METHODOLOGY FOR THE QUANTIFICATION, MONITORING, REPORTING AND VERIFICATION OF GREENHOUSE GAS EMISSIONS REDUCTIONS AND REMOVALS FROM

RESTORATION OF POCOSIN WETLANDS

VERSION 1.0

October 2017

ACR
AT WINROCK INTERNATIONAL

METHODOLOGY FOR THE QUANTIFICATION, MONITORING, REPORTING AND VERIFICATION OF GREENHOUSE GAS EMISSIONS REDUCTIONS AND REMOVALS FROM

RESTORATION OF POCOSIN WETLANDS

VERSION 1.0

October 2017

ACR[SM]

OFFICE ADDRESS
c/o Winrock International
204 E. 4th Street
North Little Rock, Arkansas 72114 USA
ph +1 571 402 4235

ACR@winrock.org
acrcarbon.org

ABOUT ACR[SM]

ACR is a leading global carbon crediting program operating in regulated and voluntary carbon markets. Founded in 1996 as the first private voluntary greenhouse gas (GHG) registry in the world, ACR creates confidence in the integrity of carbon markets to catalyze transformational climate results. ACR ensures carbon credit quality through the development of environmentally rigorous, science-based standards and methodologies as well as oversight of carbon offset project verification, registration, and credit issuance and retirement reporting through its transparent registry system. ACR is governed by Environmental Resources Trust LLC, a wholly-owned nonprofit subsidiary of Winrock International.

Acknowledgements

The development of this methodology was a collective effort led by TerraCarbon and The Nature Conservancy (TNC), with the drafting team led by David Shoch, James Eaton and Erin Swails of TerraCarbon. Funding was provided by Duke Energy LLC and administered by TNC. In particular, the drafting team wishes to acknowledge, for their input and careful review of previous drafts, the contributions of Chuck Peoples, Christine Pickens, Brian Boutin and Eric Soderholm of TNC, Sara Ward and Howard Phillips of USFWS, Ken Krauss and Nicole Cormier of the U.S. Geological Survey, Linda Blum of the University of Virginia and Philippe Hensel of the National Oceanographic and Atmospheric Administration. Development of the conceptual framework and monitoring approaches benefited from research findings at Pocosin Lakes National Wildlife Refuge generously shared by Curt Richardson and Hongjun Wang of Duke University Wetland Center and Louise Armstrong of East Carolina University.

This methodology was developed by:

The Nature Conservancy

TerraCarbon

Acronyms

C	Carbon
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CH_4	Methane
ERT	Emission reduction ton
IPCC	Intergovernmental Panel on Climate Change
GHG	Greenhouse gas
GIS	Geographic information system
GPS	Global Positioning System
GWP	Global warming potential
N_2O	Nitrous oxide
MT	Metric ton
QA	Quality assurance
QC	Quality control
RMSE	Root mean squared error
RSET	Rod Surface Elevation Tables
RTK	Real time kinematic

Contents

FIGURES

TABLES

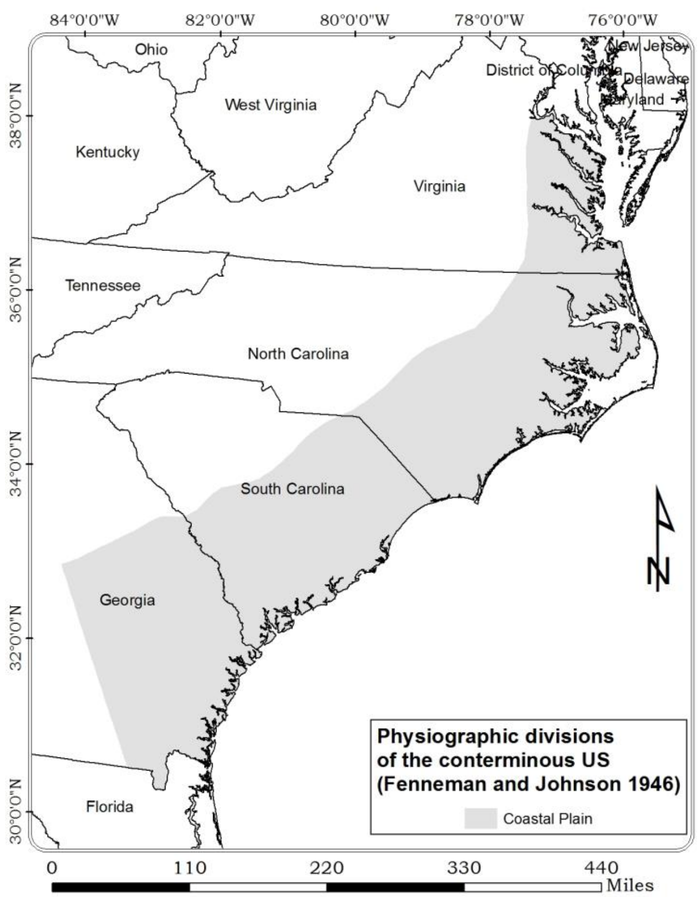
EQUATIONS

1 Methodology Description

1.1 Scope

This methodology accounts for the GHG emission reductions from rewetting previously drained pocosins. Pocosins are here defined as freshwater wetlands, with some component of broad-leaved evergreen shrubs or low trees, on organic soils in the coastal plain of southeast Virginia, North Carolina, South Carolina or Georgia, that are seasonally saturated primarily through precipitation. The baseline scenario assumes continuation of the pre-existing drained state, and ongoing emissions from the soil organic carbon (peat) pool associated with drainage. Leakage is excluded from accounting via an applicability condition stipulating the absence of any productive land use (that could be displaced or result in commodity shortages) in the project area within five years prior to the project start date.

Figure 1: Area of Applicability (Shaded) of the Methodology – Coastal Plain of Virginia, North Carolina, South Carolina and Georgia



1.2 Applicability Conditions

General applicability conditions for this methodology are:

I. The project area has been free of any land use that could be displaced outside the project area (e.g., agriculture) for five or more years prior to project start date;

II. The project area is a previously-drained pocosin. Continuation of the drained state is the most likely baseline scenario. Throughout this document, "drained" is defined as subject to a lowering of water table due to deliberate hydrological manipulation, e.g., through ditching and diking;

III. Project activity involves re-wetting previously drained wetlands, in which rewetting is defined as raising the elevation of the average annual water table in drained wetland by partially or entirely reversing the pre-existing drained state;

IV. Any areas of soil disturbance associated with implementation of the project activity are less than 3% of the project area;

V. N-fertilizers are not used in the with-project scenario;

VI. Infrastructure and/or management protocols are in place to manage for average annual water level at or below the surface elevation mid-point of the project area (e.g., by setting maximum height of outflow structure equal to the surface elevation mid-point of the project area);

VII. The project activity does not result in increased GHG emissions outside the project area via hydrological connectivity (i.e., would not result in drainage of adjacent areas);

VIII. No timber harvest will occur in the baseline or with-project scenarios;

IX. The project activity and project area meet all eligibility requirements set by the currently governing versions of the *ACR Standard* and *ACR Forest Carbon Project Standard*.

X. A baseline site must be identified and accessible on which one or more parameters are monitored in the baseline scenario. Parameter-specific criteria to demonstrate the appropriateness of a baseline site are detailed in Table 4.

Use of this methodology also requires that applicability conditions specific to the chosen accounting approach (stock change or flux; see Section 1.4) are met, as well as similarity criteria demonstrating the validity of one or more selected baseline sites (see Section 1.4 below).

1.3 Pools and Sources

1.3.1 CARBON POOLS

Table 1: Carbon Pools Accounted for in the Project Boundary

CARBON POOLS	INCLUDED / OPTIONAL / EXCLUDED	JUSTIFICATION / EXPLANATION OF CHOICE
Above-ground biomass carbon	Included (includes trees and woody shrubs)	Required as the project activity may result in increased mortality or decreased growth and recruitment
Below-ground biomass carbon	Included (includes trees and woody shrubs)	Required as the project activity may result in increased mortality or decreased growth and recruitment
Dead wood	Excluded	Conservatively excluded (pool is expected to be greater in the project scenario with potentially higher mortality and lower decomposition due to flooding)
Harvested wood products	Excluded	Excluded per applicability condition
Litter / Forest Floor	Excluded	The pool is conservatively omitted
Soil organic carbon	Included	Largest pool expected to be subject to change with the project activity

1.3.2 EMISSION SOURCES

Emissions of CO_2 are included through monitoring the carbon pools above.

Emissions of N_2O and CH_4 from intentional burns in the project scenario are included.

Emissions of N_2O and CH_4 from heterotrophic respiration are excluded as insignificant[1] within the constraints of the methodology.

1.4 Methodology Summary

The methodology centers on two different approaches for estimating belowground emissions: (1) a stock change approach which estimates emissions from net surface level change (due to subsidence and root dynamics), and (2) a flux approach which models emissions as a function of one or more proxy variables (e.g., soil moisture, temperature, etc.) that are demonstrated to be significantly correlated with belowground emissions. One or the other approach may be used, provided approach-specific applicability conditions are met.

The methodology is simplified by exclusion of leakage from accounting (explained above) and by accounting for uncertainty as a step in the derivation of parameter values (i.e., uncertainty is not accounted separately and deducted in final calculations as in other methodologies). Uncertainty is accounted in this way for all parameters driving differences between with-project and baseline scenario emissions, which include surface elevation change, above- and belowground biomass, proxy (independent) variables and emissions (dependent variable) modeled as a function of proxy variable(s). Also, in all accounting steps throughout this methodology, sources/sinks collectively amounting to less than 3% of total ex-ante estimate of net emission reductions may be excluded from accounting.

Monitoring is conducted in the project area and in a valid baseline site that matches conditions expected in the project area in the absence of the project activity (i.e., rewetting) (see Table 4). Either net surface elevation change (stock change approach) or one or more proxy variables (flux approach) are monitored to estimate emissions from belowground. Trees and woody shrubs are monitored on permanent sample plots to assess and account for any detected differences in stock change due to growth/recruitment/mortality between the project area and the baseline site. With the stock change approach, peat accretion is monitored as an undifferentiated component of net surface elevation change. Peat accretion is not monitored with the flux approach.

Unintentional (natural) fire is conservatively excluded from accounting. Where unintentional burns occur in the project area, it is assumed that equal emissions occur in the baseline (i.e., net zero). Intentional fires (e.g., prescribed burns) in the project area are monitored and emissions (from CO_2, N_2O and CH_4) accounted.

[1] Richardson et al. 2014. Impacts of Peatland Ditching and Draining on Water Quality and Carbon Sequestration Benefits of Peatland Restoration. Final Report. Duke University Wetlands Center for the US Fish and Wildlife Service and The Nature Conservancy.

As explained above, two approaches are provided for estimating net greenhouse gas emissions in the baseline and with-project cases: stock change and flux. One approach must be selected and used for the entire project crediting period.

The stock change approach may be employed if the following applicability conditions are met and measurement procedures adhered to (note that conditions related to measurement and monitoring apply equally to the project and baseline cases, as measurement and monitoring are carried out in the project area and in a representative baseline site):

XI. Net surface elevation change measured using Rod Surface Elevation Tables (RSETs), Real Time Kinematic (RTKs) satellite-based approaches and/or other technologies;

XII. Clear and detailed rules and procedures for determining peat surface level, and distinguishing it from any overlying litter, are documented in field standard operating procedures and adhered to;

XIII. Bulk density in top 10 cm (below any overlying litter layer) is monitored; the top layer being the aerated labile portion from which emissions are expected to be sourced, and as well is a conservative value as it's the lowest bulk density throughout the peat profile. The top 10 cm should also capture the majority of root biomass, and permit estimation of emissions from surface level change resulting from root expansion/mortality. Bulk density samples must include soil organic carbon and belowground biomass (fine and coarse roots).

XIV. Baseline site has been subject to drainage/hydrological alteration for at least 10 years (to minimize influence of new root growth and expansion on surface elevation and bulk density)

XV. Repeat measurements of surface elevation change are made at the same water table level (+/- 10% of level at the time of the t = 0 measurement, as recorded at the same site(s) measured at t =0) and in the dry season. Water table level will be assessed from data from a groundwater well located at the site, or if this does not exist, from the nearest USGS groundwater well, sourced from https://waterdata.usgs.gov/nwis/gw ;

XVI. In with-project case, initial surface elevation level is measured no less than 12 months after re-wetting takes place (after initial swell has occurred);

XVII. In both the project area and baseline site, no significant erosion or sedimentation expected to occur (flat terrain, no river flow over project area);

XVIII. In both the project area and baseline site, no significant compaction (by machinery or treading) expected to occur and procedures will be in place to safeguard against compaction resulting from surface elevation measurements in the field.

Note that the stock change approach treats soil organic carbon and belowground (root) biomass as a single source/sink.

The flux approach may be employed where a regression equation correlating one or more proxy variables to belowground emissions meeting the following conditions is available:

XIX. Peer-reviewed;

XX. Empirically-based;

XXI. Dependent variable is restricted to heterotrophic emissions (due to microbial respiration) from the soil organic carbon and dead belowground biomass pools (i.e., heterotrophic respiration of litter and autotrophic respiration are excluded);

XXII. Relationship between proxy variable and emissions must be significant at $P < 0.1$ and unbiased (i.e., with minimal trend in residuals);

XXIII. The study site(s) from which proxy relationship developed must include drained pocosins (as defined in Section 1.1) that have been subject to drainage/hydrological alteration for no less than 50% of the length of time that the project area has been subject to drainage/ hydrological alteration prior to project start;

XXIV. Relationship incorporates one or more proxy variables that are:

   A. measured *ex post* in a valid baseline site,

   B. measured *ex post* in the project area (e.g., precipitation, temperature), and/or

   C. modeled in the project area on the basis of proxy variables monitored *ex post* in the project area (e.g., water table modeled from monitored precipitation);

XXV. Uncertainty in predicted emissions (dependent variable) is known and calculated as the root mean squared error (RMSE);

XXVI. Relationship must be based on emissions assessed over at least one entire year, with frequent (at least bi-monthly) measurements.

The same relationship must be used in both the project and baseline cases. The regression may be revised based on new data, provided it meets the above requirements. See also Section 5 for further guidance.

Accounting using each approach is summarized in the following diagrams, which demonstrate key parameters and calculation flow. The diagrams are intended only to provide a high level view of the methodology structure. Operation of the methodology follows measurement and calculation procedures detailed in Sections 3, 4 and 5 below.

Figure 2: Overview of Accounting Using the Stock Change Approach

Note that change in aboveground biomass carbon stocks in the baseline is accounted in $Net\Delta AGB_{wp}$ which represents the net of baseline and with project changes in this pool, hence "net change". GHG emissions resulting from intentional burns in the project scenario are also included in accounting (not included in the figure for ease of readability).

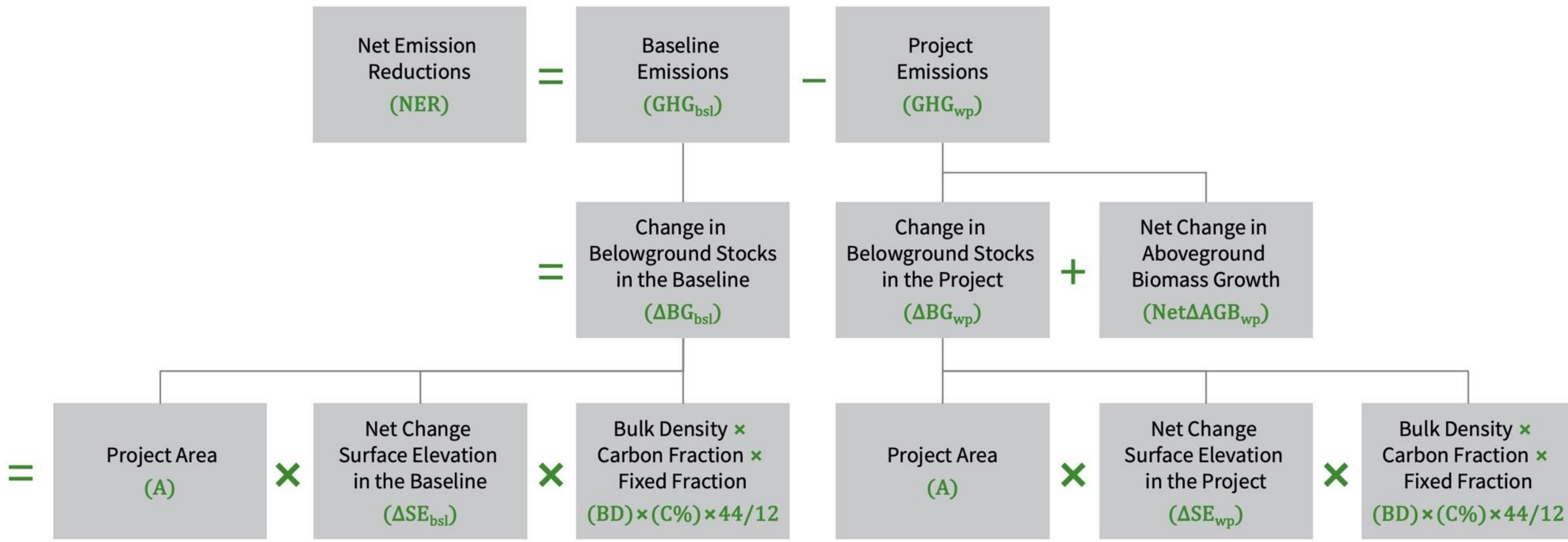
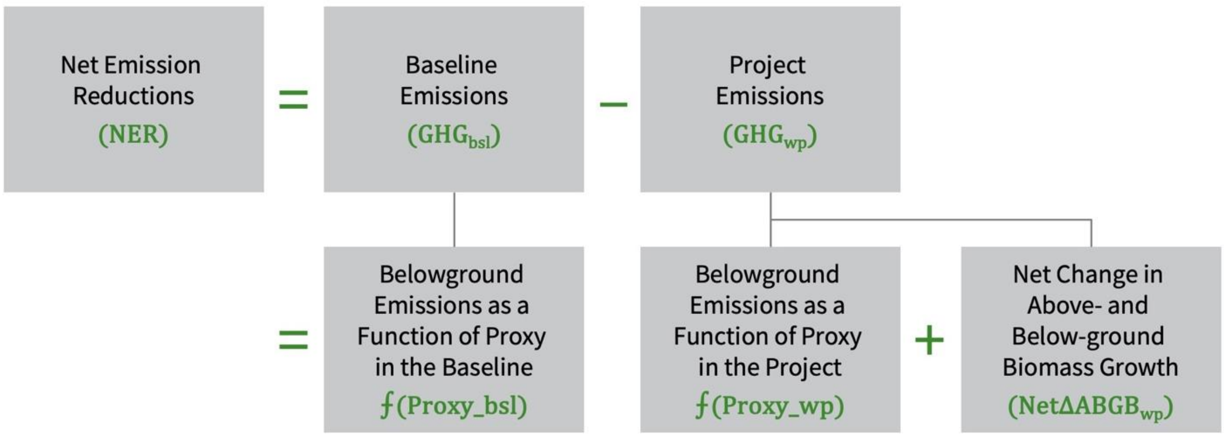


Figure 3: Overview of Accounting Using the Flux Approach.

Note that change in above- and belowground biomass carbon stocks in the baseline is accounted in $Net\Delta ABGB_{wp}$ which represents the net of baseline and with project changes in this pool, hence "net change". GHG emissions resulting from intentional burns in the project scenario are also included in accounting (not included in the figure for ease of readability).



Monitoring procedures are reviewed in the tables below, which, as for the diagrams above, are intended as an overview and to draw distinctions in requirements between the two accounting approaches. Note that for both the stock change and flux approaches, a baseline site is required to monitor parameters in the baseline scenario.

Table 2: Monitoring for the Stock Change Approach

PARAMETER	GENERAL MONITORING OF BASELINE SCENARIO	GENERAL MONITORING OF PROJECT SCENARIO
Net surface elevation change; ΔSE	Monitored on baseline site via direct measurement of permanent sample points	Monitored on project area via direct measurement of permanent sample points
Aboveground biomass carbon; AGB	Monitored on baseline site via direct measurement on permanent sample plots	Monitored on project area via direct measurement on permanent sample plots
Area of unintentional fire; A_{burn_unint}	Monitored in project area via aerial imagery and management records	Monitored in project area via aerial imagery and management records

PARAMETER	GENERAL MONITORING OF BASELINE SCENARIO	GENERAL MONITORING OF PROJECT SCENARIO
Area of intentional fire; A_{burn_int}	N/A	Monitored in project area via aerial imagery and management records

Table 3: Monitoring for the Flux Approach

PARAMETER	GENERAL MONITORING OF BASELINE SCENARIO	GENERAL MONITORING OF PROJECT SCENARIO
Proxy variable(s) significantly correlated with belowground emissions; Proxy A, B, etc …	Either monitored via direct measurement in a valid baseline site, monitored via direct measurement in the project area, or modeled in the project area (e.g., using a hydrologic model) on the basis of one or more monitored, directly-measured proxy variables (e.g., precipitation) in the project area.	Monitored via direct measurement in the project area
Above- and belowground biomass carbon; ABGB	Monitored on baseline site via direct measurement on permanent sample plots	Monitored on project area via direct measurement on permanent sample plots
Area of intentional fire; A_{burn_int}	N/A	Monitored in project area via aerial imagery and management records
Surface elevation change due to intentional fire; $\Delta SE_{burn\_int,wp,t}$	N/A	Monitored in the project area in the planned burn area via direct measurement of sample points immediately prior to and after the burn
Area of unintentional fire; A_{burn_unint}	Monitored in project area via aerial imagery and management records	Monitored in project area via aerial imagery and management records

PARAMETER	GENERAL MONITORING OF BASELINE SCENARIO	GENERAL MONITORING OF PROJECT SCENARIO
Surface elevation change due to unintentional fire; $\Delta SE_{burn\_unint,wp,t}$	Monitored in the project area via direct measurement of sample points in the burn area and outside the burn area after the burn	Monitored in the project area via direct measurement of sample points in the burn area and outside the burn area after the burn

1.4.1 BASELINE SITE SIMILARITY CRITERIA

Operation of this methodology requires that one or more baseline sites be identified on which to monitor a range of parameters in the baseline scenario. The table below outlines similarity criteria that must be met to demonstrate the validity of a baseline site.

Table 4: Baseline Site Similarity Criteria

BASELINE SITE SIMILARITY CRITERION	NET SURFACE ELEVATION CHANGE; ΔSE	ABOVEGROUND BIOMASS CARBON; AGB AND ABOVE- AND BELOWGROUND BIOMASS CARBON; $ABGB$	PROXY VARIABLE(S) SIGNIFICANTLY CORRELATED WITH BELOWGROUND EMISSIONS; PROXY A, B, ETC …
Drained freshwater wetland on organic soils in the coastal plain of southeast Virginia, North Carolina, South Carolina or Georgia	Yes	Yes	Yes
Flat terrain (slopes not exceeding 10%), not located within any immediate river floodplain, and unlikely to be subject to significant ongoing soil compaction (by machinery or treading) and/or mechanical disturbance (e.g., tilled farmland subject to repeated traffic by heavy machinery).	Yes	N/A	N/A
Not subject to fire	Yes	Yes	N/A

BASELINE SITE SIMILARITY CRITERION	NET SURFACE ELEVATION CHANGE; ΔSE	ABOVEGROUND BIOMASS CARBON; AGB AND ABOVE- AND BELOWGROUND BIOMASS CARBON; $ABGB$	PROXY VARIABLE(S) SIGNIFICANTLY CORRELATED WITH BELOWGROUND EMISSIONS; PROXY A, B, ETC …
Mean bulk density of top 10 cm of peat at project start date*	Within +/- 20% of mean bulk density in project area	N/A	N/A
Mean percent carbon (as % of dry weight) of top 10 cm of peat at project start date*	Within +/- 20%, in relative terms, of mean percent organic matter in project area	N/A	N/A
Mean peat depth at project start date*	Equal to or less than mean peat depth in project area	N/A	N/A
Average annual water level at project start date**	Within +/-20% of average annual water level in project area prior to project start (i.e., prior to rewetting of project area)	Within +/-20% of average annual water level in project area prior to project start (i.e., prior to rewetting of project area)	N/A

* For these criteria, estimates must be derived from un-biased, representative sampling of the reference site, with a minimum sample size of 20, and accuracy ensured through adherence to the same measurement procedures for corresponding parameters measured and monitored in the project area (Section 5).

** Average annual water table (for the year preceding the project start date) must be estimated from data from a groundwater well located at the site, or if this does not exist, from the nearest USGS groundwater well, sourced from https://waterdata.usgs.gov/nwis/gw.

BASELINE SITE SIMILARITY CRITERION	NET SURFACE ELEVATION CHANGE; ΔSE	ABOVEGROUND BIOMASS CARBON; AGB AND ABOVE- AND BELOWGROUND BIOMASS CARBON; ABGB	PROXY VARIABLE(S) SIGNIFICANTLY CORRELATED WITH BELOWGROUND EMISSIONS; PROXY A, B, ETC …
Length of time subject to drainage/hydrological alteration prior to project start[2]	No less than 50% of length of time the project area has been subject to drainage/ hydrological alteration prior to project start	N/A	N/A
Vegetation: Age class and percent cover trees and shrubs	Similar to project area immediately prior to project start (age class within 10 years, percent cover trees and shrubs, and basal area of pines > 10 cm dbh within +/-20%)	Similar to project area immediately prior to project start (age class within 10 years, percent cover trees and shrubs, and basal area of pines > 10 cm dbh within +/-20%)	N/A
Value of proxy variable at project start date	N/A	N/A	Not outside of range of measured values from which regression derived

[2] Note that both the project area and baseline site must have been subject to drainage/hydrological alteration for at least 10 years per applicability condition for the stock change approach

Baseline sites should ideally be selected to have stable management through the project crediting period, however, should the baseline site become invalid (due to non-compliance with similarity criteria, e.g. if it becomes subject to a burn) at any time during the project crediting period, a new valid baseline site may be selected to replace the former, or the existing baseline site may be reconfigured (e.g., excluding a burned area, and any sample points within it, from the reference site), while continuing to ensure compliance with the similarity criteria. Different baseline sites may be used for different parameters. Multiple baseline sites may be used for a single parameter, in which case the similarity criteria are assessed for the composite area.

2 Boundaries, Additionality and Permanence

2.1 Project Geographic Boundary

The project boundary shall be defined at the beginning of a proposed project activity and shall remain fixed through the project crediting period. The project activity may contain more than one discrete area of land.

For all discrete land areas included in the project boundary, the following will be provided:

- Unique identifier for each discrete parcel of land;
- Geo-referenced GIS shapefile of the land parcel boundary;
- Details of ownership and land use rights holder.

Further guidance is provided in the project area parameter table in Section 5.

2.2 Project Temporal Boundary

The project crediting period is the time period for which GHG emission reductions generated by the project are accounted and eligible for issuance as Emission Reduction Tons (ERTs). The project must have a robust monitoring plan covering this period.

The start of the crediting period is marked by the start of the project activity, i.e., following the onset of rewetting. Note that using the stock change approach the start of the crediting period must be no less than 12 months following the onset of rewetting. The crediting period shall be for 20 years, and may be renewed following governing ACR requirements.

2.3 Additionality

The project activity must demonstrate additionality applying the ACR's three-pronged additionality test: beyond regulatory requirements, beyond common practice, and facing at least one of three implementation barriers (financial, technological, or institutional).

2.4 Method of Assurance of Permanence

To ensure permanence of credited emission reductions, the project will apply the ACR Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination.

3 Stock Change Approach: Baseline and With-project Scenarios

3.1 Baseline Accounting

Equation 1

$$GHG_{bsl,t} = \Delta BG_{stock\_bsl,t}$$

WHERE

$GHG_{bsl,t}$	Annual greenhouse gas emissions in the baseline in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$\Delta BG_{stock\_bsl,t}$	Mean annual change in the soil organic carbon and belowground biomass using the stock change method in the baseline scenario in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
t	1, 2, 3, … **t** years elapsed since the project start date

Note that change in aboveground biomass carbon stocks in the baseline is accounted in parameter ΔAGB_{wp} (derived in Section 3.2.2 below) which represents the net of baseline and with project changes in aboveground biomass carbon stocks.

3.1.1 EMISSIONS FROM BELOWGROUND IN THE BASELINE

Emissions from belowground are estimated from net surface level change. Note that the emission inferred from net surface level change, ΔBG_{stock_bsl}, covers net emissions (due to sequestration and respiration) from soil organic carbon and belowground biomass.

Equation 2

$$\Delta BG_{stock\_bsl,t} = (A - A_{burn\_unint,wp,t}) \times -\Delta SE_{bsl,t} \times \left(\frac{1}{x}\right) \times 10 \times BD_{wp,t-x} \times C\%_{soil,wp} \times \left(\frac{44}{12}\right)$$

WHERE

$\Delta BG_{stock\_bsl,t}$	Mean annual change in the soil organic carbon and belowground biomass pools using the stock change method in the baseline scenario in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$\Delta SE_{bsl,t}$	Mean net surface elevation change (subsidence + peat accretion + root expansion/mortality) in the baseline site in monitoring interval ending in year **t**; mm
$BD_{wp,t-x}$	Mean dry bulk density in the project area at time **t-x**; g cm^{-3}
$C\%_{soil,wp}$	Percentage of soil organic **C** (percent dry weight) in the project area; %
$44/12$	Ratio of molecular weight of CO_2 to carbon, MT CO_2-e MT C^{-1}
A	Project area; ha
$A_{burn\_unint,wp,t}$	Area of unintentional burn in the project area occurring in monitoring interval ending in year **t**; ha
t	1, 2, 3, … **t** years elapsed since the project start date
x	Number of years in monitoring interval; years

The net surface elevation change term is monitored in the baseline site. Parameter $\Delta SE_{bsl,t}$ incorporates uncertainty where the half width of the 90% confidence interval exceeds 10% of the mean value (see parameter table).

3.2 With-project Accounting

Equation 3

$$GHG_{wp,t} = \Delta BG_{stock\_wp,t} + Net\Delta AGB_{wp,t} + E_{BGburn\_int,wp,t} + E_{AGBburn\_int,wp,t}$$

WHERE

$GHG_{wp,t}$	Annual greenhouse gas emissions in the project scenario in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$\Delta BG_{stock\_wp,t}$	Mean annual change in the soil organic carbon and belowground biomass pool using the stock change method in the project scenario in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$Net\Delta AGB_{wp,t}$	Annual net change in aboveground biomass carbon stocks in the project scenario in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$E_{BGburn\_int,wp,t}$	Emissions from soil organic carbon from intentional fire in the project scenario in year **t**; MT CO_2-e
$E_{AGBburn\_int,wp,t}$	Emissions from aboveground biomass from intentional fire in the project scenario in year **t**; MT CO_2-e
t	1, 2, 3, … **t** years elapsed since the project start date

3.2.1 EMISSIONS FROM BELOWGROUND IN THE PROJECT

Emissions from belowground are estimated from net surface level change. Note that the emission inferred from net surface level change, ΔBG_{stock_bsl}, covers net emissions (due to sequestration and respiration) from soil organic carbon and belowground biomass.

Equation 4

$$\Delta BG_{stock\_wp,t} = (A - A_{burn\_unint,wp,t}) \times -\Delta SE_{wp,t} \times \left(\frac{1}{x}\right) \times 10 \times BD_{wp,t-x} \times C\%_{soil,wp} \times \left(\frac{44}{12}\right)$$

WHERE

$\Delta BG_{stock\_wp,t}$	Mean annual change in the soil organic carbon and belowground biomass pool using the stock change method in the project scenario in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$\Delta SE_{wp,t}$	Mean net surface elevation change (subsidence + peat accretion + root expansion/mortality) in the project area in monitoring interval ending in year **t**; mm
$BD_{wp,t-x}$	Mean dry bulk density in the project area at time **t-x**; g cm^{-3}

$C\%_{soil,wp}$	Percentage of soil organic **C** in the project area; %
$44/12$	Ratio of molecular weight of CO_2 to carbon, MT CO_2-e MT C^{-1}
A	Project area; ha
$A_{burn\_unint,wp,t}$	Area of unintentional burn in the project area occurring in monitoring interval ending in year **t**; ha
t	1, 2, 3, … **t** years elapsed since the project start date
x	Number of years in monitoring interval; years

The net surface elevation change term must be monitored in the project area. Parameter $\Delta SE_{wp,t}$ incorporates uncertainty where the half width of the 90% confidence interval exceeds 10% of the mean value (see parameter table).

Bulk density is measured at the project start and every 5 years and includes belowground biomass (roots) and soil organic carbon.

3.2.2 EMISSIONS FROM ABOVEGROUND BIOMASS IN THE PROJECT

Emissions from aboveground biomass (in trees and shrubs) in the project, $Net\Delta AGB_{wp}$, represent net emissions from aboveground biomass (i.e., net of baseline and with project) resulting from stock change in the project case relative to a baseline site. This term is set equal to zero if there is no significant difference (significantly different using an unpaired t test at P <0.05) in stock change between the project and the baseline site.

3.2.2.1 Step 1

Measure change in stocks of aboveground biomass in the project area and in a baseline site. Stock change in aboveground biomass is measured on permanent sample plots, and represents the net of biomass increment, recruitment and mortality. Calculate mean annual change in stocks of aboveground biomass in the project area, ΔAGB_{wp}, and in a baseline site, ΔAGB_{bsl}.

Equation 5

$$\Delta AGB_{wp,t} = \left(\frac{1}{n}\right) \times \sum_{j=1}^{n} \left((AGB_{wp,j,t} - AGB_{wp,j,t-x}) \times \left(\frac{1}{x}\right) \right)$$

WHERE

$\Delta AGB_{wp,t}$	Mean annual change in aboveground biomass carbon stocks in the project area in monitoring interval ending in year **t**; MT CO_2e ha^{-1} yr^{-1}
$AGB_{wp,j,t}$	Aboveground biomass carbon stocks in the project area in plot **j** at time **t**; MT CO_2e/ha
$AGB_{wp,j,t-x}$	Aboveground biomass carbon stocks in the project area in plot **j** at time **t-x**; MT CO_2e/ha
j	1, 2, 3 … **n** sample plots
x	Number of years in monitoring interval; years
t	1, 2, 3, … **t** years elapsed since the project start date

Equation 6

$$\Delta AGB_{bsl,t} = \left(\frac{1}{n}\right) \times \sum_{j=1}^{n} \left((AGB_{bsl,j,t} - AGB_{bsl,j,t-x}) \times \left(\frac{1}{x}\right) \right)$$

WHERE

$\Delta AGB_{bsl,t}$	Mean annual change in aboveground biomass carbon stocks in the baseline reference area in monitoring interval ending in year **t**; MT CO_2e ha^{-1} yr^{-1}
$AGB_{bsl,j,t}$	Aboveground biomass carbon stocks in the baseline reference area in plot **j** at time **t**; MT CO_2e/ha
$AGB_{bsl,j,t-x}$	Aboveground biomass carbon stocks in the baseline reference area in plot **j** at time **t-x**; MT CO_2e/ha
j	1, 2, 3 … **n** sample plots
x	Number of years in monitoring interval; years

t	1, 2, 3, … t years elapsed since the project start date

3.2.2.2 Step 2

If $\Delta AGB_{wp,t}$ is not equal to $\Delta AGB_{bsl,t}$ (significantly different using an unpaired t test at $P < 0.05$), then net emissions from aboveground biomass carbon are equal to the difference in stock change between the baseline site and the project area. Note that this term can be less than zero, where growth in the project area exceeds that in the baseline site, e.g., due to tree and shrub planting efforts conducted as part of the project activity.

Equation 7

$$\mathbf{Net\Delta AGB_{wp,t}} = \left((\mathbf{\Delta AGB_{bsl,t}} + \mathbf{UNC_{\Delta AGB,bsl,t}}) - (\mathbf{\Delta AGB_{wp,t}} - \mathbf{UNC_{\Delta AGB,wp,t}})\right) \times (\mathbf{A} - \mathbf{A_{burn\_unint,wp,t}})$$

WHERE

$Net\Delta AGB_{wp,t}$	Annual net change in aboveground biomass carbon stocks in the project area in monitoring interval ending in year t; MT CO_2e yr^{-1}
$\Delta AGB_{wp,t}$	Mean annual change in aboveground biomass carbon stocks in the project area in monitoring interval ending in year t; MT CO_2e ha^{-1} yr^{-1}
$\Delta AGB_{bsl,t}$	Mean annual change in aboveground biomass carbon stocks in the baseline reference area in monitoring interval ending in year t; MT CO_2e ha^{-1} yr^{-1}
$UNC_{\Delta AGB,wp,t}$	Half width of 90% confidence interval exceeding 10% of the mean annual change in aboveground biomass carbon stocks in the project area in monitoring interval ending in year t; MT CO_2e ha^{-1} yr^{-1}
$UNC_{\Delta AGB,bsl,t}$	Half width of 90% confidence interval exceeding 10% of the mean annual change in aboveground biomass carbon stocks in the baseline reference area in monitoring interval ending in year t; MT CO_2e ha^{-1} yr^{-1}
A	Project area; ha
$A_{burn\_unint,wp,t}$	Area of unintentional burn in the project area occurring in monitoring interval ending in year t; ha
t	t years elapsed since the project start date

If $\Delta AGB_{wp,t}$ is not significantly different from $\Delta AGB_{bsl,t}$, then $Net\Delta AGB_{wp,t} = 0$

3.2.3 EMISSIONS FROM FIRE IN THE PROJECT

3.2.3.1 Unintentional Burns

Where unintentional burns occur in the project area, emissions from those burns are assumed, conservatively, to be equal in the project and baseline scenarios. Emissions from unintentional burns in the project area are excluded from accounting by delineating the area of the burn, parameter $A_{burn\_unint,wp,t}$, consulting aerial imagery and assigning zero net emissions to the area for the monitoring interval spanning the burn (i.e., from the monitoring event immediately prior to the burn to the monitoring event immediately after the burn); see equations 2 and 4 above. Plans for intentional burns (e.g., prescribed burns) in the project area must be recorded in management records to distinguish unintentional burns (on the absence of management records). Any sample plots/points for surface elevation and/or aboveground biomass located within the area of an unintentional burn in the project area, will not be used to calculate net change in surface elevation, $\Delta SE_{wp,t}$, or change in aboveground biomass stocks, $\Delta AGB_{wp,t}$, in the project area for the monitoring interval spanning the burn (i.e., from the monitoring event immediately prior to the burn to the monitoring event immediately after the burn).

3.2.3.2 Intentional Burns

Carbon dioxide emissions from the belowground and aboveground biomass pools resulting from intentional burns in the project are captured through monitoring parameters $\Delta SE_{wp,t}$ and $\Delta AGB_{wp,t}$. referencing measurements collected at all sample plots/points for surface elevation and/or aboveground biomass located within the project area.

Nitrous oxide and methane emissions from intentional burns from belowground (due to combustion of peat), $E_{BGburn\_int,wp,t}$, and aboveground biomass, $E_{AGBburn\_int,wp,t}$, are monitored referencing pre- and post-burn measurements collected at the subset of sample plots/points for surface elevation and aboveground biomass located within the actual intentional burned area in year *t*. The actual intentional burned area, $A_{burn\_int,wp,t}$, is determined after the burn takes place by consulting aerial imagery.

Parameters $\Delta SE_{wp,t}$ and $\Delta AGB_{Aburn\_int\_wp,t}$ incorporate uncertainty where the half width of the 90% confidence interval exceeds 10% of the mean value (see parameter tables). Note that because this involves subsets of the total sampling networks, it may be desired to augment sampling in the intentional burn area prior to the burn to reduce uncertainty.

Equation 8

$$E_{BGburn\_int,wp,t} = \sum_{g=1}^{G} (A_{burn\_int,wp,t} \times -\Delta SE_{wp,b,t} \times 10 \times BD_{stock,wp,t-x}) \times EF_{peat,g} \times GWP_g$$

WHERE

$E_{BGburn\_int,wp,t}$	Emissions from soil organic carbon from intentional fire in the project scenario in year **t**; MT CO_2-e
$\Delta SE_{wp,b,t}$	Mean net surface elevation change in the actual area of intentional burn in the project area in year **t**; mm
$BD_{stock,wp,t-x}$	Mean dry bulk density (as defined for the stock change approach; i.e., including coarse roots) in the project area at time **t-x**; g cm^{-3}
$EF_{peat,g}$	Emission factor for gas **g**; MT gas **g** emitted **×** MT dry matter peat burned^{-1}
GWP_g	Global warming potential for gas **g**; MT CO_2e/t gas **g**
$A_{burn\_int,wp,t}$	Actual (not planned) area of intentional burn in the project area in year **t**; ha
t	1, 2, 3, … **t** years elapsed since the project start date
10	Converts result to units of metric tons
g	1, 2, 3 … G greenhouse gases (to include nitrous oxide and methane)
x	Number of years in monitoring interval; years

Equation 9

$$E_{AGBburn\_int,wp,t} = \sum_{g=1}^{G} (A_{burn\_int,wp,t} \times -\Delta AGB_{Aburn\_int,wp,t} \times 0.58) \times EF_{biomass,g} \times GWP_g$$

WHERE

$E_{AGBburn\_int,wp,t}$	Emissions from aboveground biomass from intentional fire in the project scenario in year **t**; MT CO_2-e

$\Delta AGB_{Aburn\_int,wp,t}$	Mean change in aboveground biomass carbon stocks in the actual (not planned) area of intentional burn in the project area in year **t**; MT CO_2e ha^{-1} yr^{-1}
0.58	Factor to convert MT CO_2e to MT dry matter biomass (assumes 0.47 MT C MT $d.m.^{-1}$ and 44/12 ratio of molecular weight of CO_2 to carbon, MT CO_2-e MT C^{-1})
$EF_{biomass,g}$	Emission factor for gas **g**; MT CO_2e emitted × MT dry matter biomass $burned^{-1}$
GWP_g	Global warming potential for gas **g**; MT CO_2e MT gas g^{-1}
$A_{burn\_int,wp,t}$	Actual (not planned) area of intentional burn in the project area in year **t**; ha
t	1, 2, 3, … **t** years elapsed since the project start date
g	G greenhouse gases (to include nitrous oxide and methane)

4 Flux Approach: Baseline and With-project Scenarios

4.1 Baseline Accounting

Equation 10

$$GHG_{bsl,t} = \Delta BG_{flux\_bsl,t}$$

WHERE

$GHG_{bsl,t}$	Annual greenhouse gas emissions in the baseline in monitoring interval ending in year **t**; MT CO_2e yr-1
$\Delta BG_{flux\_bsl,t}$	Annual emissions from the soil organic carbon and dead belowground biomass using the flux approach in the baseline scenario in monitoring interval ending in year **t**; MT CO_2e yr-1
t	1, 2, 3, … **t** years elapsed since the project start date

Note that change in above- and belowground biomass carbon stocks in the baseline is accounted in parameter ΔABGBwp (derived in Section 4.2.2 below) which represents the net of baseline and with project changes in above- and belowground biomass carbon stocks.

4.1.1 EMISSIONS FROM BELOWGROUND IN THE BASELINE

Emissions from belowground are estimated as a function of one or more proxy variables. Note that the emission inferred from the proxy variable(s) covers heterotrophic emissions (due to microbial respiration) from soil organic carbon and dead belowground biomass. Sequestration in live belowground (root) biomass is assessed separately, as part of parameter $\Delta ABGB_{wp}$.

Equation 11

$$\Delta BG_{flux\_bsl,t} = f_t(\text{Proxy } A_{bsl,t}, \text{Proxy } B_{bsl,t} \ldots) \times A$$

WHERE

ΔBG_{flux_bsl}	Annual emissions from the soil organic carbon and dead belowground biomass pools using the flux approach in the baseline scenario in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
f_t (Proxy $A_{bsl,t}$, Proxy $B_{bsl,t}$,...)	Regression equation correlating one or more proxy variables to emissions from the soil organic carbon and dead belowground biomass at time **t**; output in MT CO_2e ha^{-1} yr^{-1}
Proxy $A_{bsl,t}$	Mean value of proxy variable **A** in the baseline at time **t**; units unspecified
Proxy $B_{bsl,t}$	Mean value of proxy variable **B** in the baseline at time **t**; units unspecified etc…
A	Project area; ha
t	1, 2, 3, … **t** years elapsed since the project start date

Note that the output of the regression equation incorporates uncertainty, derived in proportion to the root mean squared error (RMSE) of the regression (see parameter table).

The proxy variable(s) can be either measured in a valid baseline site, measured in the project area (for variables not affected by the project activity, e.g., temperature or rainfall), or modeled in the project area. If using a model (e.g., a hydrologic model) to estimate the proxy variable(s), the model(s) must be:

- Peer-reviewed
- Empirically-based
- Incorporate one or more proxy variables that are monitored *ex post* in the project area (e.g. precipitation)

The value(s) of parameter(s) Proxy $A_{bsl,t}$ etc. incorporate uncertainty where the half width of the 90% confidence interval exceeds 10% of the mean value (see parameter table).

Note that the cumulative emissions over time from ΔBG_{flux_bsl}, from both soil respiration and from unintentional fires in the project area (assumed to occur equally in the baseline and project scenarios), cannot exceed the total initial stock in that pool subject to oxidation, $BG_{wp,t=0}$, derived below.

Equation 12

$$BG_{wp,t=0} = A \times PD_{wp,t=0} \times 10,000 \times BD_{flux,wp,t=0} \times C\%_{soil} \times \left(\frac{44}{12}\right)$$

WHERE

$BG_{wp,t=0}$	Total stocks in the soil organic carbon and belowground biomass pools in the project area at time t=0; MT CO_2e
$PD_{wp,t=0}$	Peat depth above low water level in the project area at time t=0; m
$BD_{flux,wp,t=0}$	Mean dry bulk density (as defined for flux approach, i.e., excluding coarse roots) in the project area at time t=0; g cm^{-3}
$\%C_{soil}$	Percentage of soil organic C; %
44/12	Ratio of molecular weight of CO_2 to carbon, MT CO_2-e MT C^{-1}
A	Project area; ha
t	1, 2, 3, … t years elapsed since the project start date
10,000	Converts result to units of metric tons

Therefore, if $\sum_{t=0}^{t} \Delta BG_{flux_{bsl},t} + \sum_{t=0}^{t} \Delta BG_{burn\_unint,wp,t} > BG_{wp,t=0}$

Then, if $BG_{wp,t=0} - \sum_{t=0}^{t-1} \Delta BG_{flux_{bsl},t} - \sum_{t=0}^{t-1} \Delta BG_{burn\_unint,wp,t} > 0$

Then $\Delta BG_{flux_{bsl},t} = BG_{wp,t=0} - \sum_{t=0}^{t-1} \Delta BG_{flux_{bsl},t} - \sum_{t=0}^{t-1} \Delta BG_{burn\_unint,wp,t}$

Otherwise parameter $\Delta BG_{flux\_bsl,t}$ is equal to zero.

Parameter $\Delta BG_{burn\_unint,wp,t}$, emissions from soil organic carbon from unintentional fire in the project scenario in year t, is derived in Section 4.2.3 below.

4.2 With-project Accounting

Equation 13

$$GHG_{wp,t} = \Delta BG_{flux\_wp,t} + Net\Delta ABGB_{wp,t} + E_{BGburn\_int,wp,t} + E_{AGBburn\_int,wp,t}$$

WHERE

$GHG_{wp,t}$	Annual greenhouse gas emissions in the project in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$\Delta BG_{flux\_wp,t}$	Annual emissions from the soil organic carbon and dead belowground biomass using the flux approach in the project in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$Net\Delta ABGB_{wp,t}$	Annual net change in above- and belowground biomass carbon stocks in the project in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$E_{BGburn\_int,wp,t}$	Emissions from soil organic carbon from intentional fire in the project scenario in year **t**; MT CO_2-e yr^{-1}
$E_{AGBburn\_int,wp,t}$	Emissions from aboveground biomass from intentional fire in the project scenario in year **t**; MT CO_2-e
t	1, 2, 3, … **t** years elapsed since the project start date

4.2.1 EMISSIONS FROM BELOWGROUND IN THE PROJECT

Emissions from belowground are estimated as a function of one or more proxy variables. Note that the emission inferred from the proxy variable(s), ΔBG_{flux_bsl}, covers heterotrophic emissions (due to microbial respiration) from soil organic carbon and dead belowground biomass. Sequestration in live belowground (root) biomass is assessed separately, as part of parameter $\Delta ABGB_{wp}$.

Equation 14

$$\Delta BG_{flux\_wp,t} = f_t(Proxy\ A_{wp,t}, Proxy\ B_{wp,t} \dots) \times A$$

WHERE

$\Delta BG_{flux\_wp,t}$	Annual emissions from the soil organic carbon and dead belowground biomass using the flux approach in the project in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
f_t (Proxy $A_{bsl,t}$, Proxy $B_{bsl,t,\dots}$)	Regression equation correlating on or more proxy variables to emissions from the soil organic carbon and dead belowground biomass pools at time **t**; output in MT CO_2e ha^{-1} yr^{-1}

Proxy $A_{wp,t}$	Mean value of proxy variable **A** in the project area at time **t**; units unspecified
Proxy $B_{wp,t}$	Mean value of proxy variable **B** in the project area at time **t**; units unspecified etc…
A	Project area; ha
t	1, 2, 3, … **t** years elapsed since the project start date

Note that the output of the regression equation incorporates uncertainty, derived in proportion to the root mean squared error (RMSE) of the regression (see parameter table).

The proxy variable(s) must be monitored in the project area. The value(s) of parameter(s) Proxy Awp,t etc. incorporate uncertainty where the half width of the 90% confidence interval exceeds 10% of the mean value (see parameter table).

As for the baseline, cumulative emissions over time from ΔBGflux_wp, from both soil respiration and from unintentional and intentional fires in the project area, cannot exceed the total initial stock in that pool, BGwp,t=0, derived above.

Therefore, if $\sum_{t=0}^{t} \Delta BG_{flux_{wp},t} + \sum_{t=0}^{t} \Delta BG_{burn\_unint,wp,t} + \sum_{t=0}^{t} \Delta BG_{burn\_int,wp,t} > BG_{wp,t=0}$

Then, if $BG_{wp,t=0} - \sum_{t=0}^{t-1} \Delta BG_{flux_{wp},t} - \sum_{t=0}^{t-1} \Delta BG_{burn\_unint,wp,t} - \sum_{t=0}^{t-1} \Delta BG_{burn\_int,wp,t} > 0$

Then $\Delta BG_{flux_{wp},t} = BG_{wp,t=0} - \sum_{t=0}^{t-1} \Delta BG_{flux_{wp},t} - \sum_{t=0}^{t-1} \Delta BG_{burn\_unint,wp,t} - \sum_{t=0}^{t-1} \Delta BG_{burn\_int,wp,t}$

Otherwise parameter $\Delta BG_{flux_wp,}$t is equal to zero.

Parameters $\Delta BG_{burn\_int,wp,t}$, emissions from soil organic carbon from intentional fire in the project scenario in year t, and ΔBGburn_unint,wp,t, emissions from soil organic carbon from unintentional fire in the project scenario in year t, are derived in Section 4.2.3 below.

4.2.2 EMISSIONS FROM ABOVE- AND BELOWGROUND BIOMASS IN THE PROJECT

Emissions from above- and belowground biomass (in trees and shrubs) in the project, $Net\Delta ABGB_{wp}$, represent net emissions from above- and belowground biomass (i.e., net of baseline and with project) resulting from stock change in the project case relative to a baseline site. This term is set equal to zero if there is no significant difference in stock change between the project and the baseline site.

4.2.2.1 Step 1

Measure change in stocks of above- and belowground biomass in the project area and in a baseline site. Stock change in above- and belowground biomass is measured on permanent sample plots, and represents the net of biomass increment, recruitment and mortality.

Note that in this treatment emissions due to mortality of belowground biomass (coarse roots) are double counted, as they are also included in the term, ΔBG_{flux}. This treatment is conservative, as emissions from die-off of root biomass are expected to be greater in the project (flooded) scenario, than in the baseline, and importantly, simplifies monitoring and accounting (i.e., avoids the need to separately track belowground biomass increment, recruitment and mortality).

Calculate mean annual change in stocks of above- and belowground biomass in the project area, $\Delta ABGB_{wp}$, and in a baseline site, $\Delta ABGB_{bsl}$.

Equation 15

$$\Delta \mathbf{ABGB_{wp,t}} = \left(\frac{\mathbf{1}}{\mathbf{n}}\right) \times \sum_{\mathbf{j=1}}^{\mathbf{n}} \left((\mathbf{ABGB_{wp,j,t}} - \mathbf{ABGB_{wp,j,t-x}}) \times \left(\frac{\mathbf{1}}{\mathbf{x}}\right) \right)$$

WHERE

$\Delta ABGB_{wp,t}$	Mean annual change in above- and belowground biomass carbon stocks in the project area in monitoring interval ending in year **t**; MT CO_2e ha^{-1} yr^{-1}
$ABGB_{wp,j,t}$	Above- and belowground biomass carbon stocks in the project area in plot **j** at time **t**; MT CO_2e ha^{-1}
$ABGB_{wp,j,t-x}$	Above- and belowground biomass carbon stocks in the project area in plot **j** at time **t-x**; MT CO_2e ha^{-1}
j	**n** sample plots
x	Number of years in monitoring interval; years
t	1, 2, 3, … **t** years elapsed since the project start date

Equation 16

$$\Delta ABGB_{bsl,t} = \left(\frac{1}{n}\right) \times \sum_{j=1}^{n}\left((ABGB_{bsl,j,t} - ABGB_{bsl,j,t-x}) \times \left(\frac{1}{x}\right)\right)$$

WHERE

$\Delta ABGB_{bsl,t}$	Mean annual change in above- and belowground biomass carbon stocks in the baseline reference area in monitoring interval ending in year **t**; MT CO_2e ha^{-1} yr^{-1}
$ABGB_{bsl,j,t}$	Above- and belowground biomass carbon stocks in the baseline reference area in plot j at time **t**; MT CO_2e ha^{-1}
$ABGB_{bsl,j,t-x}$	Above- and belowground biomass carbon stocks in the baseline reference area in plot j at time **t-x**; MT CO_2e ha^{-1}
j	1, 2, 3 … **n** sample plots
x	Number of years in monitoring interval; years
t	1, 2, 3, … **t** years elapsed since the project start date

4.2.2.2 Step 2

If $\Delta ABGB_{wp,t}$ is not equal to $\Delta ABGB_{bsl,t}$ (significantly different using a unpaired t test at $P < 0.05$), then net emissions from above- and belowground biomass carbon are equal to the difference in stock change between the baseline site and the project area. Note that this term can be less than zero, where growth in the project area exceeds that in the baseline site, e.g., due to tree and shrub planting efforts conducted as part of the project activity.

Equation 17

$$Net\Delta ABGB_{wp,t} = \left((\Delta ABGB_{bsl,t} + UNC_{\Delta ABGB,bsl,t}) - (\Delta ABGB_{wp,t} - UNC_{\Delta ABGB,wp,t})\right) \times (A - A_{burn\_unint,wp,t})$$

WHERE

$Net\Delta ABGB_{wp,t}$	Annual net change in above- and belowground biomass carbon stocks in the project area in monitoring interval ending in year **t**; MT CO_2e ha^{-1} yr^{-1}
$\Delta ABGB_{wp,t}$	Mean annual change in above- and belowground biomass carbon stocks in the project area in monitoring interval ending in year **t**; MT CO_2e ha^{-1} yr^{-1}

$\Delta ABGB_{bsl,t}$	Mean annual change in above- and belowground biomass carbon stocks in the baseline reference area in monitoring interval ending in year **t**; MT CO_2e ha^{-1} yr^{-1}
$UNC_{\Delta ABGB,wp,t}$	Half width of 90% confidence interval exceeding 10% of the mean annual change in above- and belowground biomass carbon stocks in the project area at time **t**; MT CO_2e ha^{-1} yr^{-1}
$UNC_{\Delta ABGB,bsl,t}$	Half width of 90% confidence interval exceeding 10% of the mean annual change in above- and belowground biomass carbon stocks in the baseline reference area at time **t**; MT CO_2e ha^{-1} yr^{-1}
A	Project area; ha
$A_{burn\_unint,wp,t}$	Area of unintentional burn in the project area occurring in monitoring interval ending in year **t**; ha
t	1, 2, 3, … **t** years elapsed since the project start date

If $\Delta ABGB_{wp,t}$ is not significantly different than $\Delta ABGB_{bsl,t}$, then $Net\Delta ABGB_{wp,t} = 0$

4.2.3 EMISSIONS FROM FIRE IN THE PROJECT

4.2.3.1 Unintentional Burns

Where unintentional burns occur in the project area, emissions from those burns are assumed, conservatively, to be equal in the project and baseline scenarios.

Net emissions from the above- and belowground biomass pool resulting from unintentional burns in the project area are excluded from accounting by delineating the area of the burn, parameter $A_{burn\_unint,wp,t}$, consulting aerial imagery; see equation 17 above. Plans for intentional burns (e.g., prescribed burns) in the project area must be recorded in management records to distinguish unintentional burns (on the absence of management records). Any sample points/plots for above- and belowground biomass located within the area of an unintentional burn in the project area, will not be used to calculate change in above- and belowground biomass stocks, $\Delta ABGB_{wp,t}$, in the project area for the monitoring interval spanning the burn (i.e., from the monitoring event immediately prior to the burn to the monitoring event immediately after the burn). Emissions from the belowground pool, $\Delta BG_{flux\_wp,t}$, are estimated applying a regression based on proxy variable measurements in the absence of fire, do not consider the emissions from fire and are calculated for the entire project area, using all proxy variable data, as usual.

Although emissions from unintentional fire are excluded from accounting, peat emissions from unintentional fire are tracked to update the threshold on emissions from the belowground pool; equations 12 and 14 above. Emissions from belowground (due to oxidation of peat) from unintentional burns, $\Delta BG_{burn\_unint,wp,t}$, are monitored by sampling surface elevation of peat in the burned area, $A_{burn\_unint,wp,t}$, and areas outside the burned area, after the burn takes place, to assess the depth of peat removed by the fire. Parameter $\Delta SE_{burn\_unint,wp,t}$ incorporates uncertainty where the half width of the 90% confidence interval exceeds 10% of the mean value (see parameter table).

Equation 18

$$\Delta \mathbf{BG}_{\mathbf{burn\_unint,wp,t}} = \mathbf{A}_{\mathbf{burn\_unint,wp,t}} \times -\Delta \mathbf{SE}_{\mathbf{burn\_unint,wp,t}} \times \mathbf{10} \times \mathbf{BD}_{\mathbf{flux,wp,t}} \times \mathbf{EF}_{\mathbf{peat,CO2}}$$

WHERE

$\Delta BG_{burn\_int,wp,t}$	Emissions from soil organic carbon from intentional fire in the project scenario in year **t**; MT CO_2-e
$\Delta SE_{burn\_unint,wp,t}$	Mean surface elevation change due to unintentional fire in the project area at time **t**; mm
$BD_{flux,wp,t}$	Mean dry bulk density (as defined for flux approach, i.e., excluding coarse roots) in the project area at time **t**; g cm^{-3}
$EF_{peat,CO2}$	Emission factor for carbon dioxide; MT CO_2e emitted × MT dry matter peat burned^{-1}
$A_{burn\_unint,wp,t}$	Area of unintentional burn in the project area occurring in monitoring interval ending in year **t**; ha
t	1, 2, 3, … **t** years elapsed since the project start date
10	Converts result to units of metric tons

4.2.3.2 Intentional Burns

Carbon dioxide emissions from above- and belowground biomass pools resulting from intentional burns in the project are captured through monitoring parameter $\Delta ABGB_{wp,t}$, referencing measurements collected at all sample plots above- and belowground biomass located within the project area.

GHG (carbon dioxide, nitrous oxide and methane) emissions from belowground (due to combustion of peat) from intentional burns, $EBG_{burn\_int,wp,t}$, are monitored by sampling the planned burn area, using temporary surface level markers to assess emission of peat. Peat level is assessed from the markers immediately prior to and after the burn takes place. The actual intentional burned area, $A_{burn\_int,wp,t}$, is determined after the burn takes place by consulting aerial imagery.

Nitrous oxide and methane emissions from the aboveground biomass pool, $EAGB_{burn\_int,wp,t}$, are monitored referencing pre- and post-burn measurements of aboveground biomass from the subset of samples located within the intentional burned area, $A_{burn\_int,wp,t}$.

Parameters $\Delta SE_{burn\_int,wp,t}$ and $\Delta AGB_{Aburn\_int\_wp,t}$ incorporate uncertainty where the half width of the 90% confidence interval exceeds 10% of the mean value (see parameter tables). Note that because $\Delta AGB_{Aburn\_int\_wp,t}$ involves a subset of the total sampling network of live tree and shrub biomass plots, it may be desired to augment sampling in the intentional burn area prior to the burn to reduce uncertainty.

Equation 19

$$E_{BGburn\_int,wp,t} = \sum_{g=1}^{G} (A_{burn\_int,wp,t} \times -\Delta SE_{burn\_int,wp,t} \times 10 \times BD_{flux,wp,t}) \times EF_{peat,g} \times GWP_g$$

WHERE

$E_{BGburn\_int,wp,t}$	Emissions from soil organic carbon from intentional fire in the project scenario in year **t**; MT CO_2-e
$\Delta SE_{burn\_int,wp,t}$	Mean surface elevation change in the actual area subject to intentional fire in the project area at time **t**; mm
$BD_{flux,wp,t}$	Mean dry bulk density (as defined for flux approach, i.e., excluding coarse roots) in the project area at time **t**; g cm^{-3}
$EF_{peat,g}$	Emission factor for gas **g**; MT gas **g** emitted **×** MT dry matter peat burned^{-1}
GWP_g	Global warming potential for gas **g**; MT CO_2e MT gas g^{-1}
$A_{burn\_int,wp,t}$	Actual (not planned) area of intentional burn in the project area in year **t**; ha
t	1, 2, 3, … **t** years elapsed since the project start date
10	Converts result to units of metric tons
g	1, 2, 3 … **G** greenhouse gases (to include carbon dioxide, nitrous oxide and methane)

Equation 20

$$E_{AGBburn\_int,wp,t} = \sum_{g=1}^{G} (A_{burn\_int,wp,t} \times -\Delta AGB_{Aburn\_int,wp,t} \times 0.58) \times EF_{biomass,g} \times GWP_g$$

WHERE

$E_{AGBburn\_int,wp,t}$	Emissions from aboveground biomass from intentional fire in the project scenario in year **t**; MT CO_2-e
$\Delta AGB_{Aburn\_int,wp,t}$	Mean change in aboveground biomass carbon stocks in the actual (not planned) area of intentional burn in the project area in year **t**; MT CO_2e ha^{-1} yr^{-1}
0.58	Factor to convert MT CO_2e to MT dry matter biomass (assumes 0.47 MT C MT d.m.-1 and 44/12 ratio of molecular weight of CO_2 to carbon, MT CO_2-e MT C^{-1})
$EF_{biomass,g}$	Emission factor for gas **g**; MT gas **g** emitted **×** MT dry matter biomass $burned^{-1}$
GWP_g	Global warming potential for gas **g**; MT CO_2e MT gas g^{-1}
$A_{burn\_int,wp,t}$	Actual (not planned) area of intentional burn in the project area in year **t**; ha
t	1, 2, 3, … **t** years elapsed since the project start date
g	1, 2, 3 … **G** greenhouse gases (to include nitrous oxide and methane)

5 Data and Parameters

5.1 Data and Parameters Available at Validation

DATA / PARAMETER	A
DATA UNIT	Hectare (ha)
DESCRIPTION	Project area
JUSTIFICATION OF CHOICE OF DATA OR DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES APPLIED	Delineation of the project area may use a combination of GIS coverages, ground survey data, remote imagery (satellite or aerial photographs), or other appropriate data.
TREATMENT OF UNCERTAINTY	Any imagery or GIS dataset must be georegistered referencing corner points, clear land marks, or other intersection points.
COMMENTS	None

DATA / PARAMETER	$\%C_{soil\_wp,t}$
DATA UNIT	%
DESCRIPTION	Percentage of soil organic C at time t
JUSTIFICATION OF CHOICE OF DATA OR DESCRIPTION OF MEASUREMENT	Soil carbon shall be determined for an aggregate sample (e.g., from 4 systematically-distributed 10 cm deep cores or auger samples) collected within a sample plot located within the project area. Note that the 10 cm depth must be referenced from the soil surface, separating the litter from the soil, referencing the same rules and procedures for determining peat

METHODS AND PROCEDURES APPLIED	surface level applied in any surface elevation measurements if using the stock change approach. This sample shall be thoroughly mixed and sieved through a 2 mm sieve to remove all non-organic material > 2 mm. Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation (e.g., allometric equations) procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Minimum sample size of 20 aggregate samples • Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan) Determination of the soil organic carbon fraction (or percent soil organic carbon) should follow established laboratory procedures, such as those found in: DeLaune, R.D., K.R. Reddy, C.J. Richardson, and J.P. Megonigal, eds. 2013. Methods in Biogeochemistry of Wetlands. Soil Science Society of America Book Series No. 10. Madison, WI: Soil Science Society of America. 10004p Nelson, D.W., and L.E. Sommers. 1982. Total carbon, organic carbon, and organic matter. p. 539–580. In A.L. Page et al. (ed.) Methods of soil Analysis. Part 2. 2nd ed. Agron. Monogr. 9. ASA and SSSA, Madison, WI. Schumacher, B. A. Methods for the determination of total organic carbon (TOC) in soils and sediments. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-02/069 (NTIS PB2003-100822), 2002.
TREATMENT OF UNCERTAINTY	None
COMMENTS	The soil organic carbon fraction is sampled prior to validation and shall be used in both the baseline and with project scenario for the length of the project.

DATA / PARAMETER	f_t (Proxy A_t, Proxy B_t,...)
DATA UNIT	output in MT CO_2e ha^{-1} yr^{-1}
DESCRIPTION	Regression equation correlating one or more proxy variables to emissions from the soil organic carbon and dead belowground biomass pools

JUSTIFICATION OF CHOICE OF DATA OR DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES APPLIED	The flux approach may be employed where a regression equation correlating one or more proxy variables to belowground emissions from heterotrophic respiration, meeting the following applicability conditions is available:
	• Peer-reviewed;
	• Empirically-based;
	• Independent variable restricted to emissions from heterotrophic respiration from the soil organic carbon and dead belowground biomass (i.e., heterotrophic respiration of litter and autotrophic respiration are excluded) pools
	• Relationship between proxy variable and emissions must be significant at $P < 0.1$ and unbiased (i.e., with minimal trend in residuals)
	• The study site(s) from which proxy relationship developed must include drained pocosins (as defined in Section 1.1) that have been subject to drainage/hydrological alteration for no less than 50% of the length of time that the project area has been subject to drainage/ hydrological alteration prior to project start
	• Relationship incorporates one or more proxy variables that are:
	  ◈ measured *ex post* in a valid baseline site,
	  ◈ measured *ex post* in the project area (e.g. precipitation, temperature), and/or
	  ◈ modeled in the project area on the basis of proxy variables monitored *ex post* in the project area (e.g. water table modeled from monitored precipitation)
	• Uncertainty in predicted emissions (dependent variable) is known and calculated as the root mean squared error (RMSE)

	• Relationship must be based on emissions assessed over at least one entire year, with frequent (at least bi-monthly) measurements The same relationship must be used in both the project and baseline cases. The regression may be revised based on new data, provided it meets the above requirements.
TREATMENT OF UNCERTAINTY	The output of the regression equation incorporates uncertainty where the half width of the (approximate) 90% confidence interval exceeds 10% of the predicted value, by: • In the baseline scenario, subtracting from the predicted dependent variable value the following term: root mean squared error (RMSE) of the regression x 1.67 minus 10% of the dependent variable value. • In the project scenario, adding to the predicted dependent variable value the following term: RMSE of the regression x 1.67 minus 10% of the dependent variable value
COMMENTS	If the value of any proxy variable is outside the range of values for which the relationship with emissions was determined, emissions are set equal to the predicted value corresponding to the end of the proxy variable range (closest to the actual proxy variable value). Used in flux approach only.

DATA / PARAMETER	$PD_{wp,t=0}$
DATA UNIT	Meter (m)
DESCRIPTION	Peat depth above low water level in the project area at time t=0
JUSTIFICATION OF CHOICE OF DATA OR DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES APPLIED	Low water level is defined as the low water level recorded over a period of at least one year preceding the project start date, estimated from data from a groundwater well located at the site, or if this does not exist, from the nearest USGS groundwater well, sourced from https://waterdata.usgs.gov/nwis/gw Peat depth is determined by inserting a depth rod (or series of connected depth rods) until either the low water level depth or mineral soil/bedrock is reached/the rod meets firm resistance. Note that the depth must be referenced from the soil surface, separating the litter from the soil.

	The parameter $PD_{wp,t=0}$ is calculated as the first quartile of the range of measured peat depths. Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Peat depth shall be measured at a minimum of 20 different points. • Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan)
TREATMENT OF UNCERTAINTY	None
COMMENTS	Used in flux approach only.

DATA / PARAMETER	$EF_{peat,g}$
DATA UNIT	MT CO_2e emitted × MT dry matter peat burned^{-1}
DESCRIPTION	Emission factor for gas **g** (based on IPCC default values or appropriate literature sources)
JUSTIFICATION OF CHOICE OF DATA OR DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES APPLIED	Source: default values from scientific literature such as Muraleedharan et al. 2000, Christian et al. 2007, Hamade et al. 2013 or IPCC.
TREATMENT OF UNCERTAINTY	None

COMMENTS	Default values shall be updated as specified in the *ACR Standard*

DATA / PARAMETER	$EF_{biomass,g}$
DATA UNIT	MT gas **g** emitted × MT dry matter biomass burned^{-1}
DESCRIPTION	Emission factor for gas **g** (based on IPCC default values or appropriate literature sources)
JUSTIFICATION OF CHOICE OF DATA OR DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES APPLIED	Source: Defaults can be found in Volume 4, Chapter 2, of the IPCC 2006 Inventory Guidelines in table 2.5 (see Annex 2: emission factors for various types of burning for CH_4 and N_2O).
TREATMENT OF UNCERTAINTY	None
COMMENTS	Default values shall be updated whenever new information becomes available or new guidelines are produced by the IPCC

DATA / PARAMETER	GWP_g
DATA UNIT	MT CO_2e MT gas g^{-1}
DESCRIPTION	Global warming potential for gas **g**
JUSTIFICATION OF CHOICE OF DATA OR DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES APPLIED	Source: Default values from the latest IPCC Assessment Report. GWP for carbon dioxide = 1.

TREATMENT OF UNCERTAINTY	None
COMMENTS	Default values shall be updated per the *ACR Standard*

5.2 Data and Parameters Monitored

DATA / PARAMETER	$A_{burn\_int,wp,t}$
DATA UNIT	Ha
DESCRIPTION	Actual (not planned) area of intentional burn in the project area in year **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored in project area via aerial imagery and management records. The actual intentional burned area, $A_{burn\_int,wp,t}$, is determined after the burn takes place by consulting aerial imagery.
FREQUENCY OF MONITORING/ RECORDING	In the event of any intentional burn, monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	Not applicable
QA/QC PROCEDURES TO BE APPLIED	Any imagery or GIS dataset must be georegistered referencing corner point, clear land marks, or other intersection points.
CALCULATION METHOD	Not applicable
TREATMENT OF UNCERTAINTY	It is assumed that area bounds are known exactly.
COMMENTS	

DATA / PARAMETER	$A_{burn\_unint,wp,t}$
DATA UNIT	ha
DESCRIPTION	Area of unintentional burn in the project area occurring in monitoring interval ending in year **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored in project area via aerial imagery and management records. The actual unintentional burned area, $A_{burn\_unint,wp,t}$, is determined after the burn takes place by consulting aerial imagery. Plans for intentional burns (e.g., prescribed burns) in the project area must be recorded in management records to distinguish unintentional burns (on the absence of management records).
FREQUENCY OF MONITORING/ RECORDING	In the event of any unintentional burn, monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	Not applicable
QA/QC PROCEDURES TO BE APPLIED	Any imagery or GIS dataset must be georegistered referencing corner point, clear land marks, or other intersection points.
CALCULATION METHOD	Not applicable
TREATMENT OF UNCERTAINTY	It is assumed that area bounds are known exactly.
COMMENTS	None

DATA / PARAMETER	$ABGB_{bsl,j,t}$
DATA UNIT	MT CO_2e/ha
DESCRIPTION	Above- and belowground biomass carbon stocks in the baseline reference area in plot **j** at time **t**

DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored on baseline site via direct measurement on permanent sample plots. Procedures to monitor biomass carbon stocks, include trees and woody shrubs, shall reference a minimum value for the independent variable(s) (e.g., dbh or basal diameter) which is fixed for the project crediting period. The default carbon fraction used to estimate carbon from biomass shall be 0.47 t C t-1 d.m. in line with the IPCC default (IPCC 2006 INV GLs AFOLU Chapter 4 Table 4.3). Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation (e.g., allometric equations) procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Sampling error quantified with 90% confidence • Biomass carbon stocks shall be estimated on a minimum of 20 plots. • Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan) • Estimation factors (e.g. allometric equations) are demonstrated to be robust in application to the project circumstances.
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years, or following a fire.
MONITORING EQUIPMENT	Measuring tape, DBH (or diameter) tape, hypsometer, clinometer
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended.

CALCULATION METHOD	Not applicable
TREATMENT OF UNCERTAINTY	Uncertainty is accounted for in the parameter $UNC_{\Delta ABGB,bsl,t}$
COMMENTS	Used in flux approach only Allometric equations and root to shoot ratios shall be peer reviewed, published in a scientific journal or government publication, relevant for the geographic area where the project occurs, and appropriate for the species/vegetation type found in the project area.

DATA / PARAMETER	$ABGB_{wp,j,t}$
DATA UNIT	MT CO_2e/ha
DESCRIPTION	Above- and belowground biomass carbon stocks in the project area in plot **j** at time **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored on project area via direct measurement on permanent sample plots. Procedures to monitor biomass carbon stocks, include trees and woody shrubs, shall reference a minimum value for the independent variable(s) (e.g., dbh or basal diameter) which is fixed for the project crediting period. The default carbon fraction used to estimate carbon from biomass shall be 0.47 t C t-1 d.m. in line with the IPCC default (IPCC 2006 INV GLs AFOLU Chapter 4 Table 4.3). Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation (e.g., allometric equations) procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Sampling error quantified with 90% confidence • Biomass carbon stocks shall be estimated on a minimum of 20 plots.

	• Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan) • Estimation factors (e.g. allometric equations) are demonstrated to be robust in application to the project circumstances.
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	Measuring tape, DBH (or diameter) tape, hypsometer, clinometer
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended.
CALCULATION METHOD	Not applicable
TREATMENT OF UNCERTAINTY	Uncertainty is accounted for in the parameter $UNC_{\Delta ABGB,wp,t}$
COMMENTS	Used in flux approach only. Allometric equations and root to shoot ratios shall be peer reviewed, published in a scientific journal or government publication, relevant for the geographic area where the project occurs, and appropriate for the species/vegetation type found in the project area. Any sample plots for above- and belowground biomass carbon stocks located within the area of an unintentional burn in the project area, will not be used to calculate $\Delta ABGB_{wp,t}$ in the project area for the monitoring interval spanning the burn (i.e., from the monitoring event immediately prior to the burn to the monitoring event immediately after the burn).

DATA / PARAMETER	$AGB_{bsl,j,t}$

DATA UNIT	MT CO_2e/ha
DESCRIPTION	Aboveground biomass carbon stocks in the baseline reference area in plot **j** at time **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored on baseline site via direct measurement on permanent sample plots. Procedures to monitor biomass carbon stocks, include trees and woody shrubs, shall reference a minimum value for the independent variable(s) (e.g., dbh or basal diameter) which is fixed for the project crediting period. The default carbon fraction used to estimate carbon from biomass shall be 0.47 t C t-1 d.m. in line with the IPCC default (IPCC 2006 INV GLs AFOLU Chapter 4 Table 4.3). Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation (e.g., allometric equations) procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Sampling error quantified with 90% confidence • Biomass carbon stocks shall be estimated on a minimum of 20 plots • Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan) • Estimation factors (e.g. allometric equations) are demonstrated to be robust in application to the project circumstances.
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	Measuring tape, DBH (or diameter) tape, hypsometer, clinometer

QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended.
CALCULATION METHOD	Not applicable
TREATMENT OF UNCERTAINTY	Uncertainty is accounted for in the parameter $UNC_{\Delta AGB,bsl,t}$
COMMENTS	Used in stock change approach only. Allometric equations shall be peer reviewed, published in a scientific journal or government publication, relevant for the geographic area where the project occurs, and appropriate for the species/vegetation type found in the project area.

DATA / PARAMETER	$AGB_{wp,j,t}$
DATA UNIT	MT CO_2e/ha
DESCRIPTION	Aboveground biomass carbon stocks in the project area in plot **j** at time **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored on project area via direct measurement on permanent sample plots. Procedures to monitor biomass carbon stocks, include trees and woody shrubs, shall reference a minimum value for the independent variable(s) (e.g., dbh or basal diameter) which is fixed for the project crediting period. The default carbon fraction used to estimate carbon from biomass shall be 0.47 t C t-1 d.m. in line with the IPCC default (IPCC 2006 INV GLs AFOLU Chapter 4 Table 4.3). Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation (e.g., allometric equations) procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must:

	• Be demonstrated to be un-biased and derived from representative sampling • Sampling error quantified with 90% confidence • Biomass carbon stocks shall be estimated on a minimum of 20 plots • Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan) • Estimation factors (e.g. allometric equations) are demonstrated to be robust in application to the project circumstances.
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	Measuring tape, DBH (or diameter) tape, hypsometer, clinometer
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended.
CALCULATION METHOD	Not applicable
TREATMENT OF UNCERTAINTY	Uncertainty is accounted for in the parameter $UNC_{\Delta AGB,wp,t}$
COMMENTS	Used in stock change approach only. Allometric equations shall be peer reviewed, published in a scientific journal or government publication, relevant for the geographic area where the project occurs, and appropriate for the species/vegetation type found in the project area. Any sample plots for aboveground biomass carbon stocks located within the area of an unintentional burn in the project area, will not be used to calculate $\Delta AGB_{wp,t}$ in the project area for the monitoring interval spanning the burn (i.e., from the monitoring event immediately prior to the burn to the monitoring event immediately after the burn).

DATA / PARAMETER	$\Delta AGB_{Aburn\_int\_wp,t}$
DATA UNIT	$MT\ CO_2e\ ha^{-1}\ yr^{-1}$
DESCRIPTION	Mean change in aboveground biomass carbon stocks in the actual (not planned) area of intentional burn in the project area in year **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored on project area via direct measurement on the subset of permanent sample plots located within the actual (not planned) area of intentional burn in the project area in year **t**. Measurement and monitoring procedures the same as for parameters $ABGB_{wp,j,t}$ and $AGB_{wp,j,t}$, excepting the minimum (total) sample size requirements (though see comment below regarding managing uncertainty).
FREQUENCY OF MONITORING/ RECORDING	See parameters $ABGB_{wp,j,t}$ and $AGB_{wp,j,t}$
MONITORING EQUIPMENT	See parameters $ABGB_{wp,j,t}$ and $AGB_{wp,j,t}$
QA/QC PROCEDURES TO BE APPLIED	See parameters $ABGB_{wp,j,t}$ and $AGB_{wp,j,t}$
CALCULATION METHOD	Calculate mean annual change in stocks of aboveground biomass from the subset of measurement plots located in the actual (not planned) area of intentional burn in the project area in year **t**. **Equation 21** $$\Delta AGB_{Aburn_{int,wp,t}} = \left(\frac{1}{n}\right) \times \sum_{j=1}^{n} \left(AGB_{wp,b,j,t} - AGB_{wp,b,j,t-x}\right) - UNC_{\Delta AGB,wp,b,t}$$ **WHERE** $\Delta AGB_{Aburn\_int\_wp,t}$: Mean change in aboveground biomass carbon stocks in the actual area of intentional burn in the project area in year **t**; $MT\ CO_2e\ ha^{-1}\ yr^{-1}$

	$AGB_{wp,b,j,t}$	Aboveground biomass carbon stocks in plot **j** located in the actual area of intentional burn in the project area in year **t**, in year **t** (post burn); MT CO_2e/ha
	$AGB_{wp,b,j,t-x}$	Aboveground biomass carbon stocks in plot **j** located in the actual area of intentional burn in the project area in year **t**, in year **t-x** (pre burn); MT CO_2e/ha
	j	1, 2, 3 … **n** sample plots located in the actual (not planned) area of intentional burn in the project area in year **t**
	t	1, 2, 3, … **t** years elapsed since the project start date
	$UNC_{\Delta AGB,wp,b,t}$	Half width of 90% confidence interval exceeding 10% of the mean change in aboveground biomass carbon stocks located in the actual area of intentional burn in the project area in year **t**; MT CO_2e/ha/yr
	If $\Delta AGB_{Aburn\_int\_wp,t}$ is positive (i.e., there is net growth, and insignificant combustion and loss of aboveground biomass), set $\Delta AGB_{Aburn\_int\_wp,t}$ to zero.	
TREATMENT OF UNCERTAINTY	Parameter value incorporates uncertainty by being calculated as the mean value minus the amount of the half width of the 90% confidence interval exceeding 10% of the mean value. Note that because this involves a subset of the total sampling network, it may be desired to augment sampling in the intentional burn area prior to the burn to reduce uncertainty.	
COMMENTS	None	

DATA / PARAMETER	$BD_{stock,wp,t}$
DATA UNIT	g cm^{-3}
DESCRIPTION	Mean dry bulk density (as defined for the stock change approach; i.e., including coarse roots) in the project area at time **t**
DESCRIPTION OF MEASUREMENT METHODS AND	Monitored in the project area using cores collected from temporary or permanent sample plots. Bulk density is defined as the dry weight of the fine soil fraction and fine and coarse roots of the core divided by the core volume. Bulk density shall be

PROCEDURES TO BE APPLIED	sampled to a depth of 10 cm. Note that the 10 cm depth must be referenced from the soil surface, separating the litter from the soil, referencing the same rules and procedures for determining peat surface level applied in surface elevation measurements. Where roots impede coring, cut roots along the outside perimeter of the sampling ring. For bulk density determination, sample cores of known volume are collected in the field and oven dried to a constant weight at 105 C (for a minimum of 48 hours). The total sample is then weighed, then any coarse rocky (i.e., non-organic) fragments (>2 mm) are sieved and weighed separately. Because coarse (>2mm) rocky fragments occupy space in the soil profile in which carbon is not stored, the volume in the bulk density equation is the volume of the core. Discounting this volume, as in traditional bulk density calculations, would overestimate soil carbon stocks when applied to a volume that does not distinguish between coarse and fine fractions. Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation (e.g., allometric equations) procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: - Be demonstrated to be un-biased and derived from representative sampling - Minimum sample size of 20 cores - Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan) Further guidance on measurement and collection approaches is provided in: DeLaune, R.D., K.R. Reddy, C.J. Richardson, and J.P. Megonigal, eds. 2013. Methods in Biogeochemistry of Wetlands. Soil Science Society of America Book Series No. 10. Madison, WI: Soil Science Society of America. 10004p
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.

MONITORING EQUIPMENT	Bulk density may be sampled using a variety of equipment.
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended. In particular, it is essential that compaction is avoided in the process of obtaining and working with field samples. The following precautions should be adhered to: • When obtaining the sample, particularly when trimming the end of the core to a sampling ring, avoid compressing, compacting or disturbing the sample. • The core should be oven-dried prior to sieving. • Large cores (approximately > 8 cm diameter) should be used preferentially; compaction tends to occur where the edge of the sampling ring meets the soil surface, and larger cores have a smaller surface to area ratio in cross section.
CALCULATION METHOD	The bulk density of the soil core is estimated as: **Equation 22** $$BD_{sample} = \frac{ODW - RF}{CV}$$ **WHERE** BD_{sample} = Bulk density of the < 2 mm fine soil fraction and coarse roots, in grams per cubic centimeter (g/cm3) ODW = Oven dry mass total sample in grams CV = Core volume in cm^3 RF = Mass of coarse rock fragments (> 2 mm) in grams
TREATMENT OF UNCERTAINTY	None
COMMENTS	Used in the stock change approach only

DATA / PARAMETER	$BD_{flux,wp,t}$
DATA UNIT	g cm^{-3}
DESCRIPTION	Mean dry bulk density (as defined for the flux approach; i.e., excluding coarse roots) in the project area at time **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored in the project area using cores collected from temporary or permanent sample plots. Where monitoring occurs after a burn, after the initial t=0 measurement, cores will be collected from plots located outside of the area of the burn. Bulk density is defined as the dry weight of the fine soil fraction of the core divided by the core volume. Bulk density shall be sampled to a depth of 10 cm. Note that the 10 cm depth must be referenced from the soil surface, separating the litter from the soil, referencing the same rules and procedures for determining peat surface level applied in surface elevation measurements. Where roots impede coring, cut roots along the outside perimeter of the sampling ring. For bulk density determination, sample cores of known volume are collected in the field and oven dried to a constant weight at 105 C (for a minimum of 48 hours). The total sample is then weighed, then any coarse rocky (i.e., non-organic) fragments (>2 mm) are sieved and weighed separately. Because coarse (>2mm) rocky fragments occupy space in the soil profile in which carbon is not stored, the volume in the bulk density equation is the volume of the core. Discounting this volume, as in traditional bulk density calculations, would overestimate soil carbon stocks when applied to a volume that does not distinguish between coarse and fine fractions. Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation (e.g., allometric equations) procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Minimum sample size of 20 cores

	• Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan) Further guidance on measurement and collection approaches is provided in: DeLaune, R.D., K.R. Reddy, C.J. Richardson, and J.P. Megonigal, eds. 2013. Methods in Biogeochemistry of Wetlands. Soil Science Society of America Book Series No. 10. Madison, WI: Soil Science Society of America. 10004p
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at the beginning of the project (t=0) and in the event of any intentional or unintentional burn, prior to the first verification event following each burn.
MONITORING EQUIPMENT	Bulk density may be sampled using a variety of equipment.
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended. In particular, it is essential that compaction is avoided in the process of obtaining and working with field samples. The following precautions should be adhered to: • When obtaining the sample, particularly when trimming the end of the core to a sampling ring, avoid compressing, compacting or disturbing the sample. • The core should be oven-dried prior to sieving. • Large cores (approximately > 8 cm diameter) should be used preferentially; compaction tends to occur where the edge of the sampling ring meets the soil surface, and larger cores have a smaller surface to area ratio in cross section.
CALCULATION METHOD	The bulk density of the soil core is estimated as: **Equation 23** $$BD_{sample} = \frac{ODW - RF}{CV}$$

	WHERE
	BD_{sample}: Bulk density of the < 2 mm fine soil fraction, in grams per cubic centimeter (g/cm^3)
	ODW: Oven dry mass total sample in grams
	CV: Core volume in cm^3
	RF: Mass of coarse rock fragments (> 2 mm) in grams
TREATMENT OF UNCERTAINTY	None
COMMENTS	Used in the flux approach only

DATA / PARAMETER	Proxy $A_{bsl,t}$
DATA UNIT	units unspecified
DESCRIPTION	Mean value of proxy variable A in the baseline at time **t**. The proxy variable is a measurable variable that is significantly correlated with belowground GHG emissions.
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Either monitored via direct measurement in a valid baseline site, monitored via direct measurement in the project area, or modeled in the project area (e.g., using a hydrologic model) on the basis of one or more monitored, directly-measured proxy variables (e.g., precipitation) in the project area. When using a model (e.g., a hydrologic model) to estimate the proxy variable(s), the model(s) must be: • Peer-reviewed • Empirically-based • Incorporate one or more proxy variables that are monitored *ex post* in the project area (e.g., precipitation) When the variable is direct measured: Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling,

	measurement and estimation procedures for measuring and sampling the proxy variable are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Sampling error quantified with 90% confidence. Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan)
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	Not specified
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended.
CALCULATION METHOD	Not applicable
TREATMENT OF UNCERTAINTY	The value of parameter Proxy $A_{bsl,t}$ incorporates uncertainty where the half width of the 90% confidence interval exceeds 10% of the mean value, as: If the parameter is positively correlated with belowground emissions (from soil organic carbon and dead belowground biomass and litter pools), the value is equal to the mean value minus the amount of the half width of the 90% confidence interval exceeding 10% of the mean value. If the parameter is negatively correlated with belowground emissions (from soil organic carbon and dead belowground biomass and litter pools), the value is equal to the mean value plus the amount of the half width of the 90% confidence interval exceeding 10% of the mean value. The 90% confidence interval is calculated referencing sample error (variance) for measured variables, or referencing model error for modeled variables.

COMMENTS	Used in flux approach only.

DATA / PARAMETER	Proxy $A_{wp,t}$
DATA UNIT	Units unspecified
DESCRIPTION	Mean value of proxy variable A in the project area at time t. The proxy variable is a measurable variable that is significantly correlated with belowground GHG emissions.
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored via direct measurement in the project area. Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation procedures for measuring and sampling the proxy variable are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Sampling error quantified with 90% confidence • Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan)
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	Not specified
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied

	in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended.
CALCULATION METHOD	Not applicable
TREATMENT OF UNCERTAINTY	The value of parameter Proxy $A_{wp,t}$ incorporates uncertainty where the half width of the 90% confidence interval exceeds 10% of the mean value, as: If the parameter is positively correlated with belowground emissions (from soil organic carbon and dead belowground biomass and litter pools), the value is equal to the mean value plus the amount of the half width of the 90% confidence interval exceeding 10% of the mean value. If the parameter is negatively correlated with belowground emissions (from soil organic carbon and dead belowground biomass and litter pools), the value is equal to the mean value minus the amount of the half width of the 90% confidence interval exceeding 10% of the mean value. The 90% confidence interval is calculated referencing sample error (variance).
COMMENTS	Used in flux approach only.

DATA / PARAMETER	$\Delta SE_{bsl,t}$
DATA UNIT	mm
DESCRIPTION	Mean net surface elevation change (subsidence + peat accretion + root expansion/mortality) in the baseline site in monitoring interval ending in year **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored on baseline site via direct measurement of permanent sample points. Sample points will be located where the ground surface is measurable (necessarily outside clump centers of tussocks e.g.). Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation procedures for measuring are not specified in the methodology and may be selected by project proponents based on

	capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Sampling error quantified with 90% confidence • Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan) Where signs of significant soil disturbance, including bioturbation, are encountered at a sample point, the disturbed sample sites must be excluded from the analysis. The change in surface elevation shall be determined using Rod Surface Elevation Tables (RSETs), Real Time Kinematic (RTKs) satellite-based approaches and/or other technologies. Use of RTK GPS should follow established field procedures, such as those found in: US Geological Survey. 2012. Topographic mapping RTK GPS standard operating procedures. Unpublished protocols. USGS, Western Ecological Research Center, San Francisco Bay Estuary Field Station, Vallejo, CA. Use of RSETs should follow established field procedures, such as those found in: Cahoon, D. R., J. C. Lynch, B. C. Perez, B. Segura, R. Holland, C. Stelly, G. Stephenson, and P. Hensel. 2002. A device for high precision measurement of wetland sediment elevation: II. The rod surface elevation table. Journal of Sedimentary Research. Vol. 72, No. 5. pp. 734-739.
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	RTK GPS, RSET station, and/or other appropriate technology
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended.

CALCULATION METHOD	For each sample point, change in surface elevation is calculated as measured surface elevation at time **t** minus measured surface elevation at time **t-x** (x = length of monitoring interval in years); i.e., net subsidence is a negative value and net accretion is a positive value. Mean change in surface elevation is calculated from the sample point-level change values. Measurements of surface elevation are made in meters above sea level (masl) or meters above a reference datum to four decimal points (1/10 mm), where possible.
TREATMENT OF UNCERTAINTY	Parameter value incorporates uncertainty by being calculated as the mean value plus the amount of the half width of the 90% confidence interval exceeding 10% of the mean value.
COMMENTS	Used in stock change approach only. The stock change approach may be employed if the following applicability conditions are met: • Net surface elevation change measured using Rod Surface Elevation Tables (RSETs), Real Time Kinematic (RTKs) satellite-based approaches and/or other technologies; • Clear and detailed rules and procedures for determining peat surface level, and distinguishing it from any overlying litter, are documented in field standard operating procedures and adhered to; • Bulk density in top 10 cm is monitored; the top layer being the aerated labile portion from which emissions are expected to be sourced, and as well is a conservative value as it's the lowest bulk density throughout the peat profile. The top 10 cm should also capture the majority of root biomass, and permit estimation of emissions from surface level change resulting from root expansion/mortality. Bulk density samples must include soil organic carbon and belowground biomass (fine and coarse roots). • Baseline site has been subject to drainage/hydrological alteration for at least 10 years (to minimize influence of new root growth and expansion on surface elevation and bulk density) • Repeat measurements of surface elevation change are made at the same water table level (+/- 10% of level at the time of the t = 0 measurement, as recorded at the same site(s) measured at t =0) and in the dry season. Water table level will be assessed from data from a groundwater well

	located at the site, or if this does not exist, from the nearest USGS groundwater well, sourced from https://waterdata.usgs.gov/nwis/gw ; - In with-project case, initial surface elevation level is measured no less than 12 months after re-wetting takes place (after initial swell has occurred); - In both the project area and baseline site, no significant erosion or sedimentation expected to occur (flat terrain, no river flow over project area); - In both the project area and baseline site, no significant compaction (by machinery or treading) expected to occur and procedures will be in place to safeguard against compaction resulting from surface elevation measurements in the field.

DATA / PARAMETER	$\Delta SE_{wp,t}$
DATA UNIT	mm
DESCRIPTION	Mean net surface elevation change (subsidence + peat accretion + root expansion/mortality) in the project area in monitoring interval ending in year t
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored on project area via direct measurement of permanent sample points. Sample points will be located where the ground surface is measurable (necessarily outside clump centers of tussocks e.g.). Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: - Be demonstrated to be un-biased and derived from representative sampling - Sampling error quantified with 90% confidence - Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan)

	Where signs of significant soil disturbance, including bioturbation, are encountered at a sample point, the disturbed sample sites must be excluded from the analysis. The change in surface elevation shall be determined using Rod Surface Elevation Tables (RSETs), Real Time Kinematic (RTKs) satellite-based approaches and/or other technologies. Use of RTK GPS should follow established field procedures, such as those found in: US Geological Survey. 2012. Topographic mapping RTK GPS standard operating procedures. Unpublished protocols. USGS, Western Ecological Research Center, San Francisco Bay Estuary Field Station, Vallejo, CA. Use of RSETs should follow established field procedures, such as those found in: Cahoon, D. R., J. C. Lynch, B. C. Perez, B. Segura, R. Holland, C. Stelly, G. Stephenson, and P. Hensel. 2002. A device for high precision measurement of wetland sediment elevation: II. The rod surface elevation table. Journal of Sedimentary Research. Vol. 72, No. 5. pp. 734-739.
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	RTK GPS, RSET station, and/or other appropriate technology
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended.
CALCULATION METHOD	For each sample point, change in surface elevation is calculated as measured surface elevation at time t minus measured surface elevation at time **t-x** (x = length of monitoring interval in years); i.e., net subsidence is a negative value and net accretion is a positive value. Mean change in surface elevation is calculated from the sample point-level change values. Measurements of surface elevation are made in meters above sea level (masl) or above a reference datum to four decimal points (1/10 mm), where possible.

TREATMENT OF UNCERTAINTY	Parameter value incorporates uncertainty by being calculated as the mean value minus the amount of the half width of the 90% confidence interval exceeding 10% of the mean value.
COMMENTS	Used in stock change approach only. The stock change approach may be employed if the following applicability conditions are met: • Net surface elevation change measured using Rod Surface Elevation Tables (RSETs), Real Time Kinematic (RTKs) satellite-based approaches and/or other technologies; • Clear and detailed rules and procedures for determining peat surface level, and distinguishing it from any overlying litter, are documented in field standard operating procedures and adhered to; • Bulk density in top 10 cm is monitored; the top layer being the aerated labile portion from which emissions are expected to be sourced, and as well is a conservative value as it's the lowest bulk density throughout the peat profile. The top 10 cm should also capture the majority of root biomass, and permit estimation of emissions from surface level change resulting from root expansion/mortality. Bulk density samples must include soil organic carbon and belowground biomass (fine and coarse roots); • Baseline site has been subject to drainage/hydrological alteration for at least 10 years (to minimize influence of new root growth and expansion on surface elevation and bulk density); • Repeat measurements of surface elevation change are made at the same water table level (+/- 10% of level at the time of the t = 0 measurement, as recorded at the same site(s) measured at t =0) and in the dry season. Water table level will be assessed from data from a groundwater well located at the site, or if this does not exist, from the nearest USGS groundwater well, sourced from https://waterdata.usgs.gov/nwis/gw ; • In with-project case, initial surface elevation level is measured no less than 12 months after re-wetting takes place (after initial swell has occurred); • In both the project area and baseline site, no significant erosion or sedimentation expected to occur (flat terrain, no river flow over project area); • In both the project area and baseline site, no significant compaction (by machinery or treading) expected to occur and procedures will be in place

	to safeguard against compaction resulting from surface elevation measurements in the field. Any sample points for surface elevation located within the area of an unintentional burn in the project area, will not be used to calculate net change in surface elevation, $\Delta SE_{wp,t}$, in the project area for the monitoring interval spanning the burn (i.e., from the monitoring event immediately prior to the burn to the monitoring event immediately after the burn).

DATA / PARAMETER	$\Delta SE_{burn\_int,wp,t}$
DATA UNIT	mm
DESCRIPTION	Mean surface elevation change in the actual area subject to intentional fire in the project area at time **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Monitored in the project area in the planned burn area, $A_{burn\_int,wp,t}$, via direct measurement of temporary sample points immediately prior to and after the burn. Sample points will be located where the ground surface is measurable (necessarily outside clump centers of tussocks e.g.). Clear and detailed rules and procedures for determining peat surface level, distinguishing it from any overlying litter layer, are documented in field standard operating procedures and adhered to. Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Sampling error quantified with 90% confidence • Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan) Where signs of significant bioturbation are encountered at a sample point, the disturbed sample sites must be excluded from the analysis.

FREQUENCY OF MONITORING/ RECORDING	In the event of intentional burns, monitoring shall be conducted at least every five years, or prior to each verification event if less than five years, and ensure pre- and post-burn measurements of all intentional burns occurring between verification events.
MONITORING EQUIPMENT	Measuring Tape
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended.
CALCULATION METHOD	For each sample point, change in surface elevation is calculated as measured surface elevation after burn minus measured surface elevation before burn; i.e., elevation change due to fire is expected to be a negative value. Mean change in surface elevation is calculated from the sample point-level change values. Measurements of surface elevation are made in meters above sea level (masl) or above a reference datum to four decimal points (1/10 mm), where possible. If $\Delta SE_{burn\_int,wp,t}$ is positive (i.e., there is net accretion, and insignificant combustion and loss of peat), set $\Delta SE_{burn\_int,wp,t}$ to zero.
TREATMENT OF UNCERTAINTY	Parameter value incorporates uncertainty by being calculated as the mean value minus the amount of the half width of the 90% confidence interval exceeding 10% of the mean value.
COMMENTS	Used in flux approach only.

DATA / PARAMETER	$\Delta SE_{burn\_int,wp,t}$
DATA UNIT	mm
DESCRIPTION	Mean surface elevation change due to unintentional fire in the project area at time **t**
DESCRIPTION OF MEASUREMENT METHODS AND	Monitored in the project area via direct measurement of temporary sample points in the unintentional burn area and outside the unintentional burn area immediately after the burn. Sample points will be located where the

PROCEDURES TO BE APPLIED	ground surface is measurable (necessarily outside clump centers of tussocks e.g.). Clear and detailed rules and procedures for determining peat surface level, distinguishing it from any overlying litter layer, are documented in field standard operating procedures and adhered to. Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstance-specific, sampling, measurement and estimation procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision, but is not required. Estimates generated must: • Be demonstrated to be un-biased and derived from representative sampling • Sampling error quantified with 90% confidence • Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan) Where signs of significant bioturbation are encountered at a sample point, the disturbed sample sites must be excluded from the analysis. Surface elevation measured using Real Time Kinematic (RTKs) satellite-based approaches and/or other technologies. Use of RTK GPS should follow established field procedures, such as those found in: US Geological Survey. 2012. Topographic mapping RTK GPS standard operating procedures. Unpublished protocols. USGS, Western Ecological Research Center, San Francisco Bay Estuary Field Station, Vallejo, CA.
FREQUENCY OF MONITORING/ RECORDING	In the event of unintentional burn(s), monitoring shall be conducted at least every five years, or prior to each verification event if less than five years, and ensure post-burn measurements of all unintentional burns occurring between verification events.
MONITORING EQUIPMENT	RTK GPS, RSET station, and/or other appropriate technology
QA/QC PROCEDURES TO BE APPLIED	Standard quality control / quality assurance (QA/QC) procedures for forest biomass/soil inventory including field data collection and data management shall be applied. Use or adaptation of QA/QCs already applied

	in national forest monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended.
CALCULATION METHOD	Mean change in surface elevation is calculated as the mean surface elevation in the burned area minus the mean surface elevation in the unburned area; i.e., elevation change due to fire is expected to be a negative value. Measurements of surface elevation are made in meters above sea level (masl) or above a reference datum to four decimal points (1/10 mm), where possible.
TREATMENT OF UNCERTAINTY	Parameter value incorporates uncertainty by being calculated as the mean value minus the amount of the half width of the 90% confidence interval exceeding 10% of the mean value.
COMMENTS	Used in flux approach only.

DATA / PARAMETER	$UNC_{\Delta ABGB,bsl,t}$
DATA UNIT	MT CO_2e/ha/yr
DESCRIPTION	Half width of 90% confidence interval exceeding 10% of the mean annual change in above- and belowground biomass carbon stocks in the baseline reference area in monitoring interval ending in year **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Not applicable as parameter is calculated.
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	Not applicable as calculated parameter.
QA/QC PROCEDURES TO BE APPLIED	Not applicable as parameter is calculated.

CALCULATION METHOD	Parameter $UNC_{\Delta ABGB,bsl,t}$ is calculated as: **Equation 24** $UNC_{\Delta ABGB,bsl,t} = \left(\frac{1}{x}\right) \times 1.67 \times \sqrt{(Var_{ABGBbsl,t} + Var_{ABGBbsl,t-x} - 2 \times Cov_{ABGBbsl,t\_ABGBbsl,t-x} \times \sqrt{Var_{ABGBbsl,t}} \times \sqrt{Var_{ABGBbsl,t-x}}) \times \left(\frac{1}{n}\right)} - 10\% \times \left(\frac{1}{n}\right) \times \sum_{j=1}^{n}((ABGB_{bsl,j,t} - ABGB_{bsl,j,t-x}) \times \left(\frac{1}{x}\right))$ **WHERE** $ABGB_{bsl,j,t}$: Above- and belowground biomass carbon stocks in the baseline reference area in plot j at time t; MT CO_2e/ha $ABGB_{bsl,j,t-x}$: Above- and belowground biomass carbon stocks in the baseline reference area in plot j at time $t-x$; MT CO_2e/ha $Var_{ABGB,bsl,t}$: Variance in above- and belowground biomass carbon stocks in the baseline reference area at time t; dimensionless $Var_{ABGB,bsl,t-x}$: Variance in above- and belowground biomass carbon stocks in the baseline reference area at time $t-x$; dimensionless $Cov_{ABGB,bsl,t\_ABGB,bsl,t-x}$: Covariance in above- and belowground biomass carbon stocks in the baseline reference area at times t and $t-x$; dimensionless j: 1, 2, 3 … n sample plots x: Number of years in monitoring interval; years t: 1, 2, 3, … t years elapsed since the project start date
TREATMENT OF UNCERTAINTY	None
COMMENTS	Used in flux approach only.

DATA / PARAMETER	$UNC_{\Delta ABGB,wp,t}$

DATA UNIT	MT CO_2e/ha/yr
DESCRIPTION	Half width of 90% confidence interval exceeding 10% of the mean annual change in above- and belowground biomass carbon stocks in the project area in monitoring interval ending in year **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Not applicable as parameter is calculated.
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	Not applicable as calculated parameter.
QA/QC PROCEDURES TO BE APPLIED	Not applicable as parameter is calculated.
CALCULATION METHOD	Parameter $UNC_{\Delta ABGB,bsl,t}$ is calculated as:

Equation 25

$$UNC_{\Delta ABGB,wp,t} = \left(\frac{1}{x}\right) \times 1.67 \times \sqrt{(Var_{ABGBwp,t} + Var_{ABGBwp,t-x} - 2 \times Cov_{ABGBwp,t\_ABGBwp,t-x} \times \sqrt{Var_{ABGBwp,t}} \times \sqrt{Var_{ABGBwp,t-x}}) \times \left(\frac{1}{n}\right)} - 10\% \times \left(\frac{1}{n}\right) \times \sum_{j=1}^{n}((ABGB_{wp,j,t} - ABGB_{wp,j,t-x}) \times \left(\frac{1}{x}\right))$$

WHERE

$ABGB_{wp,j,t}$	Above- and belowground biomass carbon stocks in the project area in plot **j** at time **t**; MT CO_2e/ha
$ABGB_{wp,j,t-x}$	Above- and belowground biomass carbon stocks in the project area in plot **j** at time **t-x**; MT CO_2e/ha

	$Var_{ABGB,wp,t}$	Variance in above- and belowground biomass carbon stocks in the project area at time **t**; dimensionless
	$Var_{ABGB,wp,t-x}$	Variance in above- and belowground biomass carbon stocks in the project area at time **t-x**; dimensionless
	$Cov_{ABGB,wp,t\_ABGB,wp,t-x}$	Covariance in above- and belowground biomass carbon stocks in the project area at times **t** and **t-x**; dimensionless
	j	1, 2, 3 … **n** sample plots
	x	Number of years in monitoring interval; years
	t	1, 2, 3, … **t** years elapsed since the project start date
TREATMENT OF UNCERTAINTY	None	
COMMENTS	Used in flux approach only.	

DATA / PARAMETER	$UNC_{\Delta AGB,bsl,t}$
DATA UNIT	MT CO_2e/ha/yr
DESCRIPTION	Half width of 90% confidence interval exceeding 10% of the mean annual change in aboveground biomass carbon stocks in the baseline reference area in monitoring interval ending in year **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Not applicable as parameter is calculated.
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.

MONITORING EQUIPMENT	Not applicable as calculated parameter.
QA/QC PROCEDURES TO BE APPLIED	Not applicable as parameter is calculated.
CALCULATION METHOD	Parameter $UNC_{\Delta AGB,bsl,t}$ is calculated as: **Equation 26** $$UNC_{\Delta AGB,bsl,t} = \left(\frac{1}{x}\right) \times 1.67 \times \sqrt{\left(Var_{AGBbsl,t} + Var_{AGBbsl,t-x} - 2 \times Cov_{AGBbsl,t\_AGBbsl,t-x} \times \sqrt{Var_{AGBbsl,t}} \times \sqrt{Var_{AGBbsl,t-x}}\right) \times \left(\frac{1}{n}\right)} - 10\% \times \left(\frac{1}{n}\right) \times \sum_{j=1}^{n}\left(\left(AGB_{bsl,j,t} - AGB_{bsl,j,t-x}\right) \times \left(\frac{1}{x}\right)\right)$$ **WHERE**

$AGB_{bsl,j,t}$	Aboveground biomass carbon stocks in the baseline reference area in plot **j** at time **t**; MT CO_2e/ha
$AGB_{bsl,j,t-x}$	Aboveground biomass carbon stocks in the baseline reference area in plot **j** at time **t-x**; MT CO_2e/ha
$Var_{AGB,bsl,t}$	Variance in aboveground biomass carbon stocks in the baseline reference area at time **t**; dimensionless
$Var_{AGB,bsl,t-x}$	Variance in aboveground biomass carbon stocks in the baseline reference area at time **t-x**; dimensionless
$Cov_{AGB,bsl,t\_AGB,bsl,t-x}$	Covariance in aboveground biomass carbon stocks in the baseline reference area at times **t** and **t-x**; dimensionless
j	1, 2, 3 … **n** sample plots
x	Number of years in monitoring interval; years
t	1, 2, 3, … **t** years elapsed since the project start date

TREATMENT OF UNCERTAINTY	None
COMMENTS	Used in flux approach only.

DATA / PARAMETER	$UNC_{\Delta AGB,wp,t}$
DATA UNIT	MT CO_2e/ha/yr
DESCRIPTION	Half width of 90% confidence interval exceeding 10% of the mean annual change in aboveground biomass carbon stocks in the project area in monitoring interval ending in year **t**
DESCRIPTION OF MEASUREMENT METHODS AND PROCEDURES TO BE APPLIED	Not applicable as parameter is calculated.
FREQUENCY OF MONITORING/ RECORDING	Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years.
MONITORING EQUIPMENT	Not applicable as calculated parameter.
QA/QC PROCEDURES TO BE APPLIED	Not applicable as parameter is calculated.
CALCULATION METHOD	Parameter $UNC_{\Delta AGB,wp,t}$ is calculated as: **Equation 27** $$UNC_{\Delta AGB,wp,t} = \left(\frac{1}{x}\right) \times 1.67 \times \sqrt{\left(Var_{AGBwp,t} + Var_{AGBwp,t-x} - 2 \times Cov_{AGBwp,t\_AGBwp,t-x} \times \sqrt{Var_{AGBwp,t}} \times \sqrt{Var_{AGBwp,t-x}}\right) \times \left(\frac{1}{n}\right)} - 10\% \times \left(\frac{1}{n}\right) \times \sum_{j=1}^{n}\left(\left(AGB_{wp,j,t} - AGB_{wp,j,t-x}\right) \times \left(\frac{1}{x}\right)\right)$$

	WHERE	
	$AGB_{wp,j,t}$	Aboveground biomass carbon stocks in the project area in plot **j** at time **t**; MT CO_2e/ha
	$AGB_{wp,j,t-x}$	Aboveground biomass carbon stocks in the project area in plot **j** at time **t-x**; MT CO_2e/ha
	$Var_{AGB,wp,t}$	Variance in aboveground biomass carbon stocks in the project area at time **t**; dimensionless
	$Var_{AGB,wp,t-x}$	Variance in aboveground biomass carbon stocks in the project area at time **t-x**; dimensionless
	$Cov_{AGB,wp,t\_AGB,wp,t-x}$	Covariance in aboveground biomass carbon stocks in the project area at times **t** and **t-x**; dimensionless
	j	1, 2, 3 … **n** sample plots
	x	Number of years in monitoring interval; years
	t	1, 2, 3, … **t** years elapsed since the project start date
TREATMENT OF UNCERTAINTY	None	
COMMENTS	Used in flux approach only.	

6 Calculation of ERTs

6.1 Calculation of ERTs

Net accounting of GHG emission reductions is produced in Equation 28 below.

Equation 28

$$NER_t = GHG_{bsl,t} - GHG_{wp,t} - GHG_{lk,t}$$

WHERE

NER_t	Annual net greenhouse gas emission reductions in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$GHG_{bsl,t}$	Annual greenhouse gas emissions in the baseline in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$GHG_{wp,t}$	Annual greenhouse gas emissions in the with-project case in monitoring interval ending in year **t**; MT CO_2e yr^{-1}
$GHG_{lk,t}$	Annual greenhouse gas emissions due to leakage in monitoring interval ending in year **t**; MT CO_2e yr^{-1}

NOTE: $GHG_{lk,t}$ = zero for all years, per applicability condition stipulating the absence of any productive land use in the project area within five years prior to the project start date.

Equation 29

$$ERT_t = NER_t \times (1 - BUF)$$

WHERE

$ERT_{,t}$	Number of Emission Reduction Tons at time **t**
NER_t	Annual net greenhouse gas emission reductions in monitoring interval ending in year **t**; MT CO_2e yr-1

BUF	The non-permanence buffer deduction as calculated by the ACR Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination (BUF will be set to zero if an ACR approved insurance product is used);

Definitions

If not explicitly defined here, the current definitions in the most recent version of the *ACR Standard* apply.

Baseline	Most likely management scenario in the absence of the Project
Bulk Density	The weight of soil in a given volume. When soil core samples are collected, bulk density is calculated as the dry weight of the fine soil fraction (<2mm) of the soil cores divided by the core volume.
Drainage	Lowering water table due to deliberate hydrological manipulation, e.g., through ditching and diking
Ex-ante	"Before the event" or predicted response of Project activity
Ex-post	"After the event" or measured response of Project activity
Leakage	Leakage refers to a decrease in sequestration or increase in emissions outside project boundaries as a result of project implementation. Leakage may be caused by shifting of the activities of people present in the project area, or by market effects whereby emission reductions are countered by emissions created by shifts in supply of and demand for the products and services affected by the project.
Offset	Reduction in emissions of GHG made in order to compensate for or to offset an emission made elsewhere
Pocosin	Freshwater wetlands, with some component of broad-leaved evergreen shrubs or low trees, on organic soils in the coastal plain of southeast Virginia, North Carolina, South Carolina or Georgia, that are seasonally saturated primarily through precipitation.
Project Proponent	An individual or entity that undertakes, develops, and/or owns a project. This may include the project investor, designer, and/or owner of the lands/facilities on which project activities are conducted. The Project Proponent and landowner/facility owner may be different entities. The Project Proponent is the ACR account holder.
Rewetting	Raising the elevation of the average annual water table in drained wetland by partially or entirely reversing the pre-existing drained state;

Stratification	A standard statistical procedure to decrease overall variability of carbon stock estimates by grouping data taken from environments with similar characteristics (e.g., vegetation type, age class, hydrology, elevation)
Tool	Guideline or procedure for performing an analysis (e.g., tool for testing significance of GHG emissions in A/R CDM Project activities) or to help use or select a module or methodology.

Appendix A: Ecological Leakage

Due to the unique rainfall-driven hydrology of pocosin ecosystems of the southeastern US, rewetting of previously drained pocosins in the Atlantic coastal plain from southeast Virginia to Georgia is unlikely to result in increased GHG emissions off-site. Ecological leakage (i.e., increased emissions off-site due to the project activity), could only be envisioned in cases where water tables are lowered at a adjacent site due to reduced water export from a re-wetted project area. Because lateral movement of water from adjacent areas is not a primary input to the water budget in undrained (Richardson et al., 1980; Daniel 1980) and drained pocosins (Daniel 1980; Amataya et al., 1997), retaining water in the project area is not expected to lower water table levels, or increase GHG emissions, in adjacent areas.

Pocosins in the Southeastern US typically occupy elevated areas between coastal streams and bays, receiving little or no surface water or ground water inputs from adjacent areas (Sharitz and Gibbons 1982, McDonald et al., 1983; Kris Bass, former NCSU extension, and Howard Phillips, USFWS, personal communication, August 10, 2017). Organic peat soils characteristic of pocosins have high infiltration rates and low hydraulic conductivity (Daniel 1980), and pocosin topography is typically flat. Storm runoff that is not channelized will slowly move out of the pocosin over a broad reach of shoreline along a bordering stream or other body of water (Daniel, 1980). Thus, precipitation falling on the surface of the pocosin is primarily lost to evapotranspiration without flowing to adjacent areas (Daniel 1980; Richardson and McCarthy, 1994; Amataya et al., 1997; Bass 2017), and with minimal (1%) loss to groundwater (Heath 1975). This is particularly true during the dry season (when the bulk of GHG emissions from peat oxidation occurs) when evapotranspiration can account for as much as 90% of outflow in undrained pocosins (Richardson, 2003).

Artificial drainage systems, characteristic of the landscape of drained pocosins in the southeastern US, generally collect and funnel surface runoff to a few discrete discharge points in coastal streams and bays (Daniel 1980; Tiner 2003). Where ditches are present, subsurface drainage occurs as lateral flow to field drainage ditches which conduct runoff to larger canals (Amataya et al., 1997). Runoff flowing through canals from higher areas effectively bypasses lower lying areas and flows directly to discharge points (Charles Peoples, personal communication, August 8, 2017; Phillips, H, USFWS, personal communication, August 10, 2017). Project activities that raise water table levels in drained pocosins will not lower water table levels in adjacent drained areas, because these areas receive inputs primarily from precipitation, not the project area.

Even where ditch networks are not immediately adjacent to a project area, rewetting activities in pocosins are not expected to significantly impact total outflow from the project area, because both drained and undrained pocosins receive water almost entirely from rainfall, and they lose water primarily by evapotranspiration (Richardson et al. 1980; Sharitz and Gibbons 1982; Richardson and McCarthy 1994). Even in drained pocosins, evapotranspiration accounts for roughly 60% - 70% of outflow in the annual water budget (Richardson and McCarthy, 1994; Amataya et al., 1997; Bass 2017). Hydrologic restoration of a North Carolina pocosin decreased outflows of drainage and surface runoff by 5%, decreasing total outflow by only 1% (Bass, 2017).

In cases where water has been impounded downstream from the project area (e.g., in a pre-existing restored wetland), rewetting of the project area is likewise not expected to result in lower water table levels in the impounded area, because, again, rainfall is the primary input to any downstream site. During the dry season, evapotranspiration dominates the water budget and outflow from upstream areas is at its lowest (Bass, 2017) and re-wetting would have negligible impact on outflow. Water table levels in both the project area and downstream areas may drop in the dry season, not as a result of the project activity, but as a result of reduced rainfall inputs and higher evapotranspiration rates. Thus, rewetting of drained pocosins in the southeastern US is not expected to result in lowering of water table levels, or increases in GHG emissions, in adjacent areas, whether they are undrained, drained, or rewetted.

Appendix B: References

Amatya, D, Skaggs, R, Gregory, J, Herrmann, R. 1997. Hydrology of a drained forested pocosin watershed. Journal of the American Water Resources Association, 33: 535-546.

Bass, K. 2017. Pocosin Lakes Wildlife Refuge Watershed 1, Phase 1 Hydrology Monitoring Study. U.S. Fish and Wildlife Service, National Wildlife Refuge System.

Cahoon, D. R., J. C. Lynch, B. C. Perez, B. Segura, R. Holland, C. Stelly, G. Stephenson, and P. Hensel. 2002. A device for high precision measurement of wetland sediment elevation: II. The rod surface elevation table. Journal of Sedimentary Research. Vol. 72, No. 5. pp. 734-739.

Daniel, C. 1980. Hydrology, geology, and soils of pocosins: A comparison of natural and altered systems. In Richardson, C, ed. Pocosin Wetlands: An Integrated Analysis of Coastal Plain Freshwater Bogs in North Carolina. Stroudsburg, Pennsylvania.

DeLaune, R.D., K.R. Reddy, C.J. Richardson, and J.P. Megonigal, eds. 2013. Methods in Biogeochemistry of Wetlands. Soil Science Society of America Book Series No. 10. Madison, WI: Soil Science Society of America. 10004p

Heath, R. C. 1975. Hydrology of the Albemarle-Pamlico region of North Carolina: a preliminary report on the impact of agricultural developments. U.S. Geological Survey, Raleigh, NC, USA. USGS Water Resources Investigation 75–9.

McDonald, C, Ash, A, Kane, E. 1983. Pocosins: a changing wetland resource. U.S. Fish and Wildlife Service, Division of Biological Services, Washington D.C. FWS/OBS-83/32. 24 pp.

Nelson, D.W., and L.E. Sommers. 1982. Total carbon, organic carbon, and organic matter. p. 539–580. In A.L. Page et al. (ed.) Methods of soil Analysis. Part 2. 2nd ed. Agron. Monogr. 9. ASA and SSSA, Madison, WI.

Richardson, C, Evans, R, Carr, D. 1980. Pocosins: an ecosystem in transition. In Richardson, C, ed. Pocosin Wetlands: An Integrated Analysis of Coastal Plain Freshwater Bogs in North Carolina. Stroudsburg, Pennsylvania.

Richardson, C, McCarthy, E. 1994. Effect of land development and forest management on hydrologic response in southeastern coastal wetlands: a review. Wetlands 14:56–71.

Richardson, C. 2003. Pocosins: hydrologically isolated or integrated wetlands on the landscape? Wetlands 23: 563-576.

Sharitz, R, Gibbons, J. 1982. The ecology of southeastern shrub bogs (pocosins) and Carolina bays: a community profile. U.S. Fish and Wildlife Service, Division of Biological Services, Washington D.C. FWS/OBS-82/04. 93 pp.

Schumacher, B. A. Methods for the determination of total organic carbon (TOC) in soils and sediments. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-02/069 (NTIS PB2003-100822), 2002.

Tiner, R. 2003. Geographically isolated wetlands of the United States. Wetlands 23: 494-516.

US Geological Survey. 2012. Topographic mapping RTK GPS standard operating procedures. Unpublished protocols. USGS, Western Ecological Research Center, San Francisco Bay Estuary Field Station, Vallejo, CA.