputs, soil nitrogen availability, moisture, or other drivers of N_2O emissions.
Methane emissions from soil conditions	CH_4	Yes, if relevant	Yes, if relevant	Conditional	Included where soil saturation, irrigation, flooding, organic amendment use, or other project-related conditions may result in measurable CH_4 emissions. Permanently flooded or predominantly anaerobic systems are not eligible unless explicitly allowed under this methodology.
Methane and nitrous oxide emissions from manure or organic amendment handling	CH_4/ N_2O	Yes, if relevant	Yes, if relevant	Conditional	Included where manure, compost, digestate, or other organic inputs are stored, handled, processed, or applied in a manner that may generate material CH_4 or N_2O emissions.
Changes in irrigation or water management attributable to the project activity	CO_2/ CH_4/ N_2O	Yes, if relevant	Yes, if relevant	Conditional	Included where changes in irrigation, pumping, water table depth, soil moisture, or anaerobic conditions materially affect energy use or non-CO_2 emissions.
Soil erosion or off-site movement of SOC/SIC attributable to the project activity	CO_2/ carbon stock loss	Yes, if relevant	Yes, if relevant	Conditional	Not credited as a removal pathway. Included where erosion, sediment transport, or off-site carbon movement materially affects SOC/SIC stock changes, leakage, or reversal risk.

Source category	Gas	Baseline scenario	Project scenario	Included?	Justification
Leakage from displaced biomass residues, organic inputs, land management, or agricultural production	CO_2/ CH_4/ N_2O	Not applicable	Yes, outside project boundary	No – assessed separately as leakage	Assessed and deducted in accordance with the BioCarbon Leakage Management Tool where material and attributable to the project activity.

All included sources shall be quantified using approaches consistent with the applicable BioCarbon Tools and, where appropriate, IPCC-based methods. Tier 2 or higher approaches shall be applied where feasible and where they materially improve accuracy. Where IPCC methods do not provide sufficient project-level procedures for SIC formation or enhanced mineral weathering, the methodology-specific quantification requirements for SOC, SIC, and mineral weathering shall apply.

10.4.3 Sources and pools excluded from crediting

The following sources, pools, and processes are excluded from crediting under this methodology. Their exclusion shall not prevent their assessment where they may materially affect project emissions, leakage, uncertainty, permanence, or safeguards.

Table 3. Sources, pools, and processes excluded from crediting

Source, pool, or process	Gas / carbon form	Baseline scenario	Project scenario	Included?	Justification
Plant respiration	CO_2	Yes	Yes	No	Considered part of the short-term biogenic carbon cycle and not credited as a separate source or sink.
Soil respiration – autotrophic and heterotrophic	CO_2	Yes	Yes	No	Reflected indirectly through measured SOC stock changes. Separate accounting would risk double counting.
Aboveground crop biomass carbon stock changes	CO_2/ carbon stock	Yes	Yes	No	Not an eligible carbon pool under this methodology. Temporary biomass changes shall not be credited.
Root biomass as a separate biomass pool	CO_2/ carbon stock	Yes	Yes	No	Root inputs may influence SOC dynamics but shall not be credited separately from SOC stock change.

Source, pool, or process	Gas / carbon form	Baseline scenario	Project scenario	Included?	Justification
Dead wood and litter	CO_2/ carbon stock	Yes	Yes	No	Not eligible carbon pools under this methodology. Their effects may be reflected indirectly through SOC stock changes where applicable.
Harvested agricultural products	CO_2/ carbon stock	Yes	Yes	No	Outside the scope of this methodology and typically short-lived or accounted for outside the project boundary.
Biochar	CO_2/ carbon stock	No	No	No	Biochar is excluded from this methodology and shall be addressed under a separate methodology.
Carbon stored in non-soil products	CO_2/ carbon stock	No	No	No	Outside the scope of this methodology, which is limited to SOC and SIC in agricultural soils.
General administrative emissions, staff commuting, office energy use, and routine business operations	CO_2	Yes	Yes	No, unless material	Excluded where demonstrably negligible and not directly relevant to SOC/SIC removals. Included only if material and attributable to project implementation.
Minor emissions from soil sampling, laboratory analysis, and verification travel	CO_2	Yes	Yes	No, unless material	Generally negligible relative to credited removals. May be included where material or where required by the applicable BioCarbon Tools.
Non-CO_2 emissions not affected by project activities	CH_4/ N_2O	Yes	Yes	No	Excluded where not materially changed by the project activity and where exclusion does not overestimate net removals.
Emission reductions from reduced fertilizer use, reduced fuel use, or improved production efficiency	CO_2/ CH_4/ N_2O	Yes	Yes	No as standalone crediting	Such reductions may improve the net GHG balance but shall not be credited as standalone mitigation outcomes under this CDR methodology. Crediting is limited to net carbon dioxide removals stored in eligible SOC and/or SIC pools.

10.4.4 Treatment of insignificant sources, sinks, and pools

Sources, sinks, and pools may be excluded where they are expected to have a negligible impact on the net carbon dioxide removals quantified under this methodology.

Such exclusion shall be permitted only where:

(a) the contribution is demonstrably immaterial;
(b) the exclusion does not lead to overestimation of net carbon dioxide removals;
(c) the exclusion is conservative;
(d) the justification is clearly documented in the Project Document or Monitoring Report; and
(e) the exclusion is assessed by the Conformity Assessment Body during validation or verification.

Where uncertainty exists regarding the significance of a source, sink, pool, or process, the project holder shall either include it in the quantification or apply a conservative deduction, uncertainty adjustment, or exclusion from crediting, as appropriate.

A source, sink, or pool shall be considered material where its inclusion or exclusion could reasonably influence the quantification of net carbon dioxide removals, the conservativeness of the net GHG balance, or the environmental integrity of the project results.

Optional emission sources, carbon pools, or processes may be excluded only where the project holder demonstrates that their contribution is not material to the overall net carbon dioxide removal calculation. The justification for excluding any source, sink, or pool shall be documented and made available for validation and verification.

The exclusion of a source, sink, or pool shall not be used to omit project-related emissions, reversals, leakage, or uncertainty that would reduce the net quantity of creditable removals.

11 Project activities

11.1 General description of project activities

Eligible project activities under this methodology shall consist of interventions implemented in managed agricultural soils that are designed to generate measurable and verifiable net carbon dioxide removals through soil organic carbon (SOC) enhancement, soil inorganic carbon (SIC) formation or accumulation, or both.

This methodology is outcome-based. Project activities shall not be credited on the basis of the use of a specific product, input, technology, agronomic practice, or production system. Crediting shall be based only on quantified and verified net carbon dioxide removals calculated in accordance with this methodology.

11.2 Eligible activity categories

Eligible project activities may include one or more of the following intervention categories:

(a) Mineral weathering interventions, including the application of eligible silicate minerals or other approved mineral amendments intended to promote mineral weathering, alkalinity generation, and SIC formation.
(b) Biological enhancement interventions, including the use of biological inputs, microbial inoculants, enzymes, metabolites, or other soil biological products intended to support SOC stabilization, mineral weathering, or SIC formation.
(c) Organic amendment interventions, excluding biochar, including the application of eligible non-carbonized organic materials intended to support SOC accumulation, SOC stabilization, or soil conditions relevant to SIC formation.
(d) Soil management interventions, including practices that improve soil physical, chemical, or biological conditions relevant to SOC enhancement, SIC formation, mineral weathering, or restoration of degraded agricultural soils.
(e) Integrated interventions, combining mineral, biological, organic, and soil management interventions, provided that the resulting net carbon dioxide removals can be attributed, quantified, and verified in accordance with this methodology.

11.3 Eligible outcomes for crediting

Under this methodology, carbon credit issuance shall be based exclusively on absolute net carbon dioxide removals stored in eligible SOC and/or SIC pools.

The following outcomes shall not be eligible for crediting unless they result in quantified and verified net carbon dioxide removals:

(a) use of a specific mineral amendment, biological input, microbial inoculant, organic amendment, or commercial product;
(b) adoption of regenerative, sustainable, climate-smart, or improved agricultural practices;
(c) increase in crop productivity or biomass production;
(d) improvement in soil fertility, soil biological activity, soil health, or water retention;
(e) reduction in emission intensity;
(f) reduction in fertilizer or fuel use.

Such outcomes may be reported as co-benefits or may contribute to the net GHG balance where relevant, but carbon credit issuance shall be based only on verified net carbon dioxide removals in eligible SOC and/or SIC pools.

11.4 Documentation of project activities

The project holder shall document all project activities in the Project Document and Monitoring Reports. Documentation shall include, at minimum, the type of intervention,

objective, location, implementation date, applicable stratum or management unit, input type and quantity where applicable, management practice changed, expected removal mechanism, and monitoring parameters used to assess the intervention.

Where project activities are modified during implementation, the project holder shall document the modification and demonstrate that it remains consistent with the scope, applicability conditions, project boundary, quantification approach, and monitoring requirements of this methodology.

Input eligibility, chain of custody, soil eligibility, carbon pool accounting, project emissions, leakage, and excluded activities shall be addressed in the corresponding sections of this methodology and the applicable BioCarbon Tools.

12 Additionality

12.1 General requirement

Project activities shall demonstrate additionality in accordance with the most recent version in force of the BioCarbon Baseline and Additionality Tool (BAT).

The application of the BAT is mandatory and shall be carried out in full. This methodology does not establish a separate or alternative additionality procedure. No project activity shall be eligible for registration, verification, or issuance under this methodology unless additionality has been demonstrated in accordance with the BAT and validated by an authorized Conformity Assessment Body.

For the purposes of this methodology, additionality shall be demonstrated for the project activity as a whole, including the implementation of eligible interventions and the monitoring, quantification, and verification of net carbon dioxide removals in soil organic carbon (SOC) and/or soil inorganic carbon (SIC) pools.

The use of a specific product, technology, mineral amendment, biological input, microbial inoculant, organic amendment, or agronomic practice shall not, by itself, constitute evidence of additionality. Additionality shall be demonstrated based on whether the quantified carbon dioxide removals and associated project activity would not occur in the absence of carbon credit revenues or equivalent enabling incentives.

12.2 Activity-specific additionality considerations

When applying the BAT, the project holder shall ensure that the additionality assessment reflects the specific characteristics of agricultural soil carbon dioxide removal activities under this methodology.

The proposed project activity shall be assessed against realistic and credible alternative scenarios, which may include, as applicable:

(a) continuation of pre-project agricultural management practices;
(b) implementation of general agricultural land management practices without carbon crediting;
(c) use of mineral amendments, biological inputs, organic amendments, or soil management practices for agronomic purposes without monitoring or crediting SOC and/or SIC removals;
(d) application of soil amendments or inputs that do not result in quantified net carbon dioxide removals;
(e) alternative land management practices commonly implemented by comparable agricultural producers in the applicable geographic area;
(f) other realistic and credible alternatives identified in accordance with the BAT.

The project holder shall demonstrate that the project activity is not merely a continuation of existing agricultural practices, not a legally required practice, and not common practice in the applicable sector and geographic area, unless material and project-specific distinctions are demonstrated in accordance with the BAT.

12.3 Regulatory surplus

The project activity shall not be legally required under enforced laws, regulations, permits, land-use obligations, agricultural management rules, environmental compliance requirements, soil conservation mandates, or other binding obligations applicable to the project area.

Where laws or regulations require practices similar to those implemented under the project activity, the project holder shall demonstrate that the project activity exceeds such requirements and that the credited SOC and/or SIC removals are not the result of mandatory compliance.

Where a legal requirement exists but is claimed to be systematically unenforced, the project holder shall provide evidence consistent with the evidentiary requirements of the BAT.

12.4 Prior consideration of carbon crediting

The project holder shall demonstrate that carbon crediting was considered prior to, or at the time of, the decision to implement the project activity, in accordance with the BAT.

Evidence may include internal decision records, feasibility studies, investment analyses, board or management approvals, agreements with farmers or landholders, correspondence with carbon market actors, conditional financing documentation, or other records demonstrating that expected carbon credit revenues were considered as part of the implementation decision.

Where prior consideration of carbon crediting cannot be credibly demonstrated, the project activity shall not be considered additional.

12.5 Barrier or investment analysis

The project holder shall apply the barrier analysis, investment analysis, or both, in accordance with the BAT.

Where a barrier analysis is applied, the project holder shall demonstrate that the implementation of the project activity faces material barriers that would prevent or significantly hinder implementation in the absence of carbon credit revenues. Such barriers may include, but are not limited to, high monitoring and laboratory costs, limited availability of technical capacity for SOC and SIC quantification, lack of access to finance for mineral amendments or soil interventions, uncertainty regarding agronomic performance, lack of local infrastructure for mineral processing or application, institutional barriers affecting smallholder or collective land systems, and barriers related to the adoption of project-level MRV systems.

Where an investment analysis is applied, the project holder shall include all relevant costs and revenues associated with the project activity, including input acquisition, mineral processing, transport, application, laboratory analysis, sampling, modelling, monitoring, reporting, verification, farmer engagement, implementation support, and transaction costs. Revenues, savings, subsidies, grants, or other financial incentives unrelated to carbon credits shall be included where applicable.

Carbon credit revenues shall play a material and determinative role in overcoming the identified barrier or improving the financial feasibility of the project activity. Marginal improvements in project economics that do not alter the implementation decision shall not be sufficient to demonstrate additionality.

12.6 Common practice analysis

A common practice analysis shall be conducted in accordance with the BAT.

For this methodology, the common practice analysis shall assess whether comparable agricultural soil carbon dioxide removal activities are already widely implemented in the applicable geographic area and sector without carbon credit revenues. The analysis shall consider not only the use of individual practices or inputs, but the integrated project activity, including SOC and/or SIC quantification, mineral weathering or SIC formation where applicable, monitoring, verification, and crediting.

The fact that one or more project interventions, such as cover cropping, organic amendment application, mineral amendment use, microbial inoculant use, reduced soil disturbance, or improved nutrient management, are practiced in the region shall not automatically mean that the project activity is common practice. However, where such practices are widely adopted and are not implemented in a manner materially different from the proposed project activity, the project holder shall demonstrate why the quantified SOC and/or SIC removals would not occur without carbon crediting.

Where similar projects or practices exist, the project holder shall identify and justify any essential differences, including differences in objective, scale, financing, monitoring requirements, mineral weathering pathway, SIC quantification, input sourcing, technical capacity, implementation cost, land tenure context, or MRV obligations.

12.7 Relationship with other agricultural land management methodologies

Additionality under this methodology shall be assessed for the agricultural soil carbon dioxide removal activity covered by this methodology, not for general agricultural land management alone.

Where a project activity only implements general improved agricultural practices without meeting the applicable SOC and/or SIC accounting, monitoring, and verification requirements of this methodology, it shall not apply this methodology and shall use the applicable agricultural land management methodology under the BioCarbon Standard.

Where project interventions overlap with practices that may be eligible under another BioCarbon agricultural land management methodology, the project holder shall demonstrate that the activity applying this methodology is materially distinct by virtue of its SOC and/or SIC carbon dioxide removal accounting, mineral weathering component where applicable, and methodology-specific monitoring and quantification requirements.

12.8 Small-scale provisions

Where the project activity meets the small-scale eligibility thresholds established in the BAT, the project holder may apply the simplified additionality provisions provided in the BAT, where applicable.

The use of simplified procedures shall not exempt the project holder from demonstrating a credible and conservative baseline scenario, regulatory surplus, prior consideration of carbon crediting, absence of common practice, and compliance with all applicability, monitoring, safeguards, and quantification requirements of this methodology.

12.9 Reassessment

Additionality and baseline validity shall be reassessed in accordance with the BAT and the BioCarbon Standard, including at renewal of the quantification period or whenever material changes occur that may affect the additionality demonstration.

Material changes may include changes in legal requirements, agricultural policy, subsidy programs, market adoption of comparable practices, mineral amendment availability, input prices, carbon market conditions, technical capacity, monitoring costs, or other circumstances that may affect the credibility of the additionality demonstration.

12.10 Documentation

The project holder shall document the additionality demonstration in the Project Document and shall provide all supporting evidence required under the BioCarbon Baseline and Additionality Tool (BAT).

Documentation shall include, where applicable, the identification of alternative scenarios, regulatory surplus assessment, prior consideration evidence, barrier analysis, investment analysis, common practice analysis, baseline selection, assumptions, data sources, financial models, stakeholder or farmer agreements, and any other evidence necessary for independent validation.

In addition to the information included in the Project Document, the project holder shall prepare a separate standalone document titled Additionality Demonstration Annex. This annex shall consolidate all relevant information used to demonstrate additionality under the BAT and shall be submitted together with the Project Document for validation.

The Additionality Demonstration Annex shall be made publicly available through the BioCarbon registry platform or other official publication channel designated by BioCarbon. The purpose of this annex is to provide sufficient transparency for stakeholders, market participants, Conformity Assessment Bodies, and external reviewers to understand the basis on which the project activity is considered additional.

The Additionality Demonstration Annex shall be updated whenever additionality or baseline validity is reassessed, including at renewal of the quantification period or when material changes occur that may affect the additionality demonstration.

13 Baseline scenario

13.1 General requirement

The baseline scenario shall be identified, justified, and selected in accordance with the most recent version in force of the BioCarbon Baseline and Additionality Tool.

For this methodology, the baseline scenario shall represent the soil carbon conditions, land management practices, input use, and associated GHG emissions and removals that would occur in the absence of the project activity.

The baseline scenario shall be established separately for soil organic carbon (SOC) and soil inorganic carbon (SIC), where applicable. SOC and SIC shall not be combined into a single undifferentiated soil carbon baseline for crediting purposes.

13.2 Baseline SOC

Baseline SOC shall be established using direct soil measurements, validated historical data, approved models, or a conservative combination of these approaches.

The project holder shall define baseline SOC stocks and, where relevant, the expected SOC trajectory in the absence of the project activity. A static SOC baseline may be used only where evidence demonstrates that SOC stocks would remain stable and that the assumption is conservative.

Where baseline management, degradation, erosion, nutrient management, irrigation, climate conditions, or productivity trends are expected to affect SOC stocks, a dynamic SOC baseline shall be applied.

13.3 Baseline SIC

Baseline SIC shall be established where SIC removals are claimed or where project activities may materially affect SIC stocks.

The project holder shall characterize pre-existing SIC, including lithogenic carbonates, pedogenic carbonates, carbonate distribution by depth, soil pH, mineralogy, parent material, and historical use of lime, carbonate amendments, silicate minerals, or other alkaline materials.

A zero SIC baseline shall not be assumed unless the project holder demonstrates that baseline SIC stocks or baseline SIC accumulation are absent or negligible and that such assumption is conservative.

Where project induced SIC formation cannot be distinguished from pre-existing lithogenic carbonate, exogenous inorganic carbon, carbonate redistribution, or non-attributable carbonate changes with sufficient confidence, SIC removals shall not be credited.

13.4 Baseline for mineral weathering

Where enhanced mineral weathering is included, the baseline scenario shall account for natural or background mineral weathering and any baseline use of mineral amendments, liming materials, carbonate materials, silicate materials, irrigation water alkalinity, or other relevant sources affecting SIC formation.

Baseline mineral weathering shall not be assumed to be zero where soil mineralogy, parent material, existing management practices, irrigation chemistry, or regional agronomic practices indicate that weathering or inorganic carbon formation would occur in the absence of the project activity.

13.5 Conservative baseline calibration

The baseline scenario shall be conservative and shall not overestimate creditable net carbon dioxide removals.

Where multiple baseline trajectories are plausible, the project holder shall select the trajectory that results in the lowest creditable net removals, provided that it remains realistic and evidence based.

For SOC and SIC, conservative baseline calibration means that baseline stock increases shall not be underestimated and baseline stock losses shall not be overestimated.

13.6 Baseline reassessment

The baseline scenario shall be reassessed in accordance with the BioCarbon Baseline and Additionality Tool and the BioCarbon Standard.

For project activities under this methodology, baseline reassessment shall occur at least at each renewal of the quantification period and whenever material changes occur that may affect baseline validity.

Material changes may include:

(a) changes in legal or regulatory requirements;
(b) changes in agricultural policies, subsidies, or incentive programs;
(c) changes in common agricultural practices in the applicable geographic area;
(d) changes in availability, cost, or use of mineral amendments, organic amendments, biological inputs, or other relevant soil inputs;
(e) changes in climate, hydrology, erosion, degradation, irrigation, or soil processes that affect SOC or SIC dynamics;
(f) availability of new soil measurements, monitoring results, scientific information, or improved models;
(g) evidence that baseline assumptions are no longer conservative or representative;
(h) significant divergence between projected baseline trajectories and observed reference or monitoring data.

Updated baselines shall apply prospectively unless otherwise required by the BioCarbon Standard.

13.7 Dynamic baseline requirement

The baseline shall be dynamic where there is evidence or reasonable expectation that SOC and/or SIC stocks would change over time in the absence of the project activity.

A dynamic baseline shall be required where one or more of the following conditions apply:

(a) baseline management practices are changing or are expected to change;
(b) SOC stocks are increasing or decreasing under baseline management;
(c) SIC stocks are increasing, decreasing, dissolving, leaching, or redistributing under baseline conditions;
(d) agricultural productivity, residue inputs, nutrient management, irrigation, or soil disturbance are changing;
(e) erosion, degradation, compaction, salinity, acidification, or other soil processes materially affect carbon stocks;

(f) climate trends or hydrological changes materially affect soil carbon dynamics;
(g) mineral amendments, liming materials, carbonate materials, or alkaline inputs are used or are likely to be used in the baseline scenario;
(h) policies, incentives, or market conditions are likely to affect baseline management practices.

Where the project holder proposes a static baseline, the justification shall demonstrate that a dynamic baseline is not required and that the static baseline is conservative.

13.8 Baseline consistency with national inventories and IPCC land categories

The baseline scenario shall be consistent with applicable national land-use classifications, national GHG inventory categories, and IPCC land-sector accounting principles, where relevant.

The project holder shall identify the applicable IPCC land-use category or categories for the project area, including cropland, grassland, or managed pasture, as relevant. The project holder shall demonstrate that baseline land representation does not result in spatial overlap, double counting, or inconsistent classification of land units.

Where national datasets, national inventory factors, national soil maps, or national reference scenarios are used, their applicability to the project area shall be documented. Where project-level methods differ from national inventory methods, the project holder shall explain the difference and demonstrate that the project-level baseline remains conservative and compatible with BioCarbon requirements.

13.9 Documentation

The project holder shall document the baseline scenario in the Project Document. Documentation shall be transparent, traceable, and sufficient to allow the Conformity Assessment Body to assess whether the baseline scenario is realistic, credible, conservative, and consistent with the BAT, this methodology, and the applicable BioCarbon Tools.

The baseline documentation shall include all data sources, assumptions, calculations, models, maps, soil analyses, management records, stratification procedures, uncertainty assessments, and conservative adjustments used to determine baseline SOC and/or SIC stocks and trajectories.

14 Quantification of carbon dioxide removals

14.1 General quantification approach

Carbon dioxide removals under this methodology shall be quantified as absolute net removals stored in eligible soil carbon pools, expressed in tonnes of CO_2 equivalent.

This methodology credits only net carbon dioxide removals in soil organic carbon (SOC) and/or soil inorganic carbon (SIC). SOC and SIC shall be quantified separately and aggregated only after all applicable deductions have been applied.

Net carbon dioxide removals for each monitoring period shall be calculated as:

$$NCDR_m = GCDR_m - PE_m - LE_m - UADJ_m \quad \text{Equation 1}$$

Where:

$NCDR_m$	=	Net carbon dioxide removals eligible for crediting in monitoring period m; tCO_2e
$GCDR_m$		Gross carbon dioxide removals in SOC and/or SIC before deductions; tCO_2e
PE_m	=	Project emissions attributable to the project activity; tCO_2e
LE_m	=	Leakage emissions attributable to the project activity; tCO_2e
$UADJ_m$	=	Uncertainty adjustment or conservative deduction; tCO_2e

Where SOC removals are not claimed, $R_{SOC,m}$ shall be set equal to zero. Where SIC removals are not claimed, $R_{SIC,m}$ shall be set equal to zero. In all cases, non-credited pools shall be assessed to ensure that their exclusion does not overestimate net carbon dioxide removals.

Where the result is less than or equal to zero, no Verified Carbon Credits shall be issued for the monitoring period.

14.2 Soil carbon stock-change basis

This methodology applies the IPCC stock-change logic for soil carbon accounting. Where changes in soil carbon stocks are measured between two points in time, the annualized stock change may be calculated using the IPCC stock-difference approach.

The soil carbon stock-change is calculated by the stock-difference method, based on IPCC Equation 2.5.

$$\Delta C_{pool} = {(C_{t2} - C_{t1})}/{(t_2 - t_1)} \quad \text{Equation 2}$$

Where:

ΔC_{pool}	=	annual carbon stock change in the relevant carbon pool; t C yr^{-1}
C_{t1}	=	carbon stock at the beginning of the period; t C
C_{t2}	=	carbon stock at the end of the period; t C
$t_2 - t_1$	=	time between measurements; years

For this methodology, the relevant pools are SOC and SIC.

$$\Delta SOC = {(SOC_{t2} - SOC_{t1})}/{(t_2 - t_1)} \quad \text{Equation 3}$$

$$\Delta SIC = {(SIC_{t2} - SIC_{t1})}/{(t_2 - t_1)} \quad \text{Equation 4}$$

For crediting purposes, removals shall be calculated for the relevant monitoring period. Annualized values may be multiplied by the number of years in the monitoring period where appropriate and consistently applied.

14.3 Total soil carbon change

IPCC recognizes total soil carbon stock change as the combination of organic carbon changes in mineral soils, carbon losses from organic soils, and changes in inorganic carbon stocks. Because this methodology applies only to mineral soils and excludes organic soils and peat soils, the applicable soil carbon structure is simplified for project-level accounting. IPCC Cropland and Grassland guidance both refer to Equation 2.24 for total soil carbon stock change, including SOC and SIC where SIC is estimated at Tier 3.

The annual change in carbon stock in soils is based on IPCC Equation 2.24.

$$\Delta C_{Soils} = \Delta C_{Mineral} - L_{Organic} + \Delta C_{Inorganic} \quad \text{Equation 5}$$

Where:

ΔC_{Soils}	=	annual change in carbon stocks in soils; t C yr^{-1}
$\Delta C_{Mineral}$	=	annual change in organic carbon stocks in mineral soils; t C yr^{-1}
$L_{Organic}$	=	annual loss of carbon from drained organic soils; t C yr^{-1}

$\Delta C_{Inorganic}$ = annual change in inorganic carbon stocks in soils; t C yr^{-1}

Because organic soils are not eligible under this methodology:

$$L_{Organic} = 0$$

Therefore, the soil carbon change under this methodology:

$$\Delta C_{Soils} = \Delta SOC + \Delta SIC \quad \text{Equation 6}$$

Where:

ΔC_{Soils}	=	Soil carbon change; t C
ΔSOC	=	change in soil organic carbon stocks; t C
ΔSIC		change in soil inorganic carbon stocks; t C

14.4 Gross carbon dioxide removals

Gross carbon dioxide removals shall be calculated as the sum of SOC removals and creditable SIC removals before deduction of project emissions, leakage, uncertainty adjustment, and reserve contributions.

$$GCDR_m = R_{SOC,m} + R_{SIC,m} \quad \text{Equation 7}$$

Where:

$GCDR_m$	=	gross carbon dioxide removals in monitoring period m; tCO_2e
$R_{SOC,m}$	=	SOC removals attributable to the project activity; tCO_2e
$R_{SIC,m}$	=	creditable SIC removals attributable to the project activity after SIC-specific deductions and, where applicable, application of the enhanced mineral weathering cap; tCO_2e

Where either SOC or SIC experiences a loss, the loss shall reduce gross carbon dioxide removals.

14.5 Soil carbon stock by stratum

SOC and SIC stocks shall be calculated by stratum using consistent soil depth, bulk density, coarse fragment correction, and laboratory analytical methods.

The SOC stock by stratum is calculated as:

$$SOC_{s,t} = A_s \times 10{,}000 \times D_s \times BD_{s,t} \times SOC_{conc_{s,t}} \times (1 - CFF_{s,t}) \quad \text{Equation 8}$$

The SIC stock by stratum is calculated as:

$$SIC_{s,t} = A_s \times 10{,}000 \times D_s \times BD_{s,t} \times SIC_{conc_{s,t}} \times (1 - CFF_{s,t}) \quad \text{Equation 9}$$

Where:

$SOC_{s,t}$	=	SOC stock in stratum s at time t; t C
$SIC_{s,t}$	=	SIC stock in stratum s at time t; t C
A_s	=	area of stratum s; ha
10,000	=	conversion factor from hectares to square meters; $m^2\ ha^{-1}$
D_s	=	soil depth included in the accounting boundary; m
$BD_{s,t}$	=	bulk density of soil in stratum s at time t; t soil m^{-3}
$SOC_{conc_{s,t}}$	=	organic carbon concentration in soil; t C t^{-1} soil
$SIC_{conc_{s,t}}$	=	inorganic carbon concentration in soil; t C t^{-1} soil
$CFF_{s,t}$	=	coarse fragment fraction in stratum s at time t; dimensionless

SOC and SIC shall be calculated using the same soil depth and stratum boundaries in the baseline and project scenarios, unless a deviation is justified and accepted under the BioCarbon Standard.

14.6 SOC removals

SOC removals shall be calculated as the difference between project SOC stock change and baseline SOC stock change.

$$R_{SOC,m} = (\Delta SOC_{P,m} - \Delta SOC_{B,m}) \times 44/12 \quad \text{Equation 10}$$

Where:

$R_{SOC,m}$	=	SOC removals attributable to the project activity; tCO_2e
$\Delta SOC_{P,m}$	=	SOC stock change under the project scenario in monitoring period m; t C
$\Delta SOC_{B,m}$	=	SOC stock change under the baseline scenario in monitoring period m; t C
$44/12$	=	molecular weight ratio to convert C to CO_2; $tCO_2\ t^{-1}\ C$

The project SOC stock change is calculated as:

$$\Delta SOC_{P,m} = \sum_{s} \left(SOC_{s,t2} - SOC_{s,t1}\right)_{P} \quad \text{Equation 11}$$

The baseline SOC stock change is calculated as:

$$\Delta SOC_{BL,m} = \sum_{s} \left(SOC_{s,t2} - SOC_{s,t1}\right)_{BL} \quad \text{Equation 12}$$

Where:

s	=	stratum
t1	=	beginning of the monitoring interval or baseline projection interval
t2	=	end of the monitoring interval or baseline projection interval

14.7 SOC stock factor approach for baseline or modelling

Where appropriate, the project holder may use the IPCC stock-change factor approach to support baseline SOC estimation, modelling, or consistency checks. This approach shall not replace project-level measurement where direct measurement is required by this methodology.

The annual change in organic carbon stocks in mineral soils, based on IPCC Equation 2.25.

$$\Delta C_{Mineral} = \left(SOC_{\theta} - SOC_{(\theta-T)}\right)/D \quad \text{Equation 13}$$

With:

$$SOC = \sum_{c,s,i} \left(SOC_{REF_{c,s,s}} \times F_{LU_{c,s,i}} \times F_{MG_{c,s,i}} \times F_{I_{c,s,i}} \times A_{c,s,i} \right) \quad \text{Equation 14}$$

Where:

$\Delta C_{Mineral}$	=	annual change in organic carbon stocks in mineral soils; t C yr^{-1}
SOC_{θ}	=	SOC stock in the last year of the inventory or project period; t C
$SOC_{(\theta-T)}$	=	SOC stock at the beginning of the period; t C
D	=	time dependence of stock change factors; years
SOC_{REF}	=	reference SOC stock; t C ha^{-1}
F_{LU}	=	land-use stock change factor; dimensionless
F_{MG}	=	management stock change factor; dimensionless
F_I	=	organic matter input factor; dimensionless
A	=	area of stratum; ha

Where this approach is used, project-specific, regional, or national data shall be preferred over generic default values where available and scientifically appropriate.

14.8 SIC removals

SIC removals shall be calculated as the project induced SIC stock change after deducting baseline SIC change, exogenous inorganic carbon, and non-attributable SIC changes.

The SIC removals before weathering cap are calculated as:

$$R_{SIC,preCap,m} = \left[\left(\Delta SIC_{P,m} - \Delta SIC_{BL,m} \right) - IC_{exog,m} - SIC_{nonattr,m} \right] \times 44/12 \quad \text{Equation 15}$$

Where:

$R_{SIC,preCap,m}$	=	SIC removals attributable to the project activity before weathering cap; tCO_2e
$\Delta SIC_{P,m}$	=	SIC stock change under the project scenario in monitoring period m; t C
$\Delta SIC_{BL,m}$	=	SIC stock change under the baseline scenario in monitoring period m; t C
$IC_{exog,m}$	=	inorganic carbon introduced through project inputs; t C
$SIC_{nonattr,m}$	=	SIC change not attributable to the project activity; t C

44/12 = molecular weight ratio to convert C to CO_2; tCO_2 t^{-1} C

The project SIC stock change is calculated as:

$$\Delta SIC_{P,m} = \sum_{s} \left(SIC_{s,t2} - SIC_{s,t1}\right)_P \quad \text{Equation 16}$$

The baseline SIC stock change is calculated as:

$$\Delta SIC_{BL,m} = \sum_{s} \left(SIC_{s,t2} - SIC_{s,t1}\right)_{BL} \quad \text{Equation 17}$$

SIC removals shall not be credited where project induced SIC formation cannot be distinguished with sufficient confidence from lithogenic carbonate, exogenous inorganic carbon, carbonate redistribution, or background SIC dynamics.

14.9 Exogenous inorganic carbon deduction

Where inorganic carbon is introduced through project inputs, such carbon shall be deducted unless the project holder demonstrates that it is not included in measured SIC stocks.

The exogenous inorganic carbon is calculated as:

$$IC_{exog,m} = \sum_{j} \left(M_{input,j,m} \times IC_{content_{j,m}}\right) \quad \text{Equation 18}$$

Where:

$IC_{exog,m}$	=	inorganic carbon introduced through project inputs; t C
$M_{input,j,m}$	=	dry mass of input j applied during monitoring period m; t material
$IC_{content_{j,m}}$	=	inorganic carbon content of input j; t C t^{-1} material

This deduction applies to carbonate minerals, bicarbonates, lime, limestone, dolomite, alkaline industrial residues, or any other input containing inorganic carbon.

14.10 Non-attributable SIC changes

Non-attributable SIC changes shall be deducted from credited SIC removals.

$$SIC_{nonattr,m} = SIC_{lith,m} + SIC_{redist,m} + SIC_{bg,m} + SIC_{uncertain,m}$$ Equation 19

Where:

$SIC_{nonattr,m}$	=	SIC change not attributable to the project activity; t C
$SIC_{lith,m}$	=	change associated with lithogenic carbonate or parent material; t C
$SIC_{redist,m}$	=	carbonate redistribution not representing new atmospheric CO_2 removal; t C
$SIC_{bg,m}$	=	background SIC change not attributable to project activity; t C
$SIC_{uncertain,m}$	=	SIC change excluded due to insufficient attribution confidence; t C

Where any component cannot be quantified with sufficient confidence, a conservative deduction shall be applied.

14.11 SIC attribution cap for enhanced mineral weathering

Where SIC removals are claimed from enhanced mineral weathering, creditable SIC removals shall not exceed the conservative atmospheric CO_2 uptake potential of the weathered mineral material.

$$R_{EWcap,m} = \sum_j \left(M_{min,j,m} \times CO_{2_{POT_j}} \times F_{weath_{j,m}} \right)$$ Equation 20

Where:

$R_{EWcap,m}$	=	conservative maximum CO_2 removal attributable to mineral weathering; tCO_2e
$M_{min,j,m}$	=	dry mass of eligible mineral amendment j applied; t mineral
$CO_{2_{POT_j}}$	=	conservative CO_2 uptake potential of mineral amendment j; $tCO_2\ t^{-1}$ mineral
$F_{weath_{j,m}}$	=	fraction of mineral amendment j weathered during monitoring period m; dimensionless

The fraction of mineral amendment weathered during a monitoring period shall be estimated using approved, project-appropriate, conservative, and verifiable methods. Modelled estimates shall be calibrated or validated with project-relevant field or laboratory data and shall include explicit uncertainty treatment. Where weathering cannot be attributed with sufficient confidence, claimed SIC removals shall be reduced or excluded.

The SIC removals after weathering cap are calculated as:

$$R_{SIC,m} = min(R_{SIC,preCap,m}, R_{EWcap,m}) \quad \text{Equation 21}$$

Where $R_{SIC,m}$ = creditable SIC removals after application of the enhanced mineral weathering cap; tCO_2e

Where enhanced mineral weathering is included, $R_{SIC,m}$ as calculated in Equation 21 shall be used in Equation 7.

Where enhanced mineral weathering is not included, or where the weathering cap is not applicable, $R_{SIC,m}$ shall equal $R_{SIC,preCap,m}$, provided that all SIC-specific deductions have been applied.

14.12 Project emissions

Project emissions shall include all material GHG emissions attributable to project implementation.

$$PE_m = PE_{MIN,m} + PE_{INP,m} + PE_{TR,m} + PE_{APP,m} + PE_{N2O,m} + PE_{CH4,m} + PE_{LIME,m} + PE_{UREA,m} + PE_{OTHER,m} \quad \text{Equation 22}$$

Where:

PE_m	=	total project emissions in monitoring period m; tCO_2e
$PE_{MIN,m}$	=	emissions from mineral extraction, crushing, grinding, processing, or preparation; tCO_2e
$PE_{INP,m}$	=	emissions from production, formulation, handling, or storage of biological and organic inputs; tCO_2e
$PE_{TR,m}$	=	emissions from transport of project inputs; tCO_2e
$PE_{APP,m}$	=	emissions from field application and project-related agricultural operations; tCO_2e
$PE_{N2O,m}$	=	incremental N_2O emissions attributable to the project activity; tCO_2e
$PE_{CH4,m}$	=	incremental CH_4 emissions attributable to the project activity; tCO_2e
$PE_{LIME,m}$	=	incremental CO_2 emissions from lime, limestone, dolomite, or carbonate amendment application; tCO_2e
$PE_{UREA,m}$	=	incremental CO_2 emissions from urea application; tCO_2e
$PE_{OTHER,m}$	=	other material project emissions; tCO_2e

Project emissions shall be calculated on an incremental basis where a source exists in both the baseline and project scenarios.

The incremental project emissions by source are calculated as:

$$PE_{i,m} = max(\theta, E_{P,i,m} - E_{BL,i,m}) \quad \text{Equation 23}$$

Where:

$PE_{i,m}$	=	incremental emissions from source i; tCO_2e
$E_{P,i,m}$	=	emissions from source i under the project scenario; tCO_2e
$E_{BL,i,m}$	=	emissions from source i under the baseline scenario; tCO_2e

Where a source is introduced only by the project activity, $E_{BL,i,m} = 0$.

Negative emission differences shall not generate standalone credits under this methodology unless an approved BioCarbon module expressly authorizes crediting of emission reductions.

14.13 Energy-related project emissions

Energy-related emissions shall include electricity and fuel use attributable to mineral processing, input preparation, storage, pumping, field operations, and application.

The electricity emissions are calculated as:

$$PE_{ELEC,m} = \sum_{k} (EC_{k,m} \times EF_{ELEC,k,m}) \quad \text{Equation 24}$$

The fuel combustion emissions are calculated as:

$$PE_{FUEL,m} = \sum_{f} (FC_{f,m} \times EF_{FUEL,f,m}) \quad \text{Equation 25}$$

Where:

$PE_{ELEC,m}$	=	emissions from electricity consumption; tCO_2e
$PE_{FUEL,m}$	=	emissions from fuel combustion; tCO_2e
$EC_{k,m}$	=	electricity consumed in process k; MWh
$EF_{ELEC,k,m}$	=	electricity emission factor; $tCO_2e\ MWh^{-1}$
$FC_{f,m}$	=	quantity of fuel f consumed; fuel unit
$EF_{FUEL,f,m}$	=	emission factor for fuel f; tCO_2e fuel $unit^{-1}$

Energy emissions may be allocated to PE_MIN,m, PE_INP,m, or PE_APP,m, provided that double counting is avoided.

14.14 Transport emissions

Transport emissions shall include transportation of mineral amendments, biological inputs, organic amendments, biomass residues, samples, or other material inputs where material.

$$PE_{TR,m} = \sum_{r} \left(M_{r,m} \times D_{r,m} \times EF_{TR,r} \right) \quad \text{Equation 26}$$

Where:

$PE_{TR,m}$	=	emissions from transport; tCO_2e
$M_{r,m}$	=	mass transported on route r; t
$D_{r,m}$	=	transport distance for route r; km
$EF_{TR,r}$	=	transport emission factor for route r and vehicle type; $tCO_2e\ t^{-1}\ km^{-1}$

The project holder shall document whether one-way or round-trip distances are used. The selected approach shall be conservative and consistently applied.

14.15 Direct N_2O emissions from managed soils

Direct N_2O emissions shall be estimated using IPCC-consistent approaches for managed soils where project activities affect nitrogen inputs, soil moisture, irrigation, organic amendments, manure application, crop residues, or soil organic matter mineralization. IPCC 2019 Chapter 11 confirms that direct N_2O emissions from managed soils are estimated under Equation 11.1, with Tier 2 refinements available where disaggregation is possible.

The direct N_2O emissions from managed mineral soils, based on IPCC Equation 11.1.

$$N_2O_{Direct-N,m} = \left[\left(F_{SN,m} + F_{ON,m} + F_{CR,m} + F_{SOM,m} \right) \times EF1 \right] + N_2O_{PRP-N,m} \quad \text{Equation 27}$$

Where:

$N_2O_{Direct-N,m}$	=	direct N_2O-N emissions from managed soils; kg N_2O-N
$F_{SN,m}$	=	synthetic fertilizer N applied; kg N
$F_{ON,m}$	=	organic N additions applied; kg N
$F_{CR,m}$	=	N in crop residues returned to soils; kg N
$F_{SOM,m}$	=	N mineralized due to SOC loss; kg N
$EF1$	=	emission factor for N inputs; kg N_2O-N kg^{-1} N
$N_2O_{PRP-N,m}$	=	N_2O-N from urine and dung deposited by grazing animals; kg N_2O-N

Because this methodology excludes organic soils, the organic soil term shall not apply.

14.16 Nitrogen mineralized due to SOC loss

Where project activities or baseline dynamics result in SOC losses, nitrogen mineralization associated with SOC loss shall be accounted for where material.

$$F_{SOM,m} = \sum_{LU} \left(\Delta C_{loss,LU,m} \times 1/R_{LU} \times 1000 \right) \quad \text{Equation 28}$$

Where:

$F_{SOM,m}$	=	net annual amount of N mineralized due to SOC loss; kg N
$\Delta C_{loss,LU,m}$	=	annual loss of SOC under land-use or management system LU; t C
R_{LU}	=	C:N ratio of soil organic matter; dimensionless
1000	=	conversion from tonnes to kilograms; kg t^{-1}

Where SOC increases, F_SOM,m shall not be used to generate negative N_2O emissions unless expressly allowed by the applicable IPCC method and BioCarbon requirements.

14.17 Indirect N_2O emissions from volatilization

Indirect N_2O emissions from atmospheric deposition of volatilized nitrogen shall be quantified where nitrogen inputs are material.

N_2O from atmospheric deposition of volatilized N, based on IPCC Equation 11.9

$$N_2O_{ATD-N,m} = \left[\left(F_{SN,m} \times Frac_{GASF} \right) + \left(\left(F_{ON,m} + F_{PRP,m} \right) \times Frac_{GASM} \right) \right] \times EF4 \quad \text{Equation 29}$$

Where:

$N_2O_{ATD-N,m}$	=	N_2O-N from atmospheric deposition of volatilized N; kg N_2O-N
$F_{SN,m}$	=	synthetic fertilizer N applied; kg N
$F_{ON,m}$	=	organic N applied; kg N
$F_{PRP,m}$	=	urine and dung N deposited by grazing animals; kg N
$Frac_{GASF}$	=	fraction of synthetic fertilizer N volatilized; kg N kg^{-1} N applied
$Frac_{GASM}$	=	fraction of organic N or manure N volatilized; kg N kg^{-1} N applied

$EF4$	=	emission factor for N_2O from atmospheric N deposition; kg N_2O-N kg^{-1} N volatilized

14.18 Indirect N_2O emissions from leaching and runoff

Indirect N_2O emissions from leaching and runoff shall be quantified where nitrogen inputs and hydrological conditions make such emissions material.

N_2O from N leaching and runoff, based on IPCC Equation 11.10

$$N_2O_{L-N,m} = \left(F_{SN,m} + F_{ON,m} + F_{PRP,m} + F_{CR,m} + F_{SOM,m}\right) \times Frac_{LEACH,m} \times EF5 \quad \text{Equation 30}$$

Where:

$N_2O_{L-N,m}$	=	N_2O-N from leaching and runoff; kg N_2O-N
$F_{SN,m}$	=	synthetic fertilizer N applied; kg N
$F_{ON,m}$	=	organic N applied; kg N
$F_{PRP,m}$	=	urine and dung N deposited by grazing animals; kg N
$F_{CR,m}$	=	N in crop residues returned to soils; kg N
$F_{SOM,m}$	=	N mineralized due to SOC loss; kg N
$Frac_{LEACH,m}$	=	fraction of N lost through leaching and runoff; kg N kg^{-1} N added
$EF5$	=	emission factor for N_2O from leached or runoff N; kg N_2O-N kg^{-1} N leached

14.19 Conversion of N_2O-N to CO_2e

The incremental N_2O project emissions are calculated as:

$$PE_{N2O,m} = max\left(\theta, \left[\left(N2O_{Total-N,P.m} - N2O_{Total-N,BL.m}\right) \times 44/28 \div 1000 \times GWP_{N2O}\right]\right) \quad \text{Equation 31}$$

Where:

$PE_{N2O,m}$	=	incremental N_2O emissions attributable to the project activity; tCO_2e
$N2O_{Total-N,P.m}$	=	total N_2O-N emissions under the project scenario; kg N_2O-N
$N2O_{Total-N,BL.m}$	=	total N_2O-N emissions under the baseline scenario; kg N_2O-N
$44/28$	=	conversion from N_2O-N to N_2O
1000	=	conversion from kg to t
GWP_{N2O}	=	global warming potential of N_2O; tCO_2e t^{-1} N_2O

Where:

Total N_2O-N emissions.

$$N2O_{Total-N,m} = N2O_{Direct-N,m} + N2O_{ATD-N,m} + N2O_{L-N,m} \quad \text{Equation 32}$$

14.20 Incremental CH_4 emissions

Incremental CH_4 emissions shall be quantified where project activities affect soil saturation, manure handling, organic amendment handling, anaerobic storage, irrigation, or other methane-generating conditions. Where livestock or manure management is relevant, IPCC Chapter 10 provides methods for CH_4 and N_2O from manure management.

The incremental CH_4 emissions are calculated as:

$$PE_{CH4,m} = max(\theta, CH4_{P,m} - CH4_{BL,m}) \times GWP_{CH4} \quad \text{Equation 33}$$

Where:

$PE_{CH4,m}$	=	incremental CH_4 emissions attributable to the project activity; tCO_2e
$CH4_{P,m}$	=	CH_4 emissions under the project scenario; t CH_4
$CH4_{BL,m}$	=	CH_4 emissions under the baseline scenario; t CH_4
GWP_{CH4}	=	global warming potential of CH_4; tCO_2e t^{-1} CH_4

14.21 CO_2 emissions from lime, limestone, dolomite, or carbonate amendments

CO_2 emissions from lime, limestone, dolomite, or carbonate amendments shall be quantified where such materials are applied. Such inputs shall also be assessed under the exogenous inorganic carbon deduction provisions of this methodology.

CO_2-C emissions from lime application, based on IPCC Equation 11.12.

$$CO_2 - C_{Lime,m} = (M_{Limestone,m} \times EF_{Limestone}) + (M_{Dolomite,m} \times EF_{Dolomite}) \quad \text{Equation 34}$$

CO_2 emissions from lime application

$$CO_{2_{Lime,m}} = CO_2 - C_{Lime,m} \times 44/12 \quad \text{Equation 35}$$

Where:

$CO_2 - C_{Lime,m}$	=	carbon emissions from lime application; t C

$CO_{2_{Lime,m}}$	=	CO_2 emissions from lime application; t CO_2
$M_{Limestone,m}$	=	amount of limestone applied; t
$M_{Dolomite,m}$	=	amount of dolomite applied; t
$EF_{Limestone}$		emission factor for limestone; t C t^{-1} limestone
$EF_{Dolomite}$		emission factor for dolomite; t C t^{-1} dolomite
$44/12$		molecular weight ratio to convert C to CO_2; tCO_2 t^{-1} C

Incremental CO_2 emissions from lime or carbonate amendments

$$PE_{Lime,m} = max(\theta, CO2_{Lime,P,m} - CO2_{Lime,BL,m}) \quad \text{Equation 36}$$

Where:

$PE_{Lime,m}$	=	incremental CO_2 emissions from lime or carbonate amendment use; tCO_2e
$CO2_{Lime,P,m}$	=	CO_2 emissions from lime or carbonate amendments under the project scenario; tCO_2
$CO2_{Lime,BL,m}$	=	CO_2 emissions from lime or carbonate amendments under the baseline scenario; tCO_2

14.22 CO_2 emissions from urea application

CO_2 emissions from urea application shall be quantified where urea is applied under the baseline or project scenario, based on IPCC Equation 11.13.

$$CO_2 - C_{Urea,m} = M_{Urea,m} \times EF_{Urea} \quad \text{Equation 37}$$

CO_2 emissions from urea application

$$CO_{2_{Urea,m}} = CO_2 - C_{Urea,m} \times 44/12 \quad \text{Equation 38}$$

Where:

$CO_2 - C_{Urea,m}$	=	carbon emissions from urea application; t C
$CO_{2_{Urea,m}}$	=	CO_2 emissions from urea application; t CO_2
$M_{Urea,m}$	=	amount of urea applied; t urea
EF_{Urea}	=	emission factor for urea; t C t^{-1} urea
$44/12$	=	molecular weight ratio to convert C to CO_2; tCO_2 t^{-1} C

Incremental CO_2 emissions from urea application

$$PE_{Urea,m} = max(\theta, CO2_{Urea,P,m} - CO2_{Urea,BL,m}) \quad \text{Equation 39}$$

Where:

$PE_{Urea,m}$	=	incremental CO_2 emissions from urea application; tCO_2e
$CO_{2\,Urea,P,m}$	=	CO_2 emissions from urea application under the project scenario; tCO_2
$CO_{2\,Urea,BL,m}$	=	CO_2 emissions from urea application under the baseline scenario; tCO_2

14.23 Leakage

Leakage shall be identified, assessed, quantified where material, and deducted in accordance with the BioCarbon Leakage Management Tool.

$$LE_m = LE_{SRC,m} + LE_{DISP,m} + LE_{PROD,m} + LE_{MKT,m} + LE_{CONS,m} + LE_{OTHER,m} \quad \text{Equation 40}$$

Where:

LE_m	=	total leakage emissions in monitoring period m; tCO_2e
$LE_{SRC,m}$	=	leakage from carbon stock losses in input source areas; tCO_2e
$LE_{DISP,m}$	=	leakage from displacement of existing uses of biomass, residues, organic inputs, or other materials; tCO_2e
$LE_{PROD,m}$	=	leakage from displacement of agricultural production; tCO_2e
$LE_{MKT,m}$	=	market leakage, where applicable; tCO_2e
$LE_{CONS,m}$	=	conservative leakage deduction where direct quantification is not feasible; tCO_2e
$LE_{OTHER,m}$	=	other material leakage; tCO_2e

14.24 Leakage from source-area carbon stock losses

Where biomass residues, organic amendments, or other biogenic materials are removed or diverted from a source area, leakage shall include carbon stock losses attributable to that removal or diversion.

$$LE_{SRC,m} = \sum_{o} (C_{loss,o,m} \times 44/12) \quad \text{Equation 41}$$

Where:

$LE_{SRC,m}$	=	leakage from carbon stock losses in input source areas; tCO_2e
$C_{loss,o,m}$	=	carbon stock loss in source area or system o attributable to project input sourcing; t C
44/12	=	molecular weight ratio to convert C to CO_2; $tCO_2\ t^{-1}\ C$

This equation applies where removal of residues or biomass reduces dead wood, litter, SOC, biomass carbon, or other relevant carbon pools outside the project boundary.

14.25 Leakage from displacement of existing input uses

Where project inputs are diverted from existing uses, leakage shall include emissions associated with substitute materials or activities.

$$LE_{DISP,m} = \sum_{j} \left(Q_{disp,j,m} \times EF_{subst,j} \right) \qquad \text{Equation 42}$$

Where:

$LE_{DISP,m}$	=	leakage from displacement of existing uses; tCO_2e
$Q_{disp,j,m}$	=	quantity of input j diverted from an existing use; t input
$EF_{subst,j}$	=	emission factor for substitute material or activity replacing input j; $tCO_2e\ t^{-1}$ input

Where no reliable evidence is available on substitute materials or activities, the project holder shall apply a conservative default or deduction factor in accordance with the BioCarbon Leakage Management Tool.

14.26 Leakage from displaced agricultural production

Where the project activity reduces or displaces agricultural production outside the project boundary, leakage shall be quantified.

$$LE_{PROD,m} = \sum_{p} \left(Q_{red,p,m} \times EF_{prod,p} \right) \qquad \text{Equation 43}$$

Where:

$LE_{PROD,m}$	=	leakage from displaced agricultural production; tCO_2e
$Q_{red,p,m}$	=	quantity of agricultural product p displaced or reduced due to project activity; t product
$EF_{prod,p}$	=	conservative emission factor for replacement production of product p; $tCO_2e\ t^{-1}$ product

Where displacement occurs through land-use expansion rather than product substitution, the project holder shall apply an approved land-use displacement approach under the Leakage Management Tool or another approved BioCarbon approach.

14.27 Conservative leakage deduction where direct quantification is not feasible

Where leakage is material but direct quantification is not technically feasible, a conservative leakage deduction shall be applied.

$$LE_{CONS,m} = D_{LE,m} \times GCDR_m \quad \text{Equation 44}$$

Where:

$LE_{CONS,m}$	=	conservative leakage deduction; tCO_2e
$D_{LE,m}$	=	conservative leakage deduction factor; dimensionless
$GCDR_m$	=	gross carbon dioxide removals before deductions; tCO_2e

Where LE_CONS,m is applied, it shall be included in LE_m and shall not be double counted with quantified leakage components.

14.28 Pre-uncertainty net removals

$$NCDR_{preU,m} = GCDR_m - PE_m - LE_m \quad \text{Equation 45}$$

Where:

$NCDR_{preU,m}$	=	net removals before uncertainty adjustment; tCO_2e
$GCDR_m$	=	gross carbon dioxide removals; tCO_2e
PE_m	=	project emissions; tCO_2e
LE_m	=	leakage emissions; tCO_2e

14.29 Uncertainty adjustment

Uncertainty shall be assessed and deducted in accordance with the BioCarbon Conservative Approach and Uncertainty Management Tool.

$$UADJ_m = D_{U,m} \times max(\theta, NCDR_{preU,m}) \quad \text{Equation 46}$$

Where:

$UADJ_m$	=	uncertainty adjustment; tCO_2e
$D_{U,m}$	=	uncertainty deduction factor determined under the BioCarbon Uncertainty Tool; dimensionless

$NCDR_{preU,m}$ = net removals before uncertainty adjustment; tCO_2e

The final net carbon dioxide removals are calculated as:

$$NCDR_m = max(\theta, NCDR_{preU,m} - UADJ_m) \quad \text{Equation 47}$$

Where:

$NCDR_m$ = final net carbon dioxide removals eligible for crediting; tCO_2e

14.30 Reporting of quantified results

For each monitoring period, the project holder shall report separately:

(a) gross SOC removals;
(b) gross SIC removals;
(c) SIC deductions for exogenous inorganic carbon and non-attributable SIC;
(d) mineral weathering removal cap, where applicable;
(e) project emissions by source category;
(f) direct and indirect N_2O emissions;
(g) CH_4 emissions, where applicable;
(h) CO_2 emissions from lime, carbonate amendments, and urea, where applicable;
(i) leakage by source category;
(j) uncertainty adjustment;
(k) reserve contribution; and
(l) final net carbon dioxide removals eligible for crediting.

All calculations shall be traceable, reproducible, and supported by the data and parameters required under this methodology and the applicable BioCarbon Tools.

15 Monitoring requirements

15.1 General requirement

Project holders shall monitor, report, and verify project activities in accordance with the most recent version in force of the BioCarbon Monitoring, Reporting and Verification Tool and the requirements of this methodology.

Monitoring shall be sufficient to quantify net carbon dioxide removals in eligible SOC and/or SIC pools, project emissions, leakage, uncertainty, and any other deductions required under the BioCarbon Standard.

Monitoring shall be based on transparent, traceable, conservative, and verifiable data. All monitoring procedures shall be described in the Monitoring Plan and validated prior to credit issuance.

15.2 Monitoring Plan

The project holder shall prepare and implement a Monitoring Plan covering all parameters required to quantify net carbon dioxide removals under this methodology.

The Monitoring Plan shall include, at minimum:

(a) project boundary and georeferenced land units;
(b) strata and sampling design;
(c) SOC and/or SIC monitoring approach;
(d) soil depth, bulk density, coarse fragment correction, and laboratory methods;
(e) monitoring of eligible mineral, biological, and organic inputs;
(f) monitoring of project emissions, including material CO_2, CH_4, and N_2O sources;
(g) leakage monitoring, where applicable;
(h) QA/QC procedures;
(i) data management, archiving, and traceability procedures;
(j) procedures for detecting deviations, reversals, or material changes affecting SOC or SIC accounting.

The Monitoring Plan shall remain consistent with the validated baseline, project boundary, stratification, quantification approach, and applicable BioCarbon Tools.

15.3 Monitoring frequency

Activity data, input records, land management data, and project implementation records shall be monitored continuously or at least annually.

SOC and SIC stock measurements shall be conducted at baseline and at each verification event for which soil carbon removals are claimed, unless an approved model-based approach is applied. Where modelling is used, direct soil measurements shall be conducted at intervals sufficient to validate model outputs and shall occur no less frequently than once every five years.

Monitoring frequency shall be sufficient to detect SOC and/or SIC stock changes with adequate statistical confidence and to support uncertainty assessment under the BioCarbon Conservative Approach and Uncertainty Management Tool.

15.4 Stratification and soil sampling

The project area shall be stratified into relatively homogeneous units based on factors that materially influence SOC and/or SIC stocks, including soil type, mineralogy, carbonate content, climate, topography, land-use history, management practices, baseline carbon stocks, and amendment application.

The sampling design shall be statistically valid, representative of each stratum, and consistent across baseline and project monitoring periods. Sampling locations, depths, compositing procedures, bulk density measurements, and analytical methods shall be documented and retained for verification.

Any change to stratification or sampling design shall be justified, documented, and assessed by the Conformity Assessment Body prior to use for credit issuance.

15.5 Monitoring of SOC

SOC monitoring shall quantify changes in soil organic carbon stocks using direct soil measurements, approved modelling, or a conservative combination of both.

SOC monitoring shall include, at minimum:

(a) soil organic carbon concentration;
(b) bulk density;
(c) coarse fragment content;
(d) soil depth included in the accounting boundary;
(e) area by stratum;
(f) land management practices affecting SOC inputs or losses;
(g) organic amendment application, residue management, and soil disturbance practices.

SOC shall be monitored separately from SIC. Temporary changes in plant biomass, crop residues, litter, or root biomass shall not be credited unless reflected in verified SOC stock changes within the monitored soil profile.

15.6 Monitoring of SIC and mineral weathering

Where SIC removals are claimed, the project holder shall monitor soil inorganic carbon stocks and all parameters required to distinguish project induced SIC formation from pre-existing or non-attributable inorganic carbon.

SIC monitoring shall include, at minimum:

(a) inorganic carbon concentration;
(b) carbonate content and distribution by depth;
(c) bulk density and coarse fragment content;
(d) soil pH and other relevant geochemical indicators;
(e) baseline lithogenic and pedogenic carbonate conditions;
(f) historical and project-period use of lime, carbonate amendments, silicate minerals, alkaline materials, or irrigation water alkalinity;
(g) exogenous inorganic carbon introduced through project inputs;
(h) evidence supporting attribution of SIC formation to project activities.

Where enhanced mineral weathering is included, monitoring shall also include mineral amendment mass, origin, mineralogical composition, particle size distribution, application rate, application date, application location, weathering assumptions, and chain-of-custody records.

SIC removals shall not be credited where monitoring data are insufficient to distinguish project induced SIC formation from lithogenic carbonate, exogenous inorganic carbon, carbonate redistribution, or background SIC dynamics.

Monitoring of SIC and mineral weathering shall include the evidence used to estimate or validate the fraction of mineral amendment weathered during each monitoring period, including field measurements, laboratory analyses, model inputs, model outputs, calibration data, uncertainty estimates, and conservative deductions where applicable.

15.7 Monitoring of inputs and chain of custody

All mineral amendments, biological inputs, microbial inoculants, organic amendments, biomass residues, and other relevant inputs shall be monitored from origin to field application.

Monitoring records shall include, as applicable:

(a) supplier and source location;
(b) batch identification;
(c) quantity produced, purchased, transported, stored, and applied;
(d) composition and laboratory certificates;
(e) transport route and distance;
(f) application date, rate, and field or stratum;
(g) evidence of legal sourcing and eligibility;
(h) records demonstrating that input sourcing does not cause material leakage or carbon stock depletion outside the project boundary.

Inputs without sufficient traceability shall not be used to support credited removals.

15.8 Monitoring of project emissions and leakage

Project holders shall monitor all material project emissions associated with implementation of the project activity, including emissions from input production, mineral extraction or processing, transport, field application, fuel use, electricity use, irrigation changes, nutrient management, organic amendment handling, and material changes in CH_4 or N_2O emissions.

Leakage shall be monitored where identified as material or potentially material under the BioCarbon Leakage Management Tool. Monitoring shall include activity data necessary to quantify leakage from input sourcing, displacement of existing input uses, carbon stock losses in source areas, displaced agricultural production, or other attributable leakage sources.

Project emissions and leakage shall be reported separately from gross SOC and SIC removals.

15.9 Data management and QA/QC

The project holder shall implement QA/QC procedures to ensure the completeness, accuracy, consistency, and traceability of all monitoring data.

QA/QC procedures shall include, as applicable:

(a) standardized field sampling protocols;
(b) laboratory accreditation or documented laboratory competence;
(c) sample custody records;
(d) duplicate samples, blanks, calibration checks, and analytical controls;
(e) internal data review and validation;
(f) consistency checks across field records, laboratory results, input records, maps, and calculations;
(g) version control of datasets, models, spreadsheets, and monitoring reports;
(h) procedures for correcting errors and documenting deviations.

All monitoring data, raw records, laboratory reports, maps, models, calculations, and supporting evidence shall be archived for the period required by the BioCarbon Standard and made available for validation, verification, oversight, and quality assurance.

15.10 Use of models and digital monitoring

Models may be used to support SOC, SIC, mineral weathering, project emissions, leakage, or uncertainty estimates only where they are appropriate to the project context, transparently documented, calibrated or validated with relevant data, and applied conservatively.

Remote sensing, GIS, field applications, sensors, digital MRV systems, and other monitoring technologies may be used to support boundary monitoring, activity data collection, stratification, land-use monitoring, disturbance detection, and data traceability. Such technologies shall not replace required soil measurements unless expressly allowed under this methodology or an approved BioCarbon module.

Models used to estimate mineral weathering, SIC attribution, or the fraction of mineral amendment weathered shall meet the requirements of Section 14.11 and shall be documented sufficiently to allow independent verification and replication.

15.11 Monitoring Report

For each verification event, the project holder shall prepare a Monitoring Report in accordance with the BioCarbon Monitoring, Reporting and Verification Tool.

The Monitoring Report shall include, at minimum:

(a) monitoring period and project implementation status;
(b) monitored SOC and/or SIC stock changes;
(c) monitored mineral, biological, and organic input data;

(d) project emissions by source category;
(e) leakage assessment and deductions;
(f) uncertainty assessment and deductions;
(g) any reversals, disturbances, deviations, or material changes;
(h) final net carbon dioxide removals eligible for crediting;
(i) supporting data, calculations, maps, laboratory results, and QA/QC records.

The Monitoring Report shall clearly report SOC removals, SIC removals, project emissions, leakage, uncertainty adjustments, and net carbon dioxide removals separately.

15.12 Verification

All monitored results shall be independently verified by an authorized Conformity Assessment Body in accordance with the BioCarbon Standard and applicable BioCarbon Tools.

The Conformity Assessment Body shall assess whether monitoring has been implemented in accordance with the validated Monitoring Plan, this methodology, and the applicable BioCarbon Tools. The assessment shall include review of sampling design, laboratory results, input traceability, SOC and SIC calculations, mineral weathering attribution, project emissions, leakage, uncertainty, QA/QC procedures, and data archiving.

No Verified Carbon Credits shall be issued for removals that are not supported by sufficient monitored evidence.

16 Permanence and reversal risk management

16.1 General requirement

Project holders shall assess, monitor, manage, and compensate reversal risks in accordance with the most recent version in force of the BioCarbon Permanence and Risk Management Tool.

Permanence shall be assessed separately for soil organic carbon (SOC) and soil inorganic carbon (SIC), recognizing that these pools differ in their formation mechanisms, vulnerability to reversal, monitoring requirements, and expected durability.

Notwithstanding the general minimum periods established in the BCR Standard, all BCR0017 activities that generate credits from SOC and/or SIC pools and are subject to reversal risk shall maintain reversal monitoring, reporting, and compensation obligations for a minimum of forty (40) years from the start of the first quantification period. This requirement applies regardless of project start date.

16.2 Pool-specific permanence treatment

SOC removals shall be treated as reversible biological removals. The project holder shall demonstrate that management practices, land tenure arrangements, monitoring systems, and risk mitigation measures are sufficient to maintain credited SOC stocks throughout the applicable permanence obligation period.

SIC removals shall be treated as potentially more durable geochemical removals, provided that the project holder demonstrates that credited SIC represents project-induced atmospheric CO_2 removal and is not attributable to lithogenic carbonate, exogenous inorganic carbon, carbonate redistribution, or non-attributable background processes.

No default 100-year permanence assumption shall apply to SOC or SIC removals under this methodology. Permanence claims shall be supported by pool-specific evidence, monitoring, and risk management.

16.3 Reversal risks

The project holder shall identify and assess reversal risks that may affect credited SOC and/or SIC removals, including risks from land-use change, soil disturbance, erosion, flooding, drought, fire, salinization, acidification, carbonate dissolution, leaching, changes in irrigation, cessation of project practices, loss of land access, governance failure, or other material events.

Where a reversal risk affects SOC and SIC differently, the risk assessment shall identify the affected pool separately.

16.4 Monitoring of permanence

The Monitoring Plan shall include procedures to detect and report any event that may reduce previously credited SOC and/or SIC stocks.

Monitoring may include soil remeasurement, land-use monitoring, geospatial monitoring, management records, erosion indicators, soil pH and carbonate monitoring, mineral amendment records, and other evidence relevant to permanence and reversal risk.

16.5 Reversals and compensation

Any confirmed loss of previously credited SOC and/or SIC removals shall be reported, quantified conservatively, classified as avoidable or unavoidable, and compensated in accordance with the BioCarbon Permanence and Risk Management Tool.

Where evidence is insufficient to determine whether a reversal occurred or whether it is avoidable or unavoidable, the reversal shall be treated conservatively in accordance with the applicable BioCarbon requirements.

16.6 Reserve contribution

Projects shall contribute to the applicable reserve or buffer mechanism in accordance with the BioCarbon Permanence and Risk Management Tool.

Where SOC and SIC have materially different reversal risks, the project holder shall provide sufficient information for the Conformity Assessment Body to assess whether pool-specific risk treatment or conservative reserve allocation is required.

17 Data and parameters

17.1 General requirements

The project holder shall identify, document, monitor, and report all data and parameters required to quantify net carbon dioxide removals under this methodology.

All parameters shall be consistent with the project boundary, baseline scenario, monitoring plan, quantification approach, and applicable BioCarbon Tools. Data shall be transparent, traceable, verifiable, and supported by documentary evidence, field measurements, laboratory analyses, models, or conservative default values, as applicable.

Where a parameter is already defined in an applicable BioCarbon Tool, IPCC method, or BioCarbon-approved module, the project holder shall apply the requirements of that source unless this methodology establishes a more specific or conservative requirement.

The project holder shall report all parameters used in the calculation of SOC removals, SIC removals, project emissions, leakage, uncertainty adjustments, and final net carbon dioxide removals.

17.2 Data and parameters available at validation

The following data and parameters shall be determined at validation and updated only where required by this methodology, the BioCarbon Standard, or an applicable BioCarbon Tool.

Table 4. Data and parameters available at validation

Parameter	Description	Unit	Source / method	Use
A_s	Area of stratum s	ha	GIS, cadastral data, georeferenced project boundary	SOC and SIC stock calculations
D_s	Soil depth included in the accounting boundary for stratum s	m	Sampling design and Monitoring Plan	SOC and SIC stock calculations
LU_s	Baseline land-use category of stratum s	categorical	Land-use records, IPCC land category, national land classification	Baseline and eligibility
$SoilType_s$	Soil type or soil classification for stratum s	categorical	Soil maps, field survey, laboratory characterization	Stratification and baseline

Parameter	Description	Unit	Source / method	Use
$Mineralogy_s$	Relevant mineralogical characteristics of soil in stratum s	categorical / %	Laboratory analysis, soil survey, mineralogical data	SIC and mineral weathering assessment
$SOC_{s,to}$	Initial SOC stock in stratum s at baseline or project start	t C	Baseline soil sampling, laboratory analysis, approved model	Baseline SOC
$SIC_{s,to}$	Initial SIC stock in stratum s at baseline or project start	t C	Baseline soil sampling, carbonate analysis, approved model	Baseline SIC
$BD_{s,to}$	Initial bulk density for stratum s	t soil/m^3	Field sampling and laboratory determination	SOC and SIC stock calculations
$CFF_{s,to}$	Initial coarse fragment fraction for stratum s	dimensionless	Field sampling and laboratory analysis	SOC and SIC stock calculations
$pH_{s,to}$	Initial soil pH for stratum s	pH units	Laboratory analysis	SIC, mineral weathering, and soil condition assessment
$Carbonate_{s,to}$	Initial carbonate content and distribution by depth	t C/t soil or %	Laboratory analysis	SIC baseline and carbonate attribution
$Lithogenic_s$	Presence and characterization of lithogenic carbonate	qualitative / quantitative	Soil survey, mineralogical analysis, parent material assessment	Exclusion of non-attributable SIC
$SOC_{BL,s}$	Baseline SOC trajectory for stratum s	t C or t C/yr	Baseline measurements, historical data, approved model	SOC removals
$SIC_{BL,s}$	Baseline SIC trajectory for stratum s	t C or t C/yr	Baseline measurements, historical data, approved model	SIC removals
CO_{2potj}	Conservative CO_2 uptake potential of eligible mineral amendment j	tCO_2/t material	Mineral composition, stoichiometric calculation, approved default	Mineral weathering cap
$IC_{contentj}$	Inorganic carbon content of input j	t C/t material	Laboratory certificate or conservative default	Exogenous inorganic carbon deduction

Parameter	Description	Unit	Source / method	Use
EF_{FUELf}	Emission factor for fuel type f	tCO_2e/fuel unit	IPCC, national factor, BioCarbon-approved factor	Fuel emissions
$EF_{ELEC,k}$	Electricity emission factor for source or grid k	tCO_2e/MWh	National grid factor, BioCarbon-approved factor	Electricity emissions
$EF_{TR,r}$	Transport emission factor for route or vehicle type r	tCO_2e/t-km	National factor, IPCC, BioCarbon-approved factor	Transport emissions
EF_1, EF_4, EF_5	IPCC emission factors for direct and indirect N_2O emissions	kg N_2O-N/kg N	IPCC or country-specific factors	N_2O emissions
GWP_{CH4}, GWP_{N2O}	Global warming potentials for CH_4 and N_2O	tCO_2e/t gas	BioCarbon Standard or applicable IPCC AR values required by BioCarbon	Conversion to CO_2e
B_m	Applicable reserve or buffer contribution	dimensionless	Permanence and Risk Management Tool	Reserve allocation
$D_{LE,m}$	Conservative leakage deduction factor, where direct quantification is not feasible	dimensionless	Leakage Management Tool or approved methodology-specific value	Leakage deduction
$D_{U,m}$	Uncertainty deduction factor	dimensionless	Conservative Approach and Uncertainty Management Tool	Uncertainty adjustment

Where any parameter listed above is updated after validation, the project holder shall justify the update and demonstrate that the revised value is conservative, traceable, and consistent with the applicable BioCarbon Tools.

17.3 Data and parameters monitored

The following data and parameters shall be monitored during each monitoring period, where relevant to the project activity.

Table 5. Data and parameters monitored

Parameter	Description	Unit	Source / method	Frequency	Use
$SOCconc_{s,t}$	SOC concentratio	t C/t soil	Laboratory analysis	At baseline and each soil	SOC stock calculation

Parameter	Description	Unit	Source / method	Frequency	Use
	n in stratum s at time t			monitoring event	
$SICconc_{s,t}$	SIC concentration in stratum s at time t	t C/t soil	Laboratory analysis	At baseline and each SIC monitoring event	SIC stock calculation
$BD_{s,t}$	Bulk density in stratum s at time t	t soil/m³	Field sampling and laboratory analysis	Each soil monitoring event	SOC and SIC stock calculation
$CFF_{s,t}$	Coarse fragment fraction in stratum s at time t	dimensionless	Field sampling and laboratory analysis	Each soil monitoring event	SOC and SIC stock calculation
$pH_{s,t}$	Soil pH in stratum s at time t	pH units	Laboratory analysis	Each SIC monitoring event or as justified	SIC attribution and weathering evidence
$Carbonate_{s,t}$	Carbonate content and distribution by depth	t C/t soil or %	Laboratory analysis	Each SIC monitoring event	SIC stock and attribution
$SOC_{s,t}$	SOC stock in stratum s at time t	t C	Calculated from monitored soil data	Each soil monitoring event	SOC removals
$SIC_{s,t}$	SIC stock in stratum s at time t	t C	Calculated from monitored soil data	Each SIC monitoring event	SIC removals
$M_{min,j,m}$	Dry mass of eligible mineral amendment j applied in monitoring period m	t mineral	Purchase, production, delivery, and application records	Each application / annually	SIC and weathering cap
$PSD_{j,m}$	Particle size distribution of mineral amendment j	% by size class	Laboratory certificate or supplier analysis	Each batch or representative lot	Mineral weathering assessment

Parameter	Description	Unit	Source / method	Frequency	Use
$MineralComp_{j,m}$	Mineralogical and chemical composition of mineral amendment j	% or t/t	Laboratory certificate	Each batch or representative lot	CO_2 uptake potential and eligibility
$Fweath_{j,m}$	Fraction of mineral amendment j weathered during monitoring period m	dimensionless	Approved model and/or project-relevant field or laboratory measurements, calibrated or validated in accordance with Section 14.11 and subject to uncertainty treatment.	Each monitoring period	Mineral weathering cap
$M_{inputj,m}$	Dry mass of input j applied	t material	Field records, invoices, delivery records	Each application / annually	Exogenous carbon, inputs, project emissions
$ICcontent_{j,m}$	Inorganic carbon content of input j	t C/t material	Laboratory analysis or conservative default	Each batch or representative lot	Exogenous inorganic carbon deduction
$M_{org,j,m}$	Dry mass of organic amendment j applied	t dry matter	Field records, laboratory moisture correction	Each application / annually	SOC, emissions, leakage
$N_{SN,m}$	Synthetic fertilizer nitrogen applied	kg N	Farm records, invoices, application logs	Each application / annually	N_2O emissions
$N_{ON,m}$	Organic nitrogen applied through amendments	kg N	Laboratory analysis and application records	Each application / annually	N_2O emissions
$N_{CR,m}$	Nitrogen in crop residues	kg N	Crop records, biomass	Annually or per crop cycle	N_2O emissions

Parameter	Description	Unit	Source / method	Frequency	Use
	returned to soils		estimates, IPCC or measured values		
$N_{PRP,m}$	Nitrogen deposited by grazing animals, where applicable	kg N	Livestock records, grazing days, IPCC methods	Annually	N_2O emissions
$FC_{f,m}$	Fuel consumption by fuel type f	fuel unit	Fuel records, machinery logs	Annually or per operation	Project emissions
$EC_{k,m}$	Electricity consumption for process k	MWh	Meter readings, invoices, operational records	Annually or per operation	Project emissions
$M_{r,m}$	Mass transported on route r	t	Delivery records, transport logs	Each shipment / annually	Transport emissions
$D_{r,m}$	Transport distance for route r	km	GIS, transport records, invoices	Each route / annually	Transport emissions
$M_{Limestone,m}$	Limestone applied	t	Input records and field logs	Each application / annually	CO_2 from lime
$M_{Dolomite,m}$	Dolomite applied	t	Input records and field logs	Each application / annually	CO_2 from lime
$M_{Urea,m}$	Urea applied	t	Fertilizer records and field logs	Each application / annually	CO_2 from urea
$CH_{4P,m}$	CH_4 emissions under project scenario, where relevant	t CH_4	IPCC method, measurement, approved model	Each monitoring period	Project emissions
$CH_{4BL,m}$	CH_4 emissions under baseline	t CH_4	Baseline model or records	Each monitoring period	Incremental CH_4

Parameter	Description	Unit	Source / method	Frequency	Use
	scenario, where relevant				
$C_{loss,o,m}$	Carbon stock loss in source area or system o attributable to project input sourcing	t C	Source-area assessment, records, conservative estimates	Each monitoring period where relevant	Leakage
$Q_{disp,j,m}$	Quantity of input j diverted from an existing use	t input	Supplier records, baseline use assessment	Each monitoring period where relevant	Displacement leakage
$Q_{red,p,m}$	Quantity of agricultural product p displaced or reduced due to project activity	t product	Production records, yield data, market data	Each monitoring period where relevant	Production displacement leakage
$ActivityData_m$	Management activities implemented during monitoring period	variable	Field logs, farm records, digital MRV, remote sensing	Continuously / annually	Eligibility and attribution
$QAQC_m$	QA/QC checks performed	records	Internal review, laboratory QA/QC, data validation	Each monitoring period	Data quality
$U_{total,m}$	Total uncertainty of quantified net removals	%	Uncertainty Tool calculation	Each monitoring period	Uncertainty adjustment

Parameters not applicable to a specific project activity may be excluded where the project holder demonstrates that the parameter is not relevant and that exclusion does not overestimate net carbon dioxide removals.

17.4 Data quality and source hierarchy

Project-specific measured data shall be preferred over regional, national, literature-based, or default values.

Where project-specific data are not available, the project holder may use national data, regional datasets, peer-reviewed literature, IPCC defaults, BioCarbon-approved values, or conservative expert judgment, in that order of preference, unless otherwise required by an applicable BioCarbon Tool.

Default values shall be selected conservatively. Where multiple plausible values are available, the value resulting in the lowest net carbon dioxide removals shall be used, unless a different value is justified and validated.

17.5 Missing data

Where monitored data are missing, incomplete, inconsistent, or not verifiable, the project holder shall apply conservative procedures in accordance with the BioCarbon MRV Tool and the Conservative Approach and Uncertainty Management Tool.

Missing data shall not be replaced by optimistic assumptions. Where missing data affect SOC or SIC removals and cannot be conservatively reconstructed, the affected removals shall not be credited.

17.6 Record keeping

All data and parameters used for quantification shall be retained in a transparent and auditable format.

The project holder shall retain, at minimum, raw field data, geospatial files, laboratory reports, input records, chain-of-custody documentation, calculation spreadsheets, model files, QA/QC records, Monitoring Reports, and supporting evidence for the period required under the BioCarbon Standard.

All data shall be made available to the Conformity Assessment Body and BioCarbon for validation, verification, oversight, and quality assurance.

18 Document status

18.1 Status

This document constitutes the Draft for Public Consultation of BCR0017 – Soil Carbon Removal through Agricultural Management and Mineral Weathering: Carbon Dioxide Removal (CDR) Modular Methodology for Agricultural Soils.

This version has been prepared for stakeholder review, technical assessment, and public consultation under the BioCarbon Standard. It is not a final approved methodology and shall

not be used for project validation, verification, registration, or issuance of Verified Carbon Credits (VCCs) until formally approved and published by BioCarbon.

18.2 Entry into force and applicability

This methodology will enter into force only upon formal approval and publication by BioCarbon.

The final approved version will specify its effective date, applicable transition provisions, version-control rules, and any conditions governing its use by project holders, Conformity Assessment Bodies, and other intended users.

Project holders shall apply the approved version of this methodology together with the most recent version in force of all applicable BioCarbon Tools at the time of validation or verification, unless otherwise specified by BioCarbon.

18.3 Revision and updates

BioCarbon may revise this methodology to reflect public consultation comments, scientific developments, methodological improvements, updates to BioCarbon Tools, changes in IPCC guidance, regulatory developments, or market integrity requirements.

Revisions may include changes to scope, applicability conditions, eligible activities, baseline requirements, quantification procedures, monitoring requirements, uncertainty treatment, leakage treatment, permanence provisions, data and parameter requirements, or appendices.

Any future version will be published with a version number, publication date, description of changes, and applicability provisions.

18.4 Use of project-specific supporting documentation

Project-specific supporting documentation required under this methodology, including additionality demonstration materials, calculation files, monitoring evidence, laboratory reports, chain-of-custody documentation, and other supporting materials, shall form part of the project documentation submitted for validation or verification, as applicable.

Where a supporting document is required to be publicly available, the project holder shall submit a public version through the BioCarbon registry platform or another official publication channel designated by BioCarbon. Confidential information may be redacted only where permitted under BioCarbon rules and where the public version remains sufficient to understand the basis of the relevant claim or calculation.

18.5 Publication format

The official version of this methodology is the digital version published by BioCarbon on its official website or other designated publication channel.

Any printed copy, unofficial reproduction, or extracted version shall be checked against the official digital version. In case of discrepancy, the official digital version published by BioCarbon shall prevail.

This document is available in English and Spanish. The English-language version is the official version; the Spanish-language version is provided as a translation. In the event of any discrepancy, inconsistency, or difference in interpretation between the two versions, the English-language version shall prevail.

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Document history

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Draft for Public Consultation	July 17, 2026	Initial version – Document submitted for public consultation