METHODOLOGY FOR TIDAL WETLAND AND SEAGRASS RESTORATION

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Relationship to Approved or Pending Methodologies

This proposed methodology is eligible under the Wetlands Restoration and Conservation (WRC) project category. This proposed methodology includes procedures that have not been covered in other existing approved methodologies. These include:

- The determination of the soil organic carbon depletion time (SDT) (the procedure for the peat depletion time was taken from VCS methodology *Baseline and monitoring methodology for the rewetting of drained peatlands used for peat extraction, forestry or agriculture based on GESTs* (under development))
- Default factors for soil carbon sequestration in marshes and mangroves
- The distinction between allochthonous and autochthonous soil organic carbon
- Means to establish a consistent reference plane for soil organic carbon estimation
- Default factors for CH_4 emissions from wetland soils
- The estimation of CH_4 and N_2O emissions from prescribed burns of herbaceous marsh vegetation
- Accounting for sea level rise, including project boundary setting and future submergence of project areas
- Calculation of the long-term average GHG benefits for ARR activities including harvesting in the baseline

The methodology also integrates procedures from other methodologies and modules, including:

- VCS methodology *Baseline and monitoring methodology for the rewetting of drained peatlands used for peat extraction, forestry or agriculture based on GESTs* (under development)
- VCS methodology *VM0024 Methodology for Coastal Wetland Creation*
- VCS module *VMD0016 Methods for stratification of REDD and WRC project areas*
- VCS module *VMD0019 Methods to Project Future Conditions*
- CDM methodology *AR-ACM0003 Afforestation and reforestation of lands except wetlands*

This proposed methodology is one of the first of its kind under the Restoration of Wetlands Ecosystems (RWE) sub-category of the WRC project category.

Table of Contents

1 SOURCES

The following methodologies have informed the development of the methodology:

- CDM methodology *AR-ACM0003 Afforestation and reforestation of lands except wetlands*
- VCS methodology *Baseline and monitoring methodology for the rewetting of drained peatlands used for peat extraction, forestry or agriculture based on GESTs* (under development)
- VCS methodology *VM0024 Methodology for Coastal Wetland Creation*

This methodology uses the latest versions of the following modules and tools:

- CDM tool *Combined tool to identify the baseline scenario and demonstrate additionality for A/R CDM project activities*
- CDM tool *Calculation of the number of sample plots for measurements within A/R CDM project activities*
- CDM tool *Tool for testing significance of GHG emissions in A/R CDM project activities*
- CDM tool *Estimation of GHG emissions related to fossil fuel combustion in A/R CDM project activities*
- VCS module *VMD0016 Methods for stratification of REDD and WRC project areas*
- VCS module *VMD0019 Methods to Project Future Conditions*

2 SUMMARY DESCRIPTION OF THE METHODOLOGY

Additionality and Crediting Method	
Additionality	Tidal wetlands (excluding seagrass meadows) in the USA: Activity Method Tidal wetlands (seagrass meadows) in the USA: Project Method Tidal wetlands outside the USA: Project Method
Crediting Baseline	Project Method

Wetland restoration occurs sporadically in the United States of America and throughout the world to facilitate wildlife habitat creation, water quality and quantity support, storm protection and food production. An often unrealized additional benefit of such activities is greenhouse gas (GHG) emission reductions and climate change mitigation.

This methodology outlines transparent and conservative procedures to estimate net greenhouse gas emission reductions and removals resulting from project activities implemented to restore tidal wetlands. Such activities include creating and/or managing hydrological conditions, sediment supply, salinity characteristics, water quality and/or native plant communities.

Project activities are expected to generate GHG emission reductions and removals though:

- Increased biomass
- Increased autochthonous soil organic carbon
- Reduced methane and/or nitrous oxide emissions due to increased salinity or changing land use
- Reduced carbon dioxide emissions due to avoided further soil carbon loss

The geographic scope of the methodology is global and includes all tidal wetland systems, including tidal forests (such as mangroves), tidal marshes and seagrass meadows. While for the entire scope a project method is used for the baseline assessment, the methodology includes a standardized method (activity method) for the additionality assessment of tidal non-seagrass wetlands in the United States of America. For tidal wetlands outside the USA and for seagrass meadows, the additionality assessment follows a project method approach.

Procedures are provided for strata with organic soil for the estimation of the Peat Depletion Time (PDT) and the assessment of the maximum eligible quantity of GHG emission reductions from the Soil Organic Carbon (SOC) pool (ie, either on the basis of the difference between the remaining soil organic carbon stock in the with-project and baseline scenarios after 100 years (total stock approach), or the difference in cumulative carbon loss in both scenarios since the project start date (stock loss approach)).

Likewise, for mineral soils and sediments, procedures are provided for the estimation of the soil organic carbon Depletion Time (SDT) and the maximum eligible quantity of GHG emission reductions from the SOC pool.

For procedures for the estimation of carbon stock changes in tree and shrub biomass the methodology incorporates the CDM methodology *AR-ACM0003 Afforestation and reforestation of lands except wetlands* and associated tools, noting that the exclusion of project activities on wetlands in the applicability conditions of AR-ACM0003 and tools can be neglected for the purpose of their use in this methodology, as accounting procedures for the wetland soil are provided here. The methodology also provides a method for herbaceous vegetation.

GHG emissions from the SOC pool are estimated by assessing emissions of CO_2, CH_4 and N_2O, for which various alternative procedures are provided (eg, based on proxies, modeling, defaults, local published values). Where allochthonous soil organic carbon accumulates on the project site in the project scenario, a procedure is provided for a compensation factor.

Proxies for emissions from the SOC pool include water table depth and soil subsidence (procedures taken from other methodologies/modules) and carbon stock changes. For non-seagrass tidal wetland systems, a general default value may be used in the absence of data suitable for the local published value approach.

CH_4 emissions in the baseline scenario may be conservatively set to zero. If project proponents can demonstrate that N_2O emissions do not increase in the project scenario compared to the baseline scenario, N_2O emissions need not be accounted for. In all cases, N_2O emissions may be conservatively excluded in the baseline scenario.

This methodology addresses anthropogenic peat fires occurring in drained areas and establishes a conservative default value (*Fire Reduction Premium*), based on fire occurrence and extension in the project area in the baseline scenario, so as to avoid the direct assessment of GHG emissions from fire in the baseline and the with-project scenarios, based on procedures provided in the VCS module *Methods for monitoring soil carbon stock changes and GHG emissions in WRC project activities* (under development). The methodology includes procedures for GHG emissions from prescribed burning and fossil fuel use, the latter by incorporating procedures from the CDM tool *Estimation of GHG emissions related to fossil fuel combustion in A/R CDM project activities*.

The methodology includes procedures for the consideration of sea level rise in determining geographic project boundaries and the determination of the baseline scenario and the baseline GHG emissions. Activity shifting leakage and market leakage are deemed zero if project proponents can demonstrate that in case the pre-project land use is
a) forestry, this forestry is non-commercial in nature
b) extraction of raw materials other than timber (eg, peat), this activity has been abandoned at least 2 years prior to the project start date
c) agriculture, crop production has been abandoned at least 2 years prior to the project start date, or drainage or degradation of additional wetland for new agricultural sites will not occur or is prohibited by law.
Furthermore, activity shifting and marketing leakage are deemed not to occur if the pre-project land use will be continued during the project crediting period.

Under the applicability conditions of this methodology, ecological leakage does not occur, by ensuring that the effect of hydrological connectivity with adjacent areas is insignificant (ie, causing no alteration of mean annual water table depths in such areas). In tidal wetland restoration projects, dewatering of downstream wetlands is not expected.

The methodology provides for the determination of the project's net GHG benefits and the resulting Verified Carbon Units (VCUs) that are generated. The methodology details the steps necessary to come to the final calculation of the project's net GHG benefits, represented by NER_{RWE}.

$$NER_{RWE} = GHG_{BSL} – GHG_{WPS} + FRP – GHG_{LK}$$

Where:

NER_{RWE}	Total net CO_2 equivalent emission reductions from the RWE project activity
GHG_{BSL}	Net CO_2 equivalent emissions in the baseline scenario
GHG_{WPS}	Net CO_2 equivalent emissions in the with-project scenario
FRP	*Fire Reduction Premium* - Net CO_2 equivalent emission reductions from organic soil combustion due to rewetting and fire management

GHG_{LK}	Net CO_2 equivalent emissions due to leakage

3 DEFINITIONS

In addition to the definitions set out in VCS document *Program Definitions*, the following definitions apply to this methodology:

Allochthonous Soil Organic Carbon
Soil organic carbon originating outside the project boundary and being deposited in the project area

Autochthonous Soil Organic Carbon
Soil organic carbon originating or forming in the place where it is accumulated (eg, from vegetation in the project area)

Mineral Soil
Soil that does not have a surface layer of organic soil

Organic Soil
Soil with a surface layer of material that has a sufficient percentage of organic carbon to meet an internationally accepted threshold (eg, host-country, FAO or IPCC) of organic soil. When in certain parameters in this methodology 'peat' is used it refers to organic soil.

Salinity Average
The average salinity value used to represent variation in salinity during periods of peak CH_4 emissions (eg, during the growing season in temperate ecosystems)

Salinity Low Point
The minimum salinity value used to represent variation in salinity during periods of peak CH_4 emissions (eg, during the growing season in temperate ecosystems)

Seagrass Meadow
An accumulation of seagrass plants over a mappable area[1]

Tidal Wetland
The subset of wetlands under the influence of wetting and drying cycles of the tides such as salt marshes, tidal freshwater marshes, tidal swamps and mangroves[2]

Water Table Depth

[1] This definition includes both the biotic community and the geographic area where the biotic community occurs. Note that the vast majority of seagrass meadows are subtidal, but a percentage are intertidal.

[2] Subtidal seagrass meadows are not subject to drying cycles, but are still included in this definition.

Depth of sub-soil or above-soil surface of water, relative to the soil surface

4 APPLICABILITY CONDITIONS

This methodology applies to project activities that restore disturbed or degraded tidal wetlands in which reestablishment of prior ecological conditions is not expected to occur in the absence of the project activity, or mudflats or open or impounded water where wetland ecological conditions leading to net GHG emission reductions and/or removals will be established. Project activities include the following:

- Rewetting of drained wetlands
- Lowering of water levels on impounded wetlands
- Raising soil surfaces by adding sediment (eg, beneficial use of dredged material)
- Increasing sediment supply by removing dams
- Restoring salinity conditions
- Improving water quality
- Revegetation
- Combinations of the above

This methodology is applicable under the following conditions:

1. Prior to the project start date, the project area:

    a. Is free of any land use that could be displaced outside the project area because:

        i. The project area is abandoned for two or more years prior to the project start date, or

        ii. The use of the area is not profitable as a result of salinity intrusion, market forces or other factors. Harvesting in the baseline scenario within the project boundary does not occur or is non-commercial in nature (excluding subsistence harvesting); or

        iii. Degradation of additional wetlands for new agricultural sites will not occur or is prohibited by law.

    OR

    b. Is under land use that will be continued during the project crediting period (eg, harvesting of reed or hay, collection of fuelwood and subsistence harvesting);

    (a) and (b) above to be demonstrated by the project proponent based on verifiable information such as laws and bylaws, management plans, annual reports, annual accounts, market studies, government studies, or land use planning reports and documents.

2. Live tree vegetation may be present and subject to carbon stock changes (eg, due to harvesting) in both the baseline and project scenarios.

3. If the project proponent intends to claim emission reductions from reduced frequency of peat fires, the project scenario must involve a combination of rewetting and fire management.
4. If the project proponent intends to claim emission reductions from reducing peat fires, it must be demonstrated that a threat of frequent on-site fires exists and the overwhelming cause of ignition of the organic soil is anthropogenic (eg, drainage of the peat, arson).
5. Lowering of the water table is limited to project activities that convert open water to tidal wetlands or in which the lowering of the water table maintains wetland conditions and is a component of a restoration project activity as defined above.
6. In peatland strata, ARR activities must be combined with rewetting.

This methodology is not applicable under the following conditions:

7. Hydrological connectivity of the project area with adjacent areas leads to a significant increase in GHG emissions outside the project area
8. The burning of organic soil as a project activity
9. Application of nitrogen fertilizer(s), such as chemical fertilizer or manure, occurs in the project area during the project period

5 PROJECT BOUNDARY

5.1 Temporal Boundaries

5.1.1 Peat Depletion Time (PDT)

Projects that do not quantify the reduction of baseline GHG emissions (eg, by limiting the accounting to GHG removals in biomass and/or soil) do not need to estimate the PDT.

The PDT ($t_{PDT\text{-}BSL,i}$) for a stratum in the baseline scenario equals the period during which the project is eligible to claim emission reductions from rewetting and is, per stratum *i*, estimated at the project start date as:

$$t_{PDT\text{-}BSL,i} = Depth_{peat,i,t0} \,/\, Rate_{peatloss\text{-}BSL,i} \qquad \textbf{(1)}$$

Where:

$t_{PDT\text{-}BSL,i}$	PDT in the baseline scenario in stratum *i* in years elapsed since the project start date; yr
$Depth_{peat,i,t0}$	Average organic soil depth above the drainage limit in stratum *i* at the project start date; m
$Rate_{peatloss\text{-}BSL,i}$	Rate of organic soil loss due to subsidence and fire in the baseline scenario in stratum *i*; a conservative (high) value may be applied; m yr^{-1}

i 1, 2, 3 … M_{BSL} strata in the baseline scenario

Organic soil depths, depths of burn scars and subsidence rates must be derived from data sources as described in Section 9.1.

5.1.2 Soil Organic Carbon Depletion Time (SDT)

Projects that do not quantify the reduction of baseline GHG emissions (eg. by limiting the accounting to GHG removals in biomass and/or soil) through restoration do not need to estimate the SDT.

The SDT ($t_{SDT-BSL,i}$) for a stratum in the baseline scenario equals the period during which the project is eligible to claim emission reductions from restoration and is, per stratum i, estimated at the project start date as:

$$t_{SDT-BSL,i} = C_{min,i,t0} / Rate_{Closs-BSL,i} \tag{2}$$

Where:

$t_{SDT-BSL,i}$ SDT in the baseline scenario in stratum i in years elapsed since the project start date; yr

$C_{min,i,t0}$ Average organic carbon content in mineral soil in stratum i at the project start date; t C ha^{-1}

$Rate_{Closs-BSL,i}$ Rate of organic soil carbon loss due to oxidation in the baseline scenario in stratum i; a conservative (high) value may be applied; t C ha^{-1} yr^{-1}

i 1, 2, 3 … M_{BSL} strata in the baseline scenario

Project proponents may determine the depth (as $Depth_{soil,i,t0}$ in Equation 11) over which $C_{min-BSL,i}$ is determined. Note that a shallower depth will lead to a shorter, and more conservative, SDT. If SDT is not determined, no reductions of baseline emissions from mineral soil may be claimed.

A complete loss of soil organic carbon may not occur in mineral soils. Therefore, it is acceptable to calculate SDT based on a soil organic carbon loss of ≥95% of $C_{min,i,t0}$.

Extrapolation of $Rate_{Closs-BSL,i}$. over the entire project crediting period must account for the possibility of a non-linear decrease of soil organic carbon over time, including the tendency of organic carbon concentrations to approach steady-state equilibrium.

SDT is conservatively set to zero for project sites drained more than twenty years prior to the project start date. SDT is conservatively set to zero for cases where significant soil erosion occurs in the baseline. ‘Significant’ is determined as >5% of $Rate_{Closs-BSL,i}$.

The accretion of sediment in the baseline scenario for the estimation of SDT is conservatively excluded.

5.2 Geographic Boundaries

5.2.1 General

Project proponents must define the project boundary at the beginning of a proposed project activity and must provide the geographical coordinates of lands (including subtidal seagrass areas, where relevant) to be included, so as to allow clear identification. Remotely sensed data, published topographic maps and data, land administration and tenure records, and/or other official documentation that facilitates the clear delineation of the project boundary must be used.

The project activity may contain more than one discrete area of land. Each discrete area of land must have a unique geographical identification.

When describing physical project boundaries, the following information must be provided for each discrete area:

- Name of the project area (including compartment numbers, local name (if any))
- Unique identifier for each discrete parcel of land
- Map(s) of the area (preferably in digital format)
- The project boundary must be geo-referenced, and provided in digital format in accordance with VCS rules.
- Total area
- Details of land rights holder and user rights

5.2.2 Stratification

If the project area at the project start date is not homogeneous, stratification may be carried out to improve the accuracy and the precision of carbon stock and GHG flux estimates. If stratification is employed, different stratifications may be required for the baseline and project scenarios in order to achieve optimal accuracy of the estimates of net GHG emission reductions or removals.

Strata may be defined on the basis of soil type and depth (including eligibility as assessed below), water table depth, vegetation cover and/or vegetation composition, salinity, open water, channel, and unvegetated sand or mudflat, or expected changes in these.

Strata must be spatially discrete and stratum areas must be known. Areas of individual strata must sum to the total project area. Strata must be identified with spatial data (eg, maps, GIS coverage, classified imagery, or sampling grids) from which the area can be determined accurately. Land use/land cover maps in particular must be ground-truthed and less than 10 years old, unless it can be demonstrated that the maps are still accurate. Strata must be discernible taking into account good practice in terms of the accuracy requirements for the definition of strata limits / boundaries. This must be indicated in the project description and the choice must be justified.

The project area may be stratified *ex ante*, and this stratification may be revised *ex post* for monitoring purposes. Established strata may be merged if reasons for their establishment have disappeared or have proven irrelevant to key variables for estimating net GHG emission reductions or removals.
Baseline stratification must remain fixed until a reassessment of the baseline scenario occurs.

Stratification in the project scenario must be updated at each monitoring event prior to verification.

<u>Areas with organic soil</u>
Procedures for the stratification of areas with organic soil are provided in VCS module *VMD0016 Methods for Stratification of REDD and WRC Project Areas* (under development).

<u>Seagrass Meadows</u>
Given the tendency of seagrasses to respond differently under different light and depth regimes, projects may differentiate between seagrass meadow sections that occur at different depths given discrete - or relatively abrupt - bathymetric and substrate changes.

For seagrass meadow restoration projects in areas with existing seagrass meadows, project proponents must quantify the percentage of natural meadow expansion that can be attributed to the restoration effort. Existing meadows (unless smaller in area than 5% of the total project area) are not eligible for inclusion in calculations of project emissions, even in cases where the restored meadow enhances carbon sequestration rates in existing meadows.

New beds that result from natural expansion must be contiguous with restored meadow plots to be included in project accounting unless project proponents can demonstrate that non-contiguous meadow patches originated from restored meadow seeds. This may be done through genetic testing or estimated as a percentage of new meadow in non-contiguous plots observed no less than four years after the project start date.[3] This percentage must not exceed the proportion of restored meadow area relative to the total seagrass meadow areal extent and project proponents must demonstrate the feasibility of current-borne seed dispersal from the restored meadow. In cases where a restored meadow coalesces with an existing meadow(s), project proponents must delineate the line at which the two meadows joined. Project proponents may use either aerial observations showing meadow extent or direct field observations.

<u>Areas with carbon sequestration in biomass</u>
For claims to carbon sequestration in biomass to be eligible, evidence must be provided in the project description that the project area was not cleared of native ecosystems to create GHG credits. Such proof is not required where such clearing took place prior to the 10-year period prior to the project start date. Areas that do not meet this requirement must be excluded from the project boundary.

<u>Stratification of vegetation cover for adoption of the default SOC accumulation rate</u>

[3] McGlathery *et al.* (2012)

The default factor for SOC accumulation rate (see Sections 8.1.4.2.3 and 8.2.4.2.1) may only be applied to non-seagrass tidal wetland systems with a crown cover of at least 50%. Areas below this threshold must be marked and excluded from the application of the default SOC accumulation rate. For the baseline scenario, crown covers must be based on time series of vegetation composition. For the project scenario, crown cover mapping must be performed according to established methods in scientific literature.

Stratification of salinity for the accounting of CH_4

Tidal wetlands may be stratified according to salinity with relevance for CH_4 emissions. Threshold values of salinity for mapping salinity strata are provided in Section 8.1.4.3.4.

Areas with unrestricted tidal exchange will maintain salinity levels similar to the tidal water source, while those with infrequent tidal flooding will not, in which case use of channel water salinity is not reliable. For such areas it is, therefore, recommended to stratify according to the frequency of tidal exchange.

Procedures for the measurement of salinity are provided in Section 9.3.8.

Stratification of water bodies lacking tidal exchange

The area of ponds, ditches or similar bodies of water within the project area must be quantified and treated as separate strata when they do not have surface tidal water exchange. CH_4 emissions from these features may be excluded from GHG accounting if the area of these features does not increase in the project scenario.

5.2.3 Sea Level Rise

In the determination of geographical project boundaries and strata, project proponents must consider expected relative sea level rise and the potential for expanding the project area landward to account for wetland migration, inundation and erosion.

For both the baseline and project scenarios, the project proponent must provide a projection of relative sea level rise within the project area based on IPCC regional forecasts or peer-reviewed literature applicable to the region. In addition, the project proponent may also utilize expert judgment[4]. Global average sea level rise scenarios are not suitable for determining changes in wetlands boundaries. Therefore, if used, IPCC most-likely global sea level rise scenarios must be appropriately downscaled to regional conditions including vertical land movements, such as subsidence.

Whether degraded in a baseline scenario or restored in a project scenario, the assessment of potential wetland migration, inundation, and erosion with projected sea level rise must account for topographical slope, land use and management, sediment supply and tidal range. The assessment may use literature relevant to the project area, expert judgment, or both.

[4] Requirements for expert judgment are provided in Section 9.3.3.

The potential for tidal wetlands to migrate horizontally must consider the topography of the adjacent land and any migration barriers that may exist. In general, and on coastlines were wetland migration is unimpaired by infrastructure, concave-up slopes may cause ‘coastal squeeze’, while straight or convex-up gradients are more likely to provide the space required for lateral movement.

The potential for tidal wetlands to rise vertically with sea level rise is sensitive to suspended sediment loads in the system. A sediment load of >300 mg per liter has been found to balance high-end IPCC scenarios for sea level rise (Orr *et al*. 2003, Stralsburg *et al*. 2011); French (2006) and Morris et al. (2012) indicate that at 250 mg per liter a sea level rise of 15 mm is balanced at a tidal range of 1 m. Therefore, for marshes with a tidal range greater than 1 meter, project proponents may use >300 mg per liter as a sediment load threshold above which wetlands are not predicted to be submerged. The project proponent may use lower threshold values for tidal range and sediment load if justified. The vulnerability of tidal wetlands to sea level rise and conversion to open water is also related to tidal range. In general, the most vulnerable tidal wetlands are those in areas with a small tidal range, those with elevations low in the tidal frame, and those in locations with low suspended sediment loads.

Irrespective of sediment availability and wetland vertical response to sea level rise the lateral migration of the project with sea level rise should be determined.

Alternatively, in the project scenario the project proponent may conservatively assume that part of the wetland within the project area erodes, and does not migrate. In the baseline scenario, the project proponent may conservatively assume that part of the project area drowns, with reduced emissions as a consequence.

The projection of wetland boundaries within the project area must be presented in maps delineating these boundaries from the project start date until the end of the project crediting period with intervals appropriate to the rate of change due to sea level rise, and at t = 100.

Procedures for the accounting of project areas submerged due to relative sea level rise during the project crediting period are provided in Section 8.2.2.

5.2.4 Wetland Areas Ineligible for Carbon Crediting

For projects quantifying CO_2 emission reductions, areas within the project boundary which do not achieve a significant difference (≥ 5%) in cumulative carbon loss over a period of 100 years beyond the project start date are not eligible for carbon crediting based on the reduction of baseline emissions, and these areas must be mapped.

The maximum eligible quantity of GHG emission reductions from soil is limited to the difference between the remaining soil organic carbon stock in the project and baseline scenarios after 100 years (total stock approach), or the difference in cumulative soil organic carbon loss in both scenarios over a period of 100 years since the project start date (stock loss approach). The assessment must be executed *ex ante* using conservative parameters.

1. Total stock approach

The difference between soil organic carbon stock in the project scenario and baseline scenario at t = 100 is estimated as:

$$C_{WPS-BSL,t100} = \sum_{i=1}^{M_{WPS}} \left(C_{WPS,i,t100} \times A_{WPS,i}\right) - \sum_{i=1}^{M_{BSL}} \left(C_{BSL,i,t100} \times A_{BSL,i}\right) \quad \textbf{(3)}$$

$C_{WPS,i,t100}$ needs no adjustments since under the applicability conditions leakage emissions are absent, as outlined in Section 8.3.

The difference between organic carbon stock in the project scenario and baseline scenario at t = 100 ($C_{WPS-BSL,t100}$) is significant if:

$$\sum_{i=1}^{M_{WPS}} \left(C_{WPS,i,t100} \times A_{WPS,i}\right) \geq 1.05 \times \sum_{i=1}^{M_{BSL}} \left(C_{BSL,i,t100} \times A_{BSL,i}\right) \quad \textbf{(4)}$$

For organic soil:

$$C_{WPS,i,t100} = Depth_{peat-WPS,i,t100} \times VC \times 10 \quad \textbf{(5)}$$

$$C_{BSL,i,t100} = Depth_{peat-BSL,i,t100} \times VC \times 10 \quad \textbf{(6)}$$

$$Depth_{peat-BSL,i,t100} = Depth_{peat,i,t0} - \sum_{t=1}^{t=100} Rate_{peatloss-BSL,i,t} \quad \textbf{(7)}$$

$$Depth_{peat-WPS,i,t100} = Depth_{peat,i,t0} - \sum_{t=1}^{t=100} Rate_{peatloss-WPS,i,t} \quad \textbf{(8)}$$

For mineral soil:

$$C_{BSL,i,t100} = C_{i,t0} - \sum_{t=1}^{t=100} Rate_{Closs-BSL,i,t} \quad \textbf{(9)}$$

$$C_{WPS,i,t100} = C_{i,t0} - \sum_{t=1}^{t=100} Rate_{Closs-WPS,i,t} \quad \textbf{(10)}$$

$$C_{i,t0} = Depth_{soil,i,t0} \times C_{min-t0,i} \times 10 \quad \textbf{(11)}$$

If a conservative constant rate of subsidence or carbon loss is applied, a possible negative outcome must be substituted by zero.

The carbon content of organic or mineral soil may be taken from measurements within the project area or from literature involving the project or similar areas.

2. Stock loss approach

The assessment may also be based on cumulative soil organic carbon loss up to t = 100 as follows:

$$C_{WPS-BSL,t100} = \sum_{i=1}^{M_{BSL}} \left(C_{loss-BSL,i,t100} \times A_{BSL,i}\right) - \sum_{i=1}^{M_{WPS}} \left(C_{loss-WPS,i,t100} \times A_{WPS,i}\right) \quad \textbf{(12)}$$

For organic soil:

$$C_{loss-BSL,i,t100} = 10 \times \sum_{t=1}^{100} \left(Rate_{peatloss-BSL,i,t} \times VC\right) \quad \textbf{(13)}$$

$$C_{loss-WPS,i,t100} = 10 \times \sum_{t=1}^{100} \left(Rate_{peatloss-WPS,i,t} \times VC\right) \quad \textbf{(14)}$$

For mineral soil:

$$C_{loss-BSL,i,t100} = 10 \times \sum_{t=1}^{100} \left(Rate_{Closs-BSL,i,t} \times VC\right) \quad \textbf{(15)}$$

$$C_{loss-WPS,i,t100} = 10 \times \sum_{t=1}^{100} \left(Rate_{Closs-WPS,i,t} \times VC\right) \quad \textbf{(16)}$$

Where:

$C_{WPS-BSL,i,t100}$	Difference between soil organic carbon stock in the project scenario and baseline scenario in subsidence stratum i at t = 100; t C ha^{-1}
$C_{WPS,i,t100}$	Soil organic carbon stock in the project scenario in stratum i at t = 100 ; t C ha^{-1}
$C_{BSL,i,t100}$	Soil organic carbon stock in the baseline scenario in stratum i at t = 100; t C ha^{-1}
$A_{WPS,i}$	Area of project stratum i; ha
$A_{BSL,i}$	Area of baseline stratum i; ha
$Depth_{peat-WPS,i,t100}$	Average organic soil depth in the with project scenario in stratum i at t = 100; m
$Depth_{peat-BSL,i,t100}$	Average orgaic soil depth in the baseline scenario in stratum i at t = 100; m
VC	Volumetric organic carbon content in organic or mineral soil; kg C m^{-3}
$Depth_{peat,i,t0}$	Average organic soil depth in stratum i at the project start date; m
$Rate_{peatloss-BSL,i,t}$	Rate of organic soil loss due to subsidence and fire in the baseline scenario in stratum i in year t; alternatively, a conservative (low) value may be applied that remains

	constant over time; m yr^{-1}
$Rate_{peatloss,WPS,i,t}$	Rate of organic soil loss due to subsidence in the project scenario in stratum *i* in year *t*; alternatively, a conservative (high) value may be applied that remains constant over time; m yr^{-1}
$C_{i,t0}$	Soil organic carbon stock in mineral soil in stratum *i* at the project start date; t C ha^{-1}
$Rate_{Closs\text{-}BSL,i,t}$	Rate of organic carbon loss in mineral soil due to oxidation in the baseline scenario in stratum *i* in year *t*; alternatively, a conservative (low) value may be applied that remains constant over time; t C ha^{-1} yr^{-1}
$Rate_{Closs,WPS,i,t}$	Rate of organic carbon loss in mineral soil due to oxidation in the project scenario in stratum *i* in year *t*; this value is conservatively set to zero as loss rates are likely to be negative; t C ha^{-1} yr^{-1}
$Depth_{soil,i,t0}$	Mineral soil depth in stratum *i* at the project start date (as in Equation 1); m
$C_{min,i,t0}$	Soil organic carbon content in mineral soil in stratum *i* at the project start date; t C m^{-3}
$C_{loss\text{-}BSL,i,t100}$	Cumulative soil organic carbon loss in the baseline scenario in stratum *i* at *t* = 100; t C ha^{-1}
$C_{loss\text{-}WPS,i,t100}$	Cumulative soil organic carbon loss in the project scenario in stratum *i* at *t* = 100; t C ha^{-1}
i	1, 2, 3 …M_{BSL} strata in the baseline scenario
t_{100}	100 years after the project start date

5.2.5 Buffer Zones

If employed, a buffer zone must be mapped in accordance with the VCS requirements.

5.3 Carbon Pools

The carbon pools that are included and excluded from the project boundary are shown in Table 5.1.

Carbon pools may be deemed *de minimis* and do not need to be accounted for if together the omitted decrease in carbon stocks or increase in GHG emissions (Table 5.2) amounts to less than 5% of the total GHG benefit generated by the project. Peer reviewed literature or the CDM tool *Tool for testing significance of GHG emissions in A/R CDM project activities* may be used to determine whether decreases in carbon pools are *de minimis*.

Table 5.1 Selection and justification of carbon pools

Carbon Pool	Included	Justification/Explanation
Above-ground tree biomass	Included	• Major carbon pool may significantly increase in the baseline, or decrease in the project, or both, in case of establishment

		or presence of tree vegetation. • Tree vegetation in the baseline scenario must be included. • Tree vegetation in the project scenario may be included or conservatively omitted.
Above-ground non-tree biomass	Included	Carbon stock in this pool may increase in the baseline scenario and may increase or decrease due to the implementation of the project activity.
Below-ground biomass	Included	• Major carbon pool may significantly increase in the baseline, or decrease in the project, or both, in case of presence of tree vegetation. • Tree vegetation in the baseline scenario must be included. • Tree vegetation in the project scenario may be included or conservatively omitted.
Litter	Included	This pool is optional for WRC methodologies. Litter is only included in association with the quantification of herbal mass.
Dead wood	Excluded	This pool is optional for WRC methodologies.
Soil	Included	The soil organic carbon stock may increase due to the implementation of the project activity.
Wood products	Excluded	This pool is optional for WRC methodologies.

5.4 Sources of Greenhouse Gases

The emissions sources included in or excluded from the project boundary are shown in Table 5.2.

GHG sources may be deemed *de minimis* and do not have to be accounted for if together the omitted decrease in carbon stocks (Table 5.1) or increase in GHG emissions amounts to less than 5% of the total GHG benefit generated by the project. Peer-reviewed literature or the CDM tool *Tool for testing significance of GHG emissions in A/R CDM project activities* may be used to determine whether increases in GHG emissions are *de minimis*.

Table 5.2 Greenhouse gases considered

Source		Gas	Included?	Justification/Explanation
Baseline	The production of methane by bacteria	CH_4	Included	May be conservatively excluded in the baseline scenario.
	Denitrification/nitrification	N_2O	Included	May be conservatively excluded in the baseline scenario.
	Burning of biomass and organic soil	CO_2	Excluded	Conservatively excluded in the baseline scenario.

Source		Gas	Included?	Justification/Explanation
		CH_4	Excluded	Conservatively excluded in the baseline scenario.
		N_2O	Excluded	Conservatively excluded in the baseline scenario.
	Fossil fuel use	CO_2	Included	May be conservatively excluded in the baseline scenario.
		CH_4	Excluded	Conservatively excluded in the baseline scenario.
		N_2O	Excluded	Conservatively excluded in the baseline scenario.
Project	The production of methane by bacteria	CH_4	Included	Potential major source of emissions in the project in low salinity and freshwater areas. Default deduction may be applied where annual salinity low point exceeds 18 ppt.
	Denitrification/nitrification	N_2O	Included	May increase as a result of the project activity. May conditionally be excluded.
	Burning of biomass	CO_2	Excluded	CO_2 is covered in carbon stock change procedures.
		CH_4	Included	Potential major source of fire emissions.
		N_2O	Included	Potential major source of fire emissions.
	Fossil fuel use	CO_2	Included	Potential major source of emissions in project fuel use.
		CH_4	Excluded	Not a significant source of emissions in project fuel use.
		N_2O	Excluded	Not a significant source of emissions in project fuel use.

6 PROCEDURE FOR DETERMINING THE BASELINE SCENARIO

6.1 Determination of the Most-Likely Baseline Scenario

At the project start date, the baseline scenario must consist of landscapes and waterscapes that are eligible for restoration to tidal wetlands within the scope of this methodology. Continuations of pre-project land uses in various alternative baseline scenarios must be determined using the latest version of the

CDM *Combined tool to identify the baseline scenario and demonstrate additionality for A/R CDM project activities*. The tool has been designed for CDM A/R project activities, but must be used for the purpose of this methodology, noting the following:

Where the tool refers to:	It must be understood as referring to:
A/R, afforestation, reforestation, or forestation	WRC, or rewetting
Net greenhouse gas removals by sinks	Net greenhouse gas emission reductions
CDM	VCS
DOE	VVB
tCERs, lCERs	VCUs

Sub-step 2b – 15 regarding forested areas since 31 December 1989 must be omitted. Footnotes 1-3 may also be omitted[5].

6.2 Reassessment of the Baseline Scenario

In accordance with VCS rules, the project proponent shall, for the duration of the project, reassess the baseline scenario every 10 years. This reassessment must use the procedure in Section 6.1 and capture changes in the drivers and/or behavior of agents that cause the change in land use and/or land management practices and changes in carbon stocks. *Ex-ante* baseline projections beyond a 10-year period are not required.

For this assessment the historic reference period is extended to include the original reference period and all subsequent monitoring periods up to the beginning of the current monitoring period. The fire reference period must not be extended, as this is a fixed 10-year period ending 5 years before the project start date. The project proponent shall, for the duration of the project, re-determine, if applicable, the PDT every 10 years. This re-assessment must use the procedure provided in Section 5.1. Data sources must be updated if new information relevant to the project area has become available.

7 PROCEDURE FOR DEMONSTRATING ADDITIONALITY

This methodology uses an activity method for the demonstration of additionality for tidal wetlands (excluding seagrass meadows[6]) in the USA.

Step 1: Regulatory Surplus

Project proponents must demonstrate regulatory surplus in accordance with the rules and requirements regarding regulatory surplus set out in the latest version of the *VCS Standard*.

[5] Sub-step and footnotes as in version 01 of the tool.

[6] As defined in Chapter 3.

Step 2: Positive List

The applicability conditions of this methodology represent the positive list. The project must demonstrate that it meets all of the applicability conditions, and in so doing, it is deemed as complying with the positive list. The positive list was established using the activity penetration option (Option A in the *VCS Standard*).

Tidal wetland restoration projects meeting the applicability conditions of this methodology and the following eligibility criteria are additional:

1. The project activity meets the requirements for regulatory surplus set out in the latest version of the *VCS Standard*.
2. The project activity occurs within the 35 coastal states, commonwealths and territories of the United States of America.

This methodology uses a project method for the demonstration of additionality for seagrass meadows in the USA and all tidal wetlands outside the USA.

Seagrass restoration projects and projects which do not meet the additional activity method conditions above, but which are otherwise eligible to apply this methodology, shall use the latest version of the CDM *Combined tool to identify the baseline scenario and demonstrate additionality for A/R CDM project activities*, taking into account the additional guidance provided in Section 6.1.

8 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

8.1 Baseline Emissions

8.1.1 General Approach

Emissions in the baseline scenario are attributed to carbon stock changes in biomass carbon pools, GHG emissions as a result of soil processes, or a combination of these, and, where relevant, the use of fossil fuel.

Biomass burning, firewood collection or hay or reed harvesting may occur in the baseline scenario.

Emissions in the baseline scenario are estimated as:

$$GHG_{BSL} = GHG_{BSL\text{-}biomass} + GHG_{BSL\text{-}soil} + GHG_{BSL\text{-}fuel} \tag{17}$$

$$GHG_{BSL\text{-}biomass} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_{BSL}} \left(\frac{44}{12} \times DC_{BSL\text{-}biomass,i,t} \right) \tag{18}$$

$$GHG_{BSL\text{-}soil} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_{BSL}} \left(\frac{44}{12} \times DC_{BSL\text{-}soil,i,t} \right) \tag{19}$$

$$GHG_{BSL\text{-}fuel} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_{BSL}} \left(\frac{44}{12} \times \Delta C_{BSL\text{-}fuel,i,t} \right) \quad \textbf{(20)}$$

Where:

GHG_{BSL}	Net CO_2 equivalent emissions in the baseline scenario up to year t^*; t CO_2e
$GHG_{BSL\text{-}biomass}$	Net CO_2 equivalent emissions from biomass carbon pools in the baseline scenario up to year t^*; t CO_2e
$GHG_{BSL\text{-}soil}$	Net CO_2 equivalent emissions from the SOC pool in the baseline scenario up to year t^*; t CO_2e
$GHG_{BSL\text{-}fuel}$	Net CO_2 equivalent emissions from fossil fuel use in the baseline scenario up to year t^*; t CO_2e
$\Delta C_{BSL\text{-}biomass,i,t}$	Net carbon stock changes in biomass carbon pools in the baseline scenario in stratum i in year t; t C yr^{-1}
$GHG_{BSL\text{-}soil,i,t}$	GHG emissions from the SOC pool in the baseline scenario in stratum i in year t; t CO_2e yr^{-1}
$GHG_{BSL\text{-}fuel,i,t}$	GHG emissions from fossil fuel use the baseline scenario in stratum i in year t; t CO_2e yr^{-1}
i	1, 2, 3 …M_{BSL} strata in the baseline scenario
t	1, 2, 3, … t^* years elapsed since the project start date

Under this methodology, estimation of GHG emissions or removals related to the biomass pool is based on carbon stock changes. Estimation of GHG emissions or removals from the SOC pool is based on either various proxies (eg, carbon stock change, water table depth) or through the use of literature, data, default factors and models.

Assessing GHG emissions in the baseline scenario consists of 3 steps:

1. Determine GHG emission proxies and assess their pre-project spatial distribution.
2. For the given baseline scenario, derive time series of GHG emissions from soils for each stratum for the entire project crediting period.
3. Determine annual GHG emissions per stratum for the entire project crediting period.

To project the future GHG emissions from soil per unit area in each stratum for each projected verification date within the project crediting period under the baseline scenario, use the latest version of the VCS module *VMD0019 Methods to Project Future Conditions*. When applying Steps 13 and 14 of this module, project proponents must use the guidance for sea level rise provided in Section 5.2 of this methodology.

Four driving factors are likely to be relevant for proper GHG accounting for the baseline. Each factor affects the evolution of the site over a 100 year period.

- Initial land use and development patterns.
- Initial infrastructure that impedes natural tidal hydrology.
- Natural plant succession for the physiographic region of the project.
- Climate variables are likely to be drivers of changes in tidal hydrology within the 100 year timeframe of the project, influencing sea level rise, precipitation and associated freshwater delivery.

Land Use and Development Patterns - To derive trends in land use, assumptions about the likelihood of future development of the project area must be documented and considered in light of current zoning, regulatory constraints to development, proximity to urban areas or transportation infrastructure, and expected population growth, including how land would develop within and surrounding the project site and how such changes would change hydrologic conditions within the project boundary. Current development patterns and plausible future land use changes must be mapped to a scale sufficient to estimate GHG emissions from the baseline scenario. In case of abandonment of pre-project land use in the baseline scenario, the project must consider non-human induced hydrologic changes brought about by collapsing dikes or ditches that would have naturally closed over time, and progressive subsidence, leading to rising relative water levels, increasingly thinner aerobic layers and reduced CO_2 emission rates.

Tidal Hydrology - To derive trends in tidal wetlands evolution, the baseline scenario must take into account the current and historic layout of any tidal barriers and drainage systems. The tidal barriers and drainage layout at the start of the project activity must be mapped at scale: 1:10,000 or any other scale justified for estimating water table depths throughout the project area. Historic tidal barriers and drainage layout must be mapped using topographic and/or hydrological maps from (if available) the start of the major hydrological impacts but covering at least the 20 years prior to the start of the project activity. Historic drainage structures (collapsed ditches) may (still) have higher hydraulic conductivity than the surrounding areas and function as preferential flow paths. Historic tidal barriers (agricultural dikes and levees) may constrain the tidal prism and prevent natural sedimentation patterns. The effect of historic tidal barriers and drainage structures on current hydrological functioning of the project area must be assessed on the basis of quantitative hydrological modeling and/or expert judgment.

Historic information on the pre-existing channel network as determined by aerial photography may serve to set trends in post-project dendritic channel formation in the field. Derivation of such trends must be done on the basis of hydrologic modeling using the total tidal volume, soil erodibility, expert judgment. With respect to hydrological functioning, the baseline scenario must be restricted by climate variables and quantify any impacts on the hydrological functioning as caused by planned measures outside the project area (such as dam construction or further changes in hydrology such as culverts), by demonstrating a hydrological connection to the planned measures.

Natural Plant Succession - Based on the assessment of changes in water table depth, time series of vegetation composition must be derived (*ex ante*), based on vegetation succession schemes in the baseline scenario from scientific literature or expert judgment. For example, diked agricultural land will undergo natural plant succession to forests, freshwater wetlands, tidal wetlands, rank uplands, or open water based on the scenario's land use trajectory, inundation scenario, proximity to native or invasive seed sources, plant succession trajectories of adjacent natural areas, or likely maintenance consistent with projected future continued human land use (eg, pasture, lawn, landscaping).

Climate Variables – Consistent with sea level rise guidance provided in the boundary determination (Section 5.2), areas of inundation and erosion within the project area must be considered in relation to the above variables. Expected changes in freshwater delivery associated with changes in rainfall patterns must be considered, including expected human responses to these changes.

The project proponent shall, for the duration of the project crediting period, reassess the baseline scenario every 10 years. Based on the reassessment defined in Chapter 6, the new baseline scenario must be incorporated into revised estimates of baseline emissions. This baseline reassessment must include the evaluation of the validity of proxies for GHG emissions.

8.1.2 Accounting for Sea Level Rise

The consequences of submergence of a given stratum due to sea level rise are:

1) Carbon stocks from aboveground biomass are lost to oxidation, and
2) Depending upon geomorphic setting, soil carbon stocks may be held intact or be eroded and transported beyond the project boundary.

Re 1. If biomass is submerged, it is assumed that this carbon is immediately and entirely returned to the atmosphere. For such strata:

$$\Delta C_{BSL\text{-}biomass,i,t} = 44/12 \times (C_{BSL\text{-}biomass,i,t} - C_{BSL\text{-}biomass,i,(t\text{-}T)}) / T \qquad \textbf{(21)}$$

For the year of submergence:

$$C_{BSL\text{-}biomass,i,t} = 0$$

Where:

$\Delta C_{BSL\text{-}biomass,i,t}$	Net carbon stock changes in biomass carbon pools in the baseline scenario in stratum *i* in year *t*; t C yr^{-1}
$C_{BSL\text{-}biomass,i,t}$	Carbon stock in biomass in the baseline scenario in stratum *i* in year *t* (from $C_{TREE\_BSL,t}$ in AR-ACM0003 multiplied with 12/44); t C ha^{-1}
i	1, 2, 3 …M_{WPS} strata in the baseline scenario
t	1, 2, 3, … *t** years elapsed since the project start date
T	Time elapsed between two successive estimations (T=$t_2 - t_1$)

The gradual loss of vegetation in a project area due to submergence can be captured by detailed stratification into areas with and areas without vegetation.

If conversion to open water is expected before the end of the project crediting period, the long-term average carbon stock must be determined by averaging the stock over the length of the project crediting period. This long-term average is the maximum for $\Delta C_{BSL\text{-}biomass}$ that may be used for the calculation of the net CO_2 equivalent emissions in the project scenario up to the moment of verification, and is calculated as follows:

$$\Delta C_{AVG\text{-}BSL\text{-}biomass,i} = \sum_{t=1}^{cp} \left(\Delta C_{BSL\text{-}biomass,i,t} \right) / \, cp \qquad \textbf{(22)}$$

Where:

$\Delta C_{AVG\text{-}BSL\text{-}biomass,i}$ Long-term average change in carbon stock in biomass carbon pools in the baseline scenario in stratum i in the crediting period cp; t CO_2-e

$\Delta C_{BSL\text{-}biomass,i,t}$ Net carbon stock changes in biomass carbon pools in the baseline scenario in stratum i in year t; t C yr^{-1}

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

cp Total number of years in the crediting period

Examples of how to calculate the long-term average carbon stock are provided in VCS AFOLU *Guidance Example for Calculating the Long-Term Average Carbon Stock for ARR Projects with Harvesting*.

Re 2. The project may apply models (see Section 8.1.4.2) to assess time and rate of drowning of the project area.
For areas that drown out while the area of ponds increases, the loss of SOC can be assumed to be insignificant. It is assumed that, upon submergence, soil carbon is not returned to the atmosphere unless site-specific scientific justification is provided.
In areas with wave action, sediment will erode and carbon will be removed. Assuming that all carbon is re-sedimented and stored (and not oxidized) is conservative. Project proponents may justify a greater oxidation rate for the baseline scenario based on appropriate scientific research.

Restoration projects may be designed in such a way that they have advantages over the baseline scenario in one or more of the following ways, as is to be quantified and justified in the PD:

- The point in time when submergence and erosion sets off
- The amount of carbon that erodes upon submergence
- The oxidation rate of eroded soil organic matter. In the most conservative approach, the oxidation constant is 0 for the baseline and 1 for the project scenario.

8.1.3 Baseline Net Carbon Stock Change in Biomass Carbon Pools ($\Delta C_{BSL\text{-}biomass,i,t}$)

Baseline net carbon stock change in biomass carbon pools are estimated as:

$$\Delta C_{BSL\text{-}biomass,i,t} = \Delta C_{BSL\text{-}tree/shrub,i,t} + \Delta C_{BSL\text{-}herb,i,t} \qquad \textbf{(23)}$$

Where:

$\Delta C_{BSL\text{-}biomass,i,t}$	Net carbon stock changes in biomass carbon pools in the baseline scenario in stratum *i* in year *t*; t C yr^{-1}
$\Delta C_{BSL\text{-}tree/shrub,i,t}$	Net carbon stock changes in tree and shrub carbon pools in the baseline scenario in stratum *i* in year *t*; t C yr^{-1}
$\Delta C_{BSL\text{-}herb,i,t}$	Net carbon stock changes in herb carbon pools in the baseline scenario in stratum *i* in year *t*; t C yr^{-1}
i	1, 2, 3 …M_{BSL} strata in the baseline scenario
t	1, 2, 3, … *t** years elapsed since the project start date

The baseline net carbon stock change in trees and shrubs are estimated using CDM methodology *AR-ACM0003 Afforestation and reforestation of lands except wetlands*, noting that:

1) The exclusion of project activities on wetlands in the applicability conditions of AR-ACM0003 and associated tools must be neglected, and
2) The following equation applies:

$$\Delta C_{BSL\text{-}tree/shrub,i,t} = 12/44 \times (\Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t}) \tag{24}$$

Where:

$\Delta C_{BSL\text{-}tree/shrub,i,t}$	Net carbon stock changes in tree and shrub carbon pools in the baseline scenario in stratum *i* in year *t*; t C yr^{-1}
$\Delta C_{TREE\_BSL,t}$	Change in carbon stock in baseline tree biomass within the project boundary in year *t*; t CO_2-e (in ACM0003; calculations are done for each stratum *i*)
$\Delta C_{SHRUB\_BSL,t}$	Change in carbon stock in baseline shrub biomass within the project boundary in year *t*; t CO_2-e (in ACM0003; calculations are done for each stratum *i*)

For strata where reforestation or revegetation activities in the project scenario include harvesting, the long-term average of $C_{TREE\_BSL,t}$ in AR-ACDM0003 must be calculated as follows, which will be used for the calculation of the long-term GHG benefit in Section 8.4.1:

$$C_{AVG\text{-}TREE\_BSL} = \frac{\sum_{t=1}^{n} C_{TREE\_BSL,t}}{n} \tag{25}$$

Where:

$C_{AVG\text{-}TREE\_BSL}$	Long-term average carbon stock in baseline tree biomass within the project boundary in time period *n*; t CO_2-e

$C_{TREE\_BSL,t}$	Carbon stock in baseline tree biomass within the project boundary in year t; t CO_2-e
t	1, 2, 3 … n years elapsed since the project start date
n	Total number of years in the established time period (see Section 8.4.1)

The baseline net carbon stock change in herbaceous vegetation biomass is estimated using a carbon stock change approach as follows:

$$\Delta C_{BSL\text{-}herb,i,t} = (C_{BSL\text{-}herb,i,t} - C_{BSL\text{-}herb,i,,(t\text{-}T)}) / T \quad \textbf{(26)}$$

Where:

$\Delta C_{BSL\text{-}herb,i,t}$	Net carbon stock changes in herb carbon pools in the baseline scenario in stratum i in year t; t C yr^{-1}
$C_{BSL\text{-}herb,i,t}$	Carbon stock in herbaceous vegetation in the baseline scenario in stratum i in year t; t C ha^{-1}
i	1, 2, 3 …M_{BSL} strata in the baseline scenario
t	1, 2, 3 … t^* years elapsed since the project start date
T	Time elapsed between two successive estimations ($T=t_2 - t_1$)

A default factor[7] for $C_{BSL\text{-}herb,i,t}$ of 3 t C ha^{-1} may be applied for strata with 100% herbaceous cover and applying a 1:1 relationship between vegetation cover and $C_{BSL\text{-}herb,i,t}$ for areas with a vegetation cover <100%. The default may be claimed for one year only during the project crediting period as herbaceous biomass quickly reaches steady state. Vegetation cover must be determined by commonly used techniques in field biology.

Procedures for measuring carbon stocks in herbaceous vegetation are provided in Section 9.3.6.

If the carbon stock change in herbaceous vegetation is included in the project scenario then it must also be included in the baseline scenario.

[7] Calculated from summary of peak aboveground biomass data from 20 sites summarized in Mitsch & Gosselink. The median of these studies is 1.3 t d.m. ha^{-1}. This was converted to the recommended value as follows: 1.3 × 0.45 × 0.5 × 10. The factor 0.45 converts organic matter mass to carbon mass; the factor 0.5 is a factor that averages annual peak biomass (factor = 1) and annual minimum biomass (factor = 0, assuming ephemeral aboveground biomass and complete litter decomposition).

8.1.4 Baseline Net GHG Emissions from Soil ($GHG_{BSL-soil,i,t}$)

8.1.4.1 General

The net GHG emissions from soil in the baseline scenario are estimated as:

$$GHG_{BSL-soil,i,t} = A_{i,t} \times (GHG_{BSL-soil-CO2,i,t} - Deduction_{alloch} + GHG_{BSL-soil-CH4,i,t} + GHG_{BSL-soil-N2O,i,t}) \quad \textbf{(27)}$$

For organic soils, for $t > t_{PDT-BSL,i}$:

$GHG_{BSL-soil,i,t} = 0$

For mineral soils, for $t > t_{SDT-BSL,i}$:

$GHG_{BSL-soil,i,t} = 0$

Where:

$GHG_{BSL-soil,i,t}$	GHG emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e yr^{-1}
$GHG_{BSL-soil-CO2,i,t}$	CO_2 emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$Deduction_{alloch}$	Deduction from CO_2 emissions from the SOC pool to account for the percentage of the carbon stock that is derived from allochthonous soil organic carbon; t CO_2e ha^{-1} yr^{-1}
$GHG_{BSL-soil-CH4,i,t}$	CH_4 emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$GHG_{BSL-soil-N2O,i,t}$	N_2O emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$A_{i,t}$	Area of stratum *i* in year *t*; ha
$t_{PDT-BSL,i}$	Peat Depletion Time in the baseline scenario in stratum *i* in years elapsed since the project start date; yr
$t_{SDT-BSL,i}$	Soil organic carbon Depletion Time in the baseline scenario in stratum *i* in years elapsed since the project start date; yr
i	1, 2, 3 …M_{BSL} strata in the baseline scenario
t	1, 2, 3, … *t** years elapsed since the project start date

<u>Use of proxies</u>

The project may use proxies (as defined in the *VCS Standard*) to derive values of GHG emissions. Project proponents must justify that these proxies are strongly correlated with the value of interest and have been developed and tested for use in systems that are in the same or similar region as the project area, share similar geomorphic, hydrologic, and biological properties, and are under similar management regimes, unless any differences should not have a substantial effect on GHG emissions.

Use of models

The project may apply deterministic models (models as defined in and meeting the requirements for models in the *VCS Standard*) to derive values of GHG emissions. Modeled GHG emissions and removals must have been validated with direct measurements from a system with the same or similar water table depth and dynamics, salinity, tidal hydrology, sediment supply and plant community type.

Use of published data

Peer-reviewed published data may be used to generate values for the average rate of GHG emissions in the same or similar systems as those in the project area. These data must be limited to systems that are in the same or similar region as the project area, share similar geomorphic, hydrologic, and biological properties, and are under similar management regimes unless any differences should not have a substantial effect on GHG emissions.

Use of emission factors

Emission factors must be derived from peer-reviewed literature and must be appropriate to ecosystem type and conditions and the geographic region of the project area.

Use of default factors

The default factors in Sections 8.1.4.2.3, 8.1.4.3.4, and 8.1.4.4.4 are subject to periodic re-assessment, as set out in VCS document *Methodology Approval Process*.

IPCC default factors[8] may be used as indicated in this methodology. Tier 1 values may be used, but their use must be justified as appropriate for project conditions.

8.1.4.2 CO_2 Emissions from Soil

CO_2 emissions from soils may be estimated using one of the following approaches:

1) Proxy-based;
2) Published value;
3) Default factor;

[8] 2013 Supplement to the 2006 Guidelines: Wetlands

4) Modeling;

5) Soil coring; or

6) Historical or chronosequence-derived.

In some cases, as defined in Section 8.1.4.2.7, allochthonous soil organic carbon may accumulate on the project site where this carbon may be accounted in the baseline towards the benefit of the project. Procedures for the estimation of a compensation factor for allochthonous soil organic carbon are provided in Section 8.1.4.2.7.

8.1.4.2.1 Proxy-based approaches

CO_2 emissions may be estimated using proxies such as carbon stock change, soil subsidence, water table and vegetation composition, as:

$$GHG_{BSL\text{-}soil\text{-}CO2,i,t} = f\text{ (GHG emission proxy)} \quad \textbf{(28)}$$

<u>Water table depth and vegetation composition</u>

Water table depth may be used as a proxy for CO_2 emissions for mineral and organic soils if project proponents are able to justify their use as described in Section 8.1.4.1. Project proponents may also use procedures for the estimation of CO_2 emissions from organic soils based on water table depth and vegetation composition as provided in the VCS methodology *Baseline and monitoring methodology for the rewetting of drained peatlands used for peat extraction, forestry and agriculture based on GESTS* (under development), noting that the applicability conditions of such methodology must be met and that the following equation applies:

$$GHG_{BSL\text{-}soil\text{-}CO2,i,t} = GHG_{GESTbsl\text{-}CO2,i,t} \quad \textbf{(29)}$$

Where:

$GHG_{BSL\text{-}soil\text{-}CO2,i,t}$	CO_2 emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$GHG_{GESTbsl\text{-}CO2,i,t}$	Emission of CO_2 from baseline GEST in stratum *i* in year *t*; t CO_2-e ha^{-1} yr^{-1} (in VCS methodology *Baseline and monitoring methodology for the rewetting of drained peatlands used for peat extraction, forestry and agriculture based on GESTS* (under development))

When using water table depth as a proxy, it must be projected for the 10-year baseline period through hydrologic modeling, considering:

- Long-term average climate variables (over 20+ years prior to the project start date from two climate stations nearest to the project area) influencing water levels and the timing and quantity of water flow;

- Planned water management activities documented in existing land management plans, predating consideration of the proposed project activity; and
- Potential offsite influences (eg, changes in sedimentation rates, upstream water supply, sea level rise).

If the mean annual water table depth in the project area exceeds the depth range for which the emission-water table depth relationship determined for the project is valid, a conservative extrapolation must be used.

Subsidence

CO_2 emissions due to soil subsidence from organic soils are estimated as:

$$GHG_{BSL\text{-}soil\text{-}CO2,i,t} = 44/12 \times C_{peatloss\text{-}BSL,i,t} \quad \textbf{(30)}$$

$$C_{peatloss\text{-}BSL,i,t} = 10 \times Rate_{peatloss\text{-}BSL,i} \times VC \quad \textbf{(31)}$$

Where:

$GHG_{BSL\text{-}soil\text{-}CO2,i,t}$	CO_2 emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$C_{peatloss\text{-}BSL,i,t}$	Organic soil carbon loss due to subsidence and fire in the baseline scenario in subsidence stratum *i* in year *t*; t C ha^{-1}
$Rate_{peatloss\text{-}BSL,i}$	Rate of organic soil loss due to subsidence and fire[9] in the baseline scenario in stratum *i*; m yr^{-1}
VC	Volumetric organic carbon content of organic soil; kg C m^{-3}
i	1, 2, 3 …M_{BSL} subsidence strata in the baseline scenario
t	1, 2, 3 … *t** years elapsed since the start of the project activity

Carbon stock change

CO_2 emissions may be derived from a carbon stock change as follows:

$$GHG_{BSL\text{-}soil\text{-}CO2,i,t} = 44/12 \times (C_{BSL\text{-}soil,i,t} - C_{BSL\text{-}soil,i,,(t-T)}) / T \quad \textbf{(32)}$$

Where:

$GHG_{BSL\text{-}soil\text{-}CO2,i,t}$	CO_2 emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e yr^{-1}
$C_{BSL\text{-}soil,i,t}$	Soil organic carbon stock in the baseline scenario in stratum *i* in year *t*; t C ha^{-1}
i	1, 2, 3 …M_{BSL} strata in the baseline scenario

[9] The procedure to derive carbon losses is described in Couwenberg & Hooijer (2013).

t	1, 2, 3 … t^* years elapsed since the start of the project activity
T	Time elapsed between two successive estimations ($T=t_2 - t_1$)

8.1.4.2.2 Published values

Peer-reviewed published data may be used to generate a value for $GHG_{BSL\text{-}soil\text{-}CO2,i,t}$ based on the average rate of CO_2 emissions in the same or similar systems as those in the project area based on the guidelines described in Section 8.1.4.1. Also see instructions in Section 5.1 for the estimation of the rate of organic soil carbon loss due to oxidation in the baseline scenario from mineral soils ($Rate_{Closs\text{-}BSL}$).

8.1.4.2.3 Default factors

1) For non-seagrass tidal wetland systems, a general default factor may be used in the absence of data suitable for using the published value approach.

$$GHG_{BSL\text{-}soil\text{-}CO2,i,t} = -1.4^{(10)} \text{ t C ha}^{-1} \text{ yr}^{-1} \times 44/12 \quad \textbf{(33)}$$

This default factor may only be applied to areas with a crown cover of at least 50%. By contrast, for areas with a crown cover of less than 15%, this value can be assumed to be insignificant and accounted as zero.

2) The most recently published IPCC emission factors[11] may be used for non-tidal wetland and seagrass systems in the absence of data suitable for using the published value approach.

8.1.4.2.4 Modeling

A peer-reviewed published model may be used to generate a value of $GHG_{BSL\text{-}soil\text{-}CO2,i,t}$ in the same or similar systems as those in the project area based on the guidelines described in Section 8.1.4.1.

8.1.4.2.5 Soil coring

Soil coring may be used to generate a value of $C_{BSL\text{-}soil,i,t}$ as outlined in Section 9.3.7. For the baseline scenario, soil cores must be collected within 2 years prior to the project start date. If using an installed reference plane for the baseline scenario, it must have been installed at least 4 years prior to the baseline measurement, which is good practice to ensure that a reliable average accumulation rate is obtained.

[10] (within Equation 33) The median rate (Poffenbarger *et al*. 2011) from the literature synthesis of Chmura *et al*. 2003 was used as a default factor. The synthesis included studies worldwide, including marshes and mangroves. The median was used as the best estimate of central tendency because the data were not normally distributed.

[11] 2013 Supplement to the 2006 Guidelines: Wetlands

8.1.4.2.6 Historical data or chronosequences

The rate of organic soil carbon loss due to oxidation in the baseline scenario from mineral soils ($Rate_{Closs-BSL}$) may be estimated using either historical data collected from the project site (as described in Section 9.3.7) or chronosequence data collected at similar sites (as described in Section 8.1.4.1). Also see instructions in Section 5.1.

8.1.4.2.7 Deduction for allochthonous carbon

A deduction from the estimate of the CO_2 emissions may be used to account for the percentage of those emissions that are derived from allochthonous soil organic carbon. A deduction must not be used if the approach used above to estimate CO_2 emissions directly estimates autochthonous CO_2 emissions or otherwise accounts for allochthonous carbon.

$$Deduction_{alloch} = GHG_{BSL\text{-}soil\text{-}CO2,i,t} \times (\%C_{alloch} / 100) \qquad \textbf{(34)}$$

Where:

$GHG_{BSL\text{-}soil\text{-}CO2,i,t}$	CO_2 emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$Deduction_{alloch}$	Deduction from CO_2 emissions from the SOC pool to account for the percentage of the carbon stock that is derived from allochthonous soil organic carbon; t CO_2e ha^{-1} yr^{-1}
$\%C_{alloch}$	Percentage of carbon stock derived from allochthonous soil organic carbon; %
i	1, 2, 3 …M_{BSL} strata in the baseline scenario
t	1, 2, 3 … *t** years elapsed since the start of the project activity

$Deduction_{alloch}$ may be conservatively set to zero for the baseline.

For strata with:

- Non-wetland systems
- Organic soils
- Seagrass systems[12]

$Deduction_{alloch} = 0$

$\%C_{alloch}$ may be estimated using either:

1) Published values
2) Field-collected data

[12] Duarte, 2011

3) Default factors

4) Modeling

(1) Published values

Peer-reviewed published data may be used to generate a value of the percentage of allochthonous soil organic carbon in the same or similar systems as those in the project area based on the guidelines described in Section 8.1.4.1.

(2) Field-collected data

Data for this method will be collected using default values (listed below) and measured through analysis of field-collected soil cores (for soil carbon), sediment tiles (for sediment carbon), or through collection of suspended sediments in tidal channels or sediments deposits in tidal flats (for sediment carbon) (see Section 9.3.7).

$$\%C_{alloch} = 100 \times VC_{alloch} / VC \quad \textbf{(35)}$$

$$VC_{alloch} = \%C_{depositedsediment} \times D_{alloch} \quad \textbf{(36)}$$

$$D_{alloch} = D_{mineral} / (1 - (\%OM_{depositedsediment} / 100)) \quad \textbf{(37)}$$

$$D_{mineral} = BD \times (100 - \%OM) / 100)) \quad \textbf{(38)}$$

$$VC = (\%C_{soil} / 100) \times BD \quad \textbf{(39)}$$

Where:

$\%C_{allochthonous}$	Allochthonous C % (percentage of the total soil organic carbon that is allochthonous); %
VC	Volumetric soil organic carbon content; kg C m^{-3}
VC_{alloch}	Volumetric allochthonous soil organic carbon content; kg C m^{-3}
$\%C_{depositedsediment}$	Percentage of organic C in deposited sediment; %
D_{alloch}	Allochthonous soil organic carbon density; kg m^{-3}
$D_{mineral}$	Mineral density (percentage of the total soil mass that is mineral); kg m^{-3}
$\%OM_{depositedsediment}$	Percentage of organic matter in deposited sediment; %
BD	Dry bulk density; kg m^{-3}
$\%OM$	Percentage of soil organic matter; %
$\%C_{soil}$	Percentage of soil organic C; %

Both the percentage of soil organic matter (%*OM*) and the percentage of organic matter in deposited sediment ($\%OM_{depositedsediment}$) may be estimated directly using loss-on-ignition (LOI) data or indirectly using equations developed through site-specific data or one of the following equations:

For marsh soil[13]:

$$\%OM = (-0.4 + \sqrt{(0.4^2 + 4 \times 0.0025 \times \%C_{soil}})\Big/(2 \times 0.0025) \quad \textbf{(40)}$$

For mangrove soil[14]:

$$\%OM = \%C_{soil} / 1.724 \quad \textbf{(41)}$$

The following default factor may be used for the determination of $\%C_{depositedsediment}$:

$\%C_{depositedsediment} = 1.5$ [15]

Dry bulk density may be directly measured using the coring approach as described in Section 9.3.7 or may be indirectly estimated from % soil carbon using the following equation or using peer-reviewed published data from the same or similar systems as those in the project area based on the guidelines described in Section 8.1.4.1.

$$BD = -0.28 \times \ln(\%OM) + 1.25 \quad \textbf{(42)}$$ [16]

(3) Modeling

A quantitative model may be used to estimate the percent allochthonous soil organic carbon. The modeled percentage allochthonous soil organic carbon must be verified with direct measurements from a system with similar water table depth and dynamics, salinity and plant community type. The model must be accepted by the scientific community as shown by publication in a peer-reviewed journal and repeated application to different wetland systems.

8.1.4.3 CH_4 Emissions from Soil

CH_4 emissions in the baseline scenario may be conservatively set to zero.

If the project proponent includes CH_4 emissions in the baseline, the following options may be applied as described below.

8.1.4.3.1 Proxy-based approach

Where relevant, CH_4 emissions from organic soil may be estimated using proxies such as water table and

[13] Craft *et al.*, 1993
[14] Allen, 1974
[15] Andrews *et al.*, 2011
[16] (within Equation 42) Anisfeld *et al.*, 1999

vegetation composition, as

$$GHG_{BSL\text{-}soil\text{-}CH4,i,t} = f\ (\text{GHG emission proxy}) \times VCS_{CH4\text{-}GWP} \quad \textbf{(43)}$$

Where:

$GHG_{BSL\text{-}soil\text{-}CH4,i,t}$	CH_4 emissions from the SOC pool in the baseline; t CO_2e ha^{-1} yr^{-1}
f (GHG emission proxy)	Proxy for CH_4 emissions; t CH_4 ha^{-1} yr^{-1}
$VCS_{CH4\text{-}GWP}$	Current VCS value for global warming potential of CH_4; dimensionless

Procedures for the estimation of CH_4 emissions from organic soil based on water table depth and vegetation composition are provided in the VCS methodology *Baseline and monitoring methodology for the rewetting of drained peatlands used for peat extraction, forestry and agriculture based on GESTS* (under development), noting that the applicability conditions of VCS methodology *Baseline and monitoring methodology for the rewetting of drained peatlands used for peat extraction, forestry and agriculture based on GESTS* (under development) must be met and that the following equation applies:

$$GHG_{BSL\text{-}soil\text{-}CH4,i,t} = GHG_{GESTbsl\text{-}CH4,i,t} \quad \textbf{(44)}$$

Where:

$GHG_{BSL\text{-}soil\text{-}CH4,i,t}$	CH_4 emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$GHG_{GESTbsl\text{-}CH4,i,t}$	Emission of CH_4 from baseline GEST in stratum *i* in year *t*; t CO_2-e ha^{-1} yr^{-1} (in VCS methodology *Baseline and monitoring methodology for the rewetting of drained peatlands used for peat extraction, forestry and agriculture based on GESTS* (under development))

8.1.4.3.2 Field-collected data

Field-collected data may be used to estimate CH_4 emissions, see Section 9.3.8.

8.1.4.3.3 Published values

Peer-reviewed published data may be used to generate a value based on the average CH_4 emissions rate in the same or similar systems as those in the project area based on the guidelines described in Section 8.1.4.1.

8.1.4.3.4 General default factor

The default factor[17] of $GHG_{BSL\text{-}soil\text{-}CH4,i,t}$ may be used for tidal wetland systems . Where the salinity average or salinity low point is > 18 ppt, projects may apply a default emission of

[17] Taken from Poffenbarger *et al.*, 2011

$$GHG_{BSL\text{-}soil\text{-}CH4,i,t} = 0.011 \text{ t } CH_4 \text{ ha}^{-1} \text{ yr}^{-1} \times VCS_{CH4\text{-}GWP} \quad \textbf{(45)}$$

Where the salinity average or salinity low point is ≥ 20 ppt, projects may apply a default emission of

$$GHG_{BSL\text{-}soil\text{-}CH4,i,t} = 0.0056 \text{ t } CH_4 \text{ ha}^{-1} \text{ yr}^{-1} \times VCS_{CH4\text{-}GWP} \quad \textbf{(46)}$$

Procedures for measuring the salinity average or salinity low point are provided in Section 9.3.8. Project proponents may not use the default value of 0.11 for the baseline and 0.0056 for the project scenario to create a difference and claim an emission reduction. The use of the default value is intended for projects that restore salinity levels from fresh/brackish to much higher levels that inhibit CH_4 emissions.

8.1.4.3.5 Modeling

A quantitative model may be used to estimate CH_4 emissions as described in Section 8.1.4.1.

8.1.4.3.6 Emission factors

The most recently published IPCC Emission Factors may be used for non-tidal wetland systems. Tier 1 values may be used, but must be applied conservatively including accounting for local salinity and vegetative cover conditions.

8.1.4.4 N_2O Emissions from Soil

N_2O emissions may be conservatively excluded in the baseline scenario. If the project proponent includes N_2O emissions in the baseline, the following options may be applied as described below.

8.1.4.4.1 Proxy-based approach

Where relevant, N_2O emissions may be estimated using proxies as described in Section 8.1.4.1 (determination of the similarity of systems should include nitrogen levels) such as water table and vegetation composition, as:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = f\,(N_2O \text{ emission proxy}) \times VCS_{N2O\text{-}GWP} \quad \textbf{(47)}$$

Where:

$GHG_{BSL\text{-}soil\text{-}N2O,i,t}$	N_2O emissions from the SOC pool in the baseline due to denitrification/nitrification; t CO_2e ha^{-1} yr^{-1}
$f\,(N_2O$ emission proxy)	Proxy for N_2O emissions; t N_2O ha^{-1} yr^{-1}
$VCS_{N2O\text{-}GWP}$	VCS global warming potential for N_2O; dimensionless

8.1.4.4.2 Field-collected data

Field-collected data may be used to estimate N_2O emissions, see Section 9.3.8.

8.1.4.4.3 Published values

Peer-reviewed published data may be used to generate a value based on the average N_2O emissions rate in the same or similar systems as those in the project area based on the guidelines described in Section 8.1.4.1; determination of the similarity of systems should include nitrogen levels.

8.1.4.4.4 General default factor

The following default factors[18] of $GHG_{BSL\text{-}soil\text{-}N2O,i,t}$ may be used in the absence of data suitable for using the published value approach for the systems listed below except when the project area receives hydrologically direct inputs from a point or non-point source of nitrogen such as wastewater effluent or an intensively nitrogen-fertilized system.

Open water systems where the salinity average or salinity low point is > 18 ppt:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.00015 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times VCS_{N2O\text{-}GWP} \quad \textbf{(48)}$$

Open water systems where the salinity average or salinity low point is > 5 ppt:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.00030 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times VCS_{N2O\text{-}GWP} \quad \textbf{(49)}$$

Other open water systems:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.00045 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times VCS_{N2O\text{-}GWP} \quad \textbf{(50)}$$

Non-seagrass wetland systems where the salinity average or salinity low point is > 18 ppt:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.00049 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times VCS_{N2O\text{-}GWP} \quad \textbf{(51)}$$

Non-seagrass wetland systems where the salinity average or salinity low point is > 5 ppt:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.00070 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times VCS_{N2O\text{-}GWP} \quad \textbf{(52)}$$

Other non-seagrass wetland systems:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.00076 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times VCS_{N2O\text{-}GWP} \quad \textbf{(53)}$$

[18] Taken from Smith *et al.*, 1983.

Procedures for measuring the salinity average or salinity low point are provided in Section 9.3.8.

8.1.4.4.5 Modeling

A quantitative model may be used to estimate N_2O emissions as described in Section 8.1.4.1.

8.1.4.4.6 Emission factors

The most recently published IPCC emission factors may be used. Tier 1 values may be used, as described in Section 8.1.4.1.

8.1.5 Emissions from fossil fuel use ($GHG_{BSL\text{-}fuel,i,t}$)

Emissions from the use of vehicles and mechanical equipment in the baseline scenario may be conservatively omitted. However, these emissions in the baseline scenario may be estimated using the procedures provided in Section 8.2.6.

8.2 Project Emissions

8.2.1 General Approach

Emissions in the project scenario are attributed to carbon stock changes in biomass carbon pools, GHG emissions as a result of soil processes, or a combination of these. In addition, where relevant, emission reductions from organic soil burns and fossil fuel use may be quantified.

The prescribed burning of herbaceous and shrub aboveground biomass (cover burns) as a project activity may occur.

Organic soil combustion due to anthropogenic fires is addressed using a conservative default factor (*Fire Reduction Premium*) that is expressed as a proportion of the CO_2 emissions avoided through rewetting (Section 8.2.7).

For *ex-ante* estimates of GHG emissions in the project scenario use the latest version of the VCS module *VMD0019 Methods to Project Future Conditions*.

Emissions in the project scenario are estimated as:

$$GHG_{WPS} = GHG_{WPS\text{-}biomass} + GHG_{WPS\text{-}soil} + GHG_{WPS\text{-}burn} + GHG_{WPS\text{-}fuel} \quad \textbf{(54)}$$

$$GHG_{WPS\text{-}biomass} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_{WPS}} \left(\frac{44}{12} \times DC_{WPS\text{-}biomass,i,t} \right) \quad \textbf{(55)}$$

$$GHG_{WPS\text{-}soil} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_{WPS}} \left(\frac{44}{12} \times DC_{WPS\text{-}soil,i,t} \right) \quad \textbf{(56)}$$

$$GHG_{WPS-burn} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_{WPS}} \left(\frac{44}{12} \times GHG_{WPS-burn,i,t} \right)$$

(57)

$$GHG_{WPS-fuel} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_{WPS}} \left(\frac{44}{12} \times DC_{WPS-fuel,i,t} \right) \tag{58}$$

Where:

GHG_{WPS}	Net CO_2 equivalent emissions in the project scenario up to year *t**; t CO_2e
$GHG_{WPS-biomass}$	Net CO_2 equivalent emissions from biomass carbon pools in the project scenario up to year *t**; t CO_2e
$GHG_{WPS-soil}$	Net CO_2 equivalent emissions from the SOC pool in the project scenario up to year *t**; t CO_2e
$GHG_{WPS-burn}$	Net CO_2 equivalent emissions from prescribed burning in the project scenario up to year *t**; t CO_2e
$GHG_{WPS-fuel}$	Net CO_2 equivalent emissions from fossil fuel use in the project scenario up to year *t**; t CO_2e
$\Delta C_{WPS-biomass,i,t}$	Net carbon stock changes in biomass carbon pools in the project scenario in stratum *i* in year *t*; t C yr^{-1}
$GHG_{WPS-soil,i,t}$	GHG emissions from the SOC pool in the project scenario in stratum *i* in year *t*; t CO_2e yr^{-1}
$GHG_{WPS-burn,i,t}$	GHG emissions from prescribed burning in the project scenario in stratum *i* in year *t*; t CO_2e yr^{-1}
$GHG_{WPS-fuel,i,t}$	GHG emissions from fossil fuel use the project scenario in stratum *i* in year *t*; t CO_2e yr^{-1}
i	1, 2, 3 …M_{WPS} strata in the project scenario
t	1, 2, 3, … *t** years elapsed since the project start date

Ex-ante estimates of GHG_{WPS} must be based on a project scenario that is defined *ex ante*.

Ex-post estimates of GHG_{WPS} must be based on monitoring results.

8.2.2 Accounting for sea level rise

See Section 8.1.2 for procedures, noting that for the project scenario, the project proponent may conservatively assume that all eroded carbon is oxidized, or may justify a smaller oxidation rate based on appropriate scientific research.

8.2.3 Project Net Carbon Stock Change in Biomass Carbon Pools ($\Delta C_{WPS-biomass,i,t}$)

Net carbon stock change in biomass carbon pools in the project scenario are estimated as

$$\Delta C_{WPS\text{-}biomass,i,t} = \Delta C_{WPS\text{-}tree/shrub,i,t} + \Delta C_{WPS\text{-}herb,i,t} \quad \textbf{(59)}$$

Where:

$\Delta C_{WPS\text{-}biomass,i,t}$	Net carbon stock changes in biomass carbon pools in the project scenario in stratum *i* in year *t*; t C yr^{-1}
$\Delta C_{WPS\text{-}tree/shrub,i,t}$	Net carbon stock changes in tree and shrub carbon pools in the project scenario in stratum *i* in year *t*; t C yr^{-1}
$\Delta C_{WPS\text{-}herb,i,t}$	Net carbon stock changes in herb carbon pools in the project in stratum *i* in year *t*; t C yr^{-1}
i	1, 2, 3 …M_{WPS} strata in the project scenario
t	1, 2, 3, … *t** years elapsed since the project start date

The value of $\Delta C_{WPS\text{-}biomass,i,t}$ is maximized as per the procedure outlined in Section 8.2.2.

The net carbon stock changes in trees and shrubs in the project scenario are estimated using CDM methodology *AR-ACM0003 Afforestation and reforestation of lands except wetlands*, noting that:

1) The exclusion of project activities on wetlands in the applicability conditions of AR-ACM0003 and associated tools must be neglected, and
2) The following equation applies:

$$\Delta C_{WPS\text{-}tree/shrub,i,t} = 12/44 \times (\Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t}) \quad \textbf{(60)}$$

Where:

$\Delta C_{BSL\text{-}tree/shrub,i,t}$	Net carbon stock changes in tree and shrub carbon pools in the project scenario in stratum *i* in year *t*; t C yr^{-1}
$\Delta C_{TREE\_PROJ,t}$	Change in carbon stock in tree biomass in project in year *t*; t CO_2-e (in AR-ACM0003; calculations are done for each stratum *i*)
$\Delta C_{SHRUB\_PROJ,t}$	Change in carbon stock in shrub biomass in project in year *t*; t CO_2-e (in AR-ACM0003; calculations are done for each stratum *i*)

Alternatively, an IPCC default factor[19] may be used.

For strata where reforestation or revegetation activities in the project scenario include harvesting, the long-term average of $C_{TREE\text{-}PROJ,t}$ in AR-ACM0003 must be calculated as follows, which will be used for the calculation of the long-term GHG benefit in Section 8.4.1:

[19] 2013 Supplement to the 2006 Guidelines: Wetlands

$$DC_{AVG-TREE\_PROJ} = \frac{\sum_{t=1}^{n} C_{TREE\_PROJ,t}}{n} \qquad (61)$$

Where:

$C_{AVG-TREE\_PROJ}$	Long-term average in carbon stock in tree biomass in project in time period *n*; t CO_2-e
$C_{TREE\_PROJ,t}$	Carbon stock in tree biomass in project in year *t*; t CO_2-e (in AR-ACM0003; calculations are done for each stratum *i*)
t	1, 2, 3 … *n* years elapsed since the project start date
n	Total number of years in the established time period (see Section 8.4.1)

The net carbon stock change in herbaceous vegetation biomass in the project scenario is estimated using a carbon stock change approach as follows:

$$\Delta C_{WPS-herb,i,t} = (C_{WPS-herb,i,t} - C_{WPS-herb,i,(t-T)}) / T \qquad (62)$$

Where:

$\Delta C_{WPS-herb,i,t}$	Net carbon stock changes in herb carbon pools in the project scenario in stratum *i* in year *t*; t C yr^{-1}
$C_{WPS-herb,i,t}$	Carbon stock in herbaceous vegetation in the project scenario in stratum *i* in year *t*; t C ha^{-1}
i	1, 2, 3 …M_{WPS} strata in the project scenario
t	1, 2, 3 … *t** years elapsed since the start of the project activity
T	Time elapsed between two successive estimations ($T=t_2 - t_1$)

A default factor for $C_{WPS-herb,i,t}$ of 3 t C ha^{-1} (se Section 8.1.3) may be applied for strata with 100% herbaceous cover and applying a 1:1 relationship between vegetation cover and $C_{WPS-herb,i,t}$ for areas with a vegetation cover <100%. The default may be claimed for one year only during the project crediting period as herbaceous biomass quickly reaches steady state. Vegetation cover must be determined by commonly used techniques in field biology.

Procedures for measuring carbons stocks in herbaceous vegetation are provided in Section 9.3.6.

If the carbon stock change in herbaceous vegetation is included in the project scenario then it must also be included in the baseline scenario.

8.2.4 Project Net GHG Emissions and Removals from Soil ($GHG_{WPS-soil,i,t}$)

8.2.4.1 General

The net GHG emissions from soils in the project scenario are estimated as:

$$GHG_{WPS-soil,i,t} = A_{i,t} \times (GHG_{WPS-soil-CO2,i,t} - Deduction_{alloch} + GHG_{WPS-soil-CH4,i,t} + GHG_{WPS-soil-N2O,i,t}) \qquad (63)$$

Where:

$GHG_{WPS-soil,i,t}$	GHG emissions from the SOC pool in the project scenario in stratum *i* in year *t*; t CO_2e yr^{-1}
$GHG_{WPS-soil-CO2,i,t}$	CO_2 emissions from the SOC pool in the project scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$Deduction_{alloch}$	Deduction from CO_2 emissions from the SOC pool to account for the percentage of the carbon stock that is derived from allochthonous soil organic carbon; t CO_2e ha^{-1} yr^{-1}
$GHG_{WPS-soil-CH4,i,t}$	CH_4 emissions from the SOC pool in the project scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$GHG_{WPS-soil-N2O,i,t}$	N_2O emissions from the SOC pool in the project scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$A_{i,t}$	Area of stratum *i* in year *t*; ha
i	1, 2, 3 …M_{WPS} strata in the project scenario
t	1, 2, 3, … *t** years elapsed since the project start date

8.2.4.2 CO_2 Emissions from Soil

CO_2 emissions from soils may be estimated using one of the following approaches:

1) Proxy-based;
2) Published value;
3) Default value;
4) Modeling; or
5) Soil coring.

In some cases, as defined in Section 8.1.4.2.7, allochthonous soil organic carbon may accumulate on the project site where this carbon must be accounted in the project scenario. Procedures for the estimation of a compensation factor for allochthonous soil organic carbon are provided in Sections 8.1.4.2.7 and 8.2.4.2.2.

8.2.4.2.1 Approaches for estimating $GHG_{WPS-soil-CO2,i,t}$

See Sections 8.1.4.2.1 – 8.1.4.2.6 for procedures. In all equations ’*BSL*‘ must be substituted by ’*WPS*’.

8.2.4.2.2 Deduction for allochthonous carbon

See Section 8.1.4.2.7 for procedures with the additional guidance below.

The determination of the deduction for allochthonous carbon is mandatory for the project scenario unless project proponents are able to demonstrate that the allochthonous carbon would have been returned to the atmosphere in the form of carbon dioxide in the absence of the project.

The deduction for allochthonous carbon must only be applied to soil layers deposited or accumulated after the initiation of the project (such as materials formed above a feldspar marker horizon).

8.2.4.3 CH_4 emissions from soil

The estimation of CH_4 emissions in project scenario may follow one of the approaches provided in Section 8.1.4.3. In all equations ’*BSL*‘ must be substituted by ’*WPS*’.

8.2.4.4 N_2O emissions from soil

If project proponents are able to demonstrate (eg, by referring to peer-reviewed literature based on similar project circumstances[20]) that N_2O emissions do not increase in the project scenario compared to the baseline scenario, N_2O emissions may be ignored.

N_2O emissions must be accounted for in the project scenario in strata where water level[21] was lowered as a result of project activities. Seagrass projects do not require N_2O emission accounting. The estimation of N_2O emissions in the project scenario may follow one of the approaches provided in Section 8.1.4.4. In all equations ’*BSL*‘ must be substituted by ’*WPS*’.

In addition, if project proponents are able to demonstrate (eg, by referring to peer-reviewed literature) that N_2O emissions in the project scenario are insignificant, N_2O emissions may be ignored. To demonstrate that N_2O emissions are insignificant in the project scenario, use CDM tool *Tool for testing significance of GHG emissions in A/R CDM project activities*, or refer to peer-reviewed literature.

8.2.5 Project net non-CO_2 emissions from prescribed burning

Under the applicability conditions, in cases where the project introduces prescribed burning of shrub and herbaceous biomass, the project must a) demonstrate that the project does not decrease carbon sequestration rates if using the ‘general default factor approach’ for carbon dioxide emissions accounting from soil; and b) account for CH_4 and N_2O emissions as follows:

$$GHG_{WPS\text{-}burn,i,t} = CO_2e_{N2O,i,t} + CO_2e_{CH4,i,t} \quad \textbf{(64)}$$

$$CO_2e_{N2O,i,t} = Biomass_{i,t} \times EF_{N2O,burn} \times VCS_{N2O\text{-}GWP} \times 10^{-6} \times A_{i,t} \quad \textbf{(65)}$$

[20] Project circumstances are defined by pre-project land use (eg, forestry, agriculture, abandonment after such activities) and its intensity (esp. related to N-fertilization), climatic zone, water table depths, and soil type.
[21] See applicability conditions.

$$CO_2e_{CH4,i,t} = Biomass_{i,t} \times EF_{CH4,burn} \times VCS_{CH4\text{-}GWP} \times 10^{-6} \times A_{i,t} \quad \textbf{(66)}$$

Where:

$GHG_{WPS\text{-}burn,i,t}$	GHG emissions from prescribed burning in the project scenario in stratum *i* in year *t*; t CO_2e yr^{-1}
$CO_2e_{N2O,i,t}$	CO_2-equivalent emissions resulting from N_2O emissions due to prescribed burning in stratum *i* in year *t*; t CO_2e yr^{-1}.
$CO_2e_{CH4,i,t}$	CO_2-equivalent emissions resulting from CH_4 emissions due to prescribed burning in stratum *i* in year *t*; t CO_2e yr^{-1}.
$Biomass_{i,t}$	Aboveground shrub and herbaceous biomass in stratum *i* in year *t* (from Section 8.2.3), kg d.m. ha^{-1}
$EF_{N2O,burn}$	Emission factor for N_2O for vegetation burning; g N_2O / kg $Biomass_{dry}$
$EF_{CH4,burn}$	Emission factor for CH_4 for vegetation burning; g CH_4 / kg $Biomass_{dry}$
$VCS_{N2O\text{-}GWP}$	Current VCS value for global warming potential of N_2O; dimensionless
$VCS_{CH4\text{-}GWP}$	Current VCS value for global warming potential of CH_4; dimensionless
$A_{i,t}$	Area of stratum *i* in year *t;* ha
i	1, 2, 3 …M_{WPS} strata in the project scenario
t	1, 2, 3, … *t** years elapsed since the project start date

8.2.6 Emissions from Fossil Fuel Use

If above *de minimis* as compared to the baseline, emissions from the use of vehicles and mechanical equipment for earth moving in WRC project activities, emissions must be estimated using the procedures provided in CDM tool *Estimation of GHG emissions related to fossil fuel combustion in A/R CDM project activities*, noting that the following equation applies:

$$GHG_{WPS\text{-}fuel,i,t} = ET_{FC,y} \quad \textbf{(67)}$$

Where:

$GHG_{WPS\text{-}fuel,i,t}$	GHG emissions from fossil fuel use the project scenario in stratum *i* in year *t*; t CO_2e yr^{-1}
$ET_{FC,y}$	CO_2 emissions from fossil fuel combustion during the year *y*; t CO_2 (in CDM tool *Estimation of GHG emissions related to fossil fuel combustion in A/R CDM project activities*; calculation are done for each stratum *i*)
i	1, 2, 3 …M_{WPS} strata in the project scenario
t	1, 2, 3, … *t** years elapsed since the project start date

The tool has been designed for A/R CDM project activities, but must be used for the purpose of this methodology, noting the following:

Where the tool refers to:	It must be understood as referring to:
A/R	WRC
CDM	VCS
DOE	VVB

8.2.7 Emission Reduction from Organic Soil Combustion due to Rewetting and Fire Management (*Fire Reduction Premium*)

This methodology addresses anthropogenic fires occurring in drained organic soils and establishes a conservative default factor, based on fire occurrence and extension in the project area in the baseline scenario, so as to avoid the direct assessment of GHG emissions from fire in the baseline and the project scenarios. Procedures for the estimation of *FRP* (the *Fire Reduction Premium*) are provided in the VCS module *Methods for monitoring soil carbon stock changes and GHG emissions in WRC project activities* (under development).

8.3 Leakage

8.3.1 Activity Shifting Leakage and Market Leakage

Activity shifting leakage and market leakage may be assumed to be zero if the applicability conditions of this methodology as outlined in Section 4 are met.

8.3.2 Ecological Leakage

Projects meeting the applicability conditions of this methodology may assume that ecological leakage does not occur, because projects must be designed in a manner which ensures that the hydrological connectivity with adjacent areas does not lead to a significant increase in GHG emissions outside the project area. Specifically, this may be achieved by a project design[22] which causes no alteration of mean annual water table depths, flooding frequency and duration in adjacent areas or limiting such alteration to levels that do not influence GHG emissions.

Project proponents must demonstrate that their project design meets this requirement through expert judgment, hydrologic modeling, or monitoring of alterations of water table depth at the project boundary. In tidal wetland restoration projects, dewatering of downstream wetlands is not expected if project boundaries are set sufficiently large to include expected areas of changed hydrology.

Hydrologic models must consider water displacement from project activities and the hydrologic connection or blockage of inlets that would change the wetland boundary. Procedures for monitoring

[22] Where, at the design stage, hydrological changes are expected to impact GHG emissions in areas outside the boundary, the project design must be adjusted to include such areas in the project boundary.

alterations of water table depth at the project boundary are provided in Section 9.3.4.

The tidal range and sediment delivery experienced by wetlands outside the project area must remain within the system tolerance, which is defined by the high and low tides and regional sediment budget, and assessed using hydrological models (and/or empirical analysis) and expert judgment.

To guide the assessment, the table below outlines avoidance criteria related to a variety of processes that may occur outside the project boundary due to an inappropriate project design.

Process outside Project Boundary	Avoidance Criterion
Lowering of water table that causes increased soil carbon oxidation	Maintain wetland conditions (e.g. converting from impounded water to a wetland doesn't cause soil oxidation)
Lowering of water table that causes increased N_2O emissions	No conversion of non-seagrass wetland to open water.
Raising of water table that causes increased CH_4 emissions	No conversion of non-wetland to wetland
Raising of water table that causes decreased vegetation production that causes decreased new soil carbon sequestration	No causation of vegetated to non-vegetated (or poorly vegetated) conditions

Projects meeting these requirements may assume that $GHG_{LK} = 0$.

8.4 Summary of GHG Emission Reduction and/or Removals

8.4.1 Calculation of Net GHG Emissions Reductions

The total net GHG emission reductions from the WRC project activity are calculated as follows:

$$NER_{RWE} = GHG_{BSL} - GHG_{WPS} + FRP - GHG_{LK} \quad \textbf{(68)}$$

Where:

NER_{RWE}	Total net CO_2 equivalent emission reductions from the RWE project activity; t CO_2e
GHG_{BSL}	Net CO_2 equivalent emissions in the baseline scenario; t CO_2e
GHG_{WPS}	Net CO_2 equivalent emissions in the project scenario; t CO_2e
FRP	*Fire Reduction Premium* - Net CO_2 equivalent emission reductions from organic soil combustion due to rewetting and fire management; t CO_2e
GHG_{LK}	Net CO_2 equivalent emissions due to leakage; t CO_2e

NER_{RWE} must be corrected for uncertainty, by estimating the total uncertainty for the WRC project activity

(NER_{RWE_ERROR}) as provided in Section 8.4.2.

8.4.2 Estimation of Uncertainty

This procedure allows for estimating uncertainty in the estimation of emissions and carbon stock changes (ie, for calculating a precision level and any deduction in credits for lack of precision following project implementation and monitoring) by assessing uncertainty in baseline and project estimations.
This procedure focuses on the following sources of uncertainty:

- Uncertainty associated with estimation of stocks in carbon pools and changes in carbon stocks
- Uncertainty in assessment of project emissions

Where an uncertainty value is not known or cannot be simply calculated, then the project proponent must justify that it is using a conservative number and an uncertainty of 0% may be used for this component.
Guidance on uncertainty – a precision target of a 90% or 95% confidence interval equal to or less than 20% or 30%, respectively, of the recorded value must be targeted. This is especially important in terms of project planning for measurement of carbon stocks where sufficient measurement plots should be included to achieve this precision level across the measured stocks.
Required conditions:

- Levels of uncertainty must be known for all aspects of baseline and project implementation and monitoring. Uncertainty will generally be known as the 90% or 95% confidence interval expressed as a percentage of the mean.
- Where uncertainty is not known it must be demonstrated that the value used is conservative.

Estimated carbon emissions and removals arising from AFOLU activities have uncertainties associated with the measures/estimates of: area or other activity data, carbon stocks, biomass growth rates, expansion factors, and other coefficients. It is assumed that the uncertainties associated with the estimates of the various input data are available, either as default factors given in IPCC Guidelines (2006), IPCC GPG-LULUCF (2003), expert judgment, or estimates based of sound statistical sampling. Alternatively, conservative estimates may also be used instead of uncertainties, provided that they are based on verifiable literature sources or expert judgment. In this case the uncertainty is assumed to be zero. However, this tool provides a procedure to combine uncertainty information and conservative estimates resulting in an overall *ex-post* project uncertainty.

Planning to Diminish Uncertainty

It is important that the process of project planning consider uncertainty. Procedures including stratification and the allocation of sufficient measurement plots help ensure that low uncertainty in carbon stocks results and ultimately full crediting can result.

It is good practice to apply this procedure at an early stage to identify the data sources with the highest uncertainty to allow the opportunity to conduct further work to diminish uncertainty.

Part 1 – Uncertainty in Baseline Estimates

$$Uncertain_{BSL,i} = \frac{\sqrt{(U_{BSL,SS1,i} * E_{BSL,SS1,i})^2 + (U_{BSL,SS2,i} * E_{BSL,SS2,i})^2 ... + ... (U_{BSL,SSn,i} * E_{BSL,SSn,i})^2}}{E_{BSL,SS1,i} + E_{BSL,SS2,i} ... + ... E_{BSL,SSn,i}} \quad \textbf{(69)}$$

Where:

$Uncertain_{BSL,i}$	Percentage uncertainty in the combined carbon stocks and GHG sources in the baseline case in stratum *i*; %
$U_{BSL,SS,i}$	Percentage uncertainty (expressed as 90% confidence interval as a percentage of the mean where appropriate) for carbon stocks and GHG sources in the baseline case in stratum *i* (1,2…n represent different carbon pools and/or GHG sources); %
$E_{BSL,SS,i}$	Carbon stock or GHG sources (eg, trees, down dead wood, etc.) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) in the baseline case; t CO_2e
i	1, 2, 3 …M_{BSL} strata in the baseline scenario

To assess uncertainty across combined strata:

$$Uncertain_{BSL} = \frac{\sqrt{(U_{BSL,1} * A_1)^2 + (U_{BSL,2} * A_2)^2 ... + ... (U_{BSL,M_{BSL}} * A_{M_{BSL}})^2}}{A_1 + A_2 ... + ... A_{M_{BSL}}} \quad \textbf{(70)}$$

Where:

$Uncertain_{BSL}$	Total uncertainty in baseline scenario; %
$U_{BSL,i}$	Uncertainty in baseline scenario in stratum *i*; %
A_i	Area of stratum *i*; ha
i	1, 2, 3 …M_{BSL} strata in the baseline scenario

Part 2 – Uncertainty Ex-Post in the Project Scenario

$$Uncertain_{WPS,i} = \frac{\sqrt{(U_{WPS,SS1,i} * E_{WPS,SS1,i})^2 + (U_{WPS,SS2,i} * E_{WPS,SS2,i})^2 ... + ... (U_{WPS,SSn,i} * E_{WPS,SSn,i})^2}}{E_{WPS,SS1,i} + E_{WPS,SS2,i} ... + ... E_{WPS,SSn,i}} \quad \textbf{(71)}$$

Where:

$Uncertain_{WPS,i}$	Percentage uncertainty in the combined carbon stocks and GHG sources in the project case in stratum *i*; %
$U_{WPS,SS,i}$	Percentage uncertainty (expressed as 90% confidence interval as a percentage of the mean where appropriate) for carbon stocks and GHG sources in the project case in stratum *i* (1,2…n represent different carbon pools and/or GHG sources); %
$E_{WPS,SS,i}$	Carbon stock or GHG sources (eg, trees, down dead wood, etc.) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) in the project case; t CO_2e
i	1, 2, 3 …M_{WPS} strata in the project scenario

To assess uncertainty across combined strata:

$$Uncertain_{WPS} = \frac{\sqrt{\left(U_{WPS,1} * A_1\right)^2 + \left(U_{WPS,2} * A_2\right)^2 \ldots + \ldots \left(U_{WPS,M_{BSL}} * A_{M_{BSL}}\right)^2}}{A_1 + A_2 \ldots + \ldots A_{M_{BSL}}} \tag{72}$$

Where:

$Uncertain_{WPS}$	Total uncertainty in project scenario; %
$U_{WPS,i}$	Uncertainty in project scenario in stratum *i*; %
A_i	Area of stratum *i*; ha
i	1, 2, 3 …M_{WPS} strata in the project scenario

Part 3 – Total Error in WRC Project Activity

$$NER_{WRC\_ERROR} = \frac{\sqrt{(Uncertain_{BSL} \times GHG_{BSL})^2 + (Uncertain_{WPS} \times GHG_{WPS})^2}}{GHG_{BSL} + GHG_{WPS}} \tag{73}$$

Where:

NER_{WRC_ERROR}	Total uncertainty for WRC project activity; %
$Uncertain_{BSL}$	Total uncertainty in baseline scenario; %
$Uncertain_{WPS}$	Total uncertainty in the project scenario; %
GHG_{BSL}	Net CO_2 equivalent emissions in the baseline scenario up to year *t**; t CO_2e
GHG_{WPS}	Net CO_2 equivalent emissions in the project scenario up to year *t**; t CO_2e

The allowable uncertainty under this methodology is 20% or 30% of $NER_{WRC,t}$ at a 90% or 95% confidence level, respectively. Where this precision level is met no deduction should result for uncertainty. Where exceeded, the deduction must be equal to the amount that the uncertainty exceeds the allowable level. The adjusted value for $NER_{WRC,t}$ to account for uncertainty must be calculated as:

$$adjusted\_NER_{WRC,t} = NER_{WRC,t} \text{ x } (100\% - NER_{WRC\_ERROR} + allowable\_uncert) \tag{74}$$

Where:

$adjusted\_NER_{WRC,t}$	Cumulative total net GHG emission reductions in year *t* adjusted to account for uncertainty; t CO_2e
$NER_{WRC,t}$	Total net GHG emission reductions from the WRC project activity up to year *t*; t CO_2e
NER_{WRC_ERROR}	Total uncertainty for WRC project activity; %
allowable_unsert	Allowable uncertainty; 20% or 30% at a 90% or 95% confidence level, respectively; %

8.4.3 Calculation of Verified Carbon Units

The concept of withholding a number of buffer credits in the AFOLU pooled buffer account is based on quantifying the net change in carbon stocks. The proxy for the net change in carbon stocks applied in this methodology is *NER* (Section 8.4.1). As this proxy includes all net GHG emissions reductions it provides a conservative estimate of the buffer withholding.

The number of Verified Carbon Units is calculated as:

$$VCU_{t2} = \left(adjusted\_NER_{RDP,t2} - adjusted\_NER_{RDP,t1}\right) - Bufferw_{t2} \qquad \textbf{(75)}$$

Where:

VCU_{t2}	Number of Verified Carbon Units in year *t2*
$NER_{RDP,\ t1}$	Total net GHG emission reductions from the WRC project activity up to year *t1*; t CO_2e
$NER_{RDP,\ t2}$	Total net GHG emission reductions from the WRC project activity up to year *t2*; t CO_2e
NER_{RDP_ERROR}	Total uncertainty for WRC project activity; %
$Bufferw_{t2}$	Number of Verified Carbon Units to be withheld in the VCS Buffer in year *t2*

$$Bufferw_{t2} = \left(NER_{WRC,t2} - NER_{WRC,t1}\right) \times Buffer\%_{t2} \qquad \textbf{(76)}$$

Where:

$Bufferw_{t2}$	Number of Verified Carbon Units to be withheld in the VCS Buffer in year *t2*
$NER_{WRC,\ t1}$	Total net GHG emission reductions from the WRC project activity up to year *t1*; t CO_2e
$NER_{WRC,\ t2}$	Total net GHG emission reductions from the WRC project activity up to year *t2*; t CO_2e
$Buffer\%_{t2}$	Percentage of Verified Carbon Units to be withheld in the VCS Buffer in year *t2*; %

The percentage to be withheld in the VCS buffer is to be determined using the latest version of the VCS AFOLU Non-Permanence Risk Tool.

For projects claiming reductions of baseline GHG emissions, the maximum quantity of GHG emission reductions that may be claimed (VCU_{max}) is limited to the difference between project and baseline scenario after a 100-year time frame. Procedures for estimating the difference between organic soil carbon stock in the project scenario and baseline scenario in stratum *i* at *t* = 100 ($C_{WPS\text{-}BSL,i,t100}$) are provided in Section 5.2.

$$VCU_{max} = \frac{44}{12} \times C_{WPS\text{-}BSL,t100} \qquad \textbf{(77)}$$

Where:

VCU_{max}	The maximum quantity of GHG emission reductions that may be claimed by the project; t

CO_2e

$C_{WPS\text{-}BSL,t100}$ Difference between organic soil carbon stock in the project scenario and baseline scenario at t=100; t C ha^{-1}

Where reforestation or revegetation activities in the project scenario include harvesting, the maximum number of GHG credits generated by these activities does not exceed the long-term average GHG benefit from these activities. In case of even-aged management, the time period *n* over which the long-term GHG benefit is calculated includes at minimum one full harvest/cutting cycle, including the last harvest/cut in the cycle. In case of conservation easements with no intention to harvest after the project crediting period (which must be shown in the PD based on verifiable information), or in case of selective cutting, the time period *n* over which the long-term average is calculated is the length of the project crediting period.

In this case Equation 67 is broken down into:

$$NER_{RWE} = (GHG_{BSL\text{-}biomass} - GHG_{WPS\text{-}biomass}) + ((GHG_{BSL\text{-}soil} + GHG_{BSL\text{-}fuel}) - (GHG_{WPS\text{-}soil} + GHG_{WPS\text{-}burn} + GHG_{WPS\text{-}fuel})) + FRP - GHG_{LK} \quad \textbf{(78)}$$

(See Equations 17, 54 and 68 for parameter descriptions)

When calculating ($GHG_{BSL\text{-}biomass} - GHG_{WPS\text{-}biomass}$), the sums of the carbon stocks in tree biomass used in Equations 18 and 55 are limited to $C_{AVG\text{-}TREE\_BSL,t}$ (Equation 25) and $C_{AVG\text{-}TREE\_PROJ,t}$ (Equation 61), respectively.

Examples of how to calculate the long-term average carbon benefits are provided in VCS AFOLU *Guidance Example for Calculating the Long-Term Average Carbon Stock for ARR Projects with Harvesting*.

9 MONITORING

9.1 Data and Parameters Available at Validation

Data / Parameter	$Depth_{peat,i,t0}$
Data unit	m
Description	Organic soil depth in stratum *i* at the project start date
Equations	1, 7, 8
Source of data	Own measurements and/or literature involving the project area.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Organic soil depths at the project start date may be derived from • Surface height measurements relative to a fixed reference point in m asl (eg, using poles fixed in the underlying mineral soil or rock) within the project area. • Literature involving the project or similar areas.
Purpose of Data	Calculation of baseline emissions Calculation of the maximum quantity of GHG emission reductions that may be claimed by the project
Comments	

Data / Parameter	$Rate_{peatloss\text{-}BSL,i}$
Data unit	m yr^{-1}
Description	Rate of organic soil loss due to subsidence and fire in the baseline scenario in stratum *i*
Equations	1, 8
Source of data	The rate of organic soil loss due to subsidence must be based on verifiable information and may be derived from: 1. Expert judgment, datasets and/or literature of historic subsidence involving the project or similar areas, based on surface height measurements relative to a fixed reference point in m asl, following methods described in Ballhorn *et al*. 2009 (eg, using poles fixed in the underlying mineral soil or rock, or by remote sensing) or similar. Information used must be verifiable. Or 2. CO_2 emissions derived from GHG emission proxies (ie, from VCS methodology *Baseline and monitoring methodology for the*

	rewetting of drained peatlands used for peat extraction, forestry and agriculture based on GESTS (under development) - Section 8.1.4.2.1), in combination with data on volumetric carbon content of the organic soil. Divide the annual CO_2 emission (t CO_2 ha^{-1}) by 44/12, then divide by volumetric carbon content (g C cm^{-3}) to obtain height loss in m. The average depth of burn scars may be derived from expert judgment, datasets and/or literature of historic burn depths involving the project or similar areas, based on surface height measurements, using field measurements or remote sensing (eg, following methods described in Ballhorn *et al*. 2009). The areal extent of burn scars may be obtained from statistics and/or maps in official reports and/or field measurements or remote sensing data. A mean annualized burn depth must be calculated and applied to the entire project area. As only part of the project area is likely to burn in the baseline, this constitutes a conservative approach. The project proponent must demonstrate, using expert judgment, datasets and/or scientific literature that the accuracy of the derived rate of organic soil loss is sufficient to fulfill the criteria set out in Section 5.2.2 (Stratification). Similarity of areas must be illustrated (by own measurements, literature resources, datasets or a combination of these) addressing organic soil type, climatic conditions, land use (forestry, agriculture, peat extraction, or abandonment after these activities), and average annual water table depth (±20%). In case of dissimilarity, the project proponent must demonstrate that such difference gives a conservative result for the net GHG benefits of the project. Forecasting organic soil subsidence rates must be based on the conservative extrapolation of a historic trend, or conservative modeling of proxies such as water table depth and land use type.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See under “Source of data”.
Purpose of Data	Calculation of baseline emissions Calculation of the maximum quantity of GHG emission reductions

	that may be claimed by the project
Comments	The use of a relatively low value for a constant rate of organic soil loss may not be confused with a relatively high value when determining the need for stratification of organic soil depth.

Data / Parameter	$Rate_{Closs\text{-}BSL,i,t}$
Data unit	t C ha^{-1} yr^{-1}
Description	Rate of organic carbon loss in mineral soil due to oxidation in the baseline scenario in stratum *i* in year *t*; alternatively, a conservative (low) value may be applied that remains constant over time
Equations	2, 15
Source of data	May be estimated using published values (see Sections 8.1.4.1 and 8.1.4.2.2 or either historical data collected from the project site or chronosequence data collected at similar sites (see Sections 8.1.4.1 and 8.1.4.2.6).
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Extrapolation of $Rate_{Closs\text{-}BSL,i}$. over the entire project crediting period must account for the possibility of a non-linear decrease of soil organic carbon over time, including the tendency of organic carbon concentrations to approach steady-state equilibrium (Section 5.1).
Purpose of Data	Calculation of baseline emissions Calculation of the maximum quantity of GHG emission reductions that may be claimed by the project
Comments	

Data / Parameter	$Rate_{Closs\text{-}WPS,i,t}$
Data unit	t C ha^{-1} yr^{-1}
Description	Rate of organic carbon loss in mineral soil due to oxidation in the project scenario in stratum *i* in year *t*.
Equations	16
Source of data	N/A
Value applied	0
Justification of choice of data or description of	This value is conservatively set to zero as loss rates are likely to be negative.

measurement methods and procedures applied	
Purpose of Data	Calculation of the maximum quantity of GHG emission reductions that may be claimed by the project
Comments	

Data / Parameter	$C_{BSL\text{-}soil,i,t}$
Data unit	t C ha^{-1}
Description	Soil organic carbon stock in the baseline scenario in stratum *i* in year *t*
Equations	32
Source of data	Soil coring may be used to generate a value of $C_{BSL\text{-}soil,i,t}$ as outlined in Section 9.3.7.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	For the baseline scenario, soil cores must be collected within 2 years prior to the project start date. If using an installed reference plane for the baseline scenario, it must have been installed at least 4 years prior to the baseline measurement, which is good practice to ensure that a reliable average accumulation rate is obtained.
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	$C_{min,i,t0}$
Data unit	t C m^{-3}
Description	Soil organic carbon content in mineral soil in stratum *i* at the project start date
Equations	11
Source of data	Own measurements and/or literature involving the project area.
Value applied	N/A
Justification of choice of data or description of measurement methods	Determined through procedures described in Section 9.3.7.

and procedures applied	
Purpose of Data	Calculation of baseline emissions Calculation of the maximum quantity of GHG emission reductions that may be claimed by the project
Comments	

Data / Parameter	$Depth_{soil,i,t0}$
Data unit	m
Description	Average mineral soil depth in stratum *i* at the project start date
Equations	11
Source of data	Own measurements and/or literature involving the project area.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Mineral soil depths at the project start date may be derived from: • Own measurements within the project area. • Literature involving the project or similar areas.
Purpose of Data	Calculation of baseline emissions Calculation of the maximum quantity of GHG emission reductions that may be claimed by the project
Comments	Only for *ex-ante* assessment

Data / Parameter	*VC*
Data unit	$t\ C\ m^{-3}$
Description	Volumetric organic carbon content of organic or mineral soil
Equations	5, 6, 13, 14, 15, 16, 31, 35, 39
Source of data	The volumetric soil organic carbon content may be taken from own measurements within the project area or from literature involving the project or similar areas.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	This parameter can be assessed using standard laboratory procedures.
Purpose of Data	Calculation of the maximum quantity of GHG emission reductions that may be claimed by the project Calculation of baseline emissions

	Calculation of project emissions
Comments	

Data / Parameter	$A_{i,t}$
Data unit	ha
Description	Area of baseline stratum *i* in year *t*
Equations	27
Source of data	Delineation of strata is done preferably using a Geographical Information System (GIS), which allows for integrating data from different sources (including GPS coordinates and Remote Sensing data).
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See under "Source of data".
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	$C_{BSL\text{-}herb,i,t}$
Data unit	t C ha^{-1}
Description	Carbon stock in herbaceous vegetation in the baseline scenario in stratum *i* in year *t*
Equations	26
Source of data	Own measurements or default factor
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	A default factor[23] of 3 t C ha^{-1} may be applied for strata with 100% herbaceous cover and applying a 1:1 relationship between vegetation cover and $C_{BSL,\text{-herb},i,t}$ for areas with a vegetation cover <100%. The default may be claimed for one year only during the project as herbaceous biomass quickly reaches steady state.

[23] Calculated from summary of peak aboveground biomass data from 20 sites summarized in Mitsch & Gosselink. The median of these studies is 1.3 t d.m. ha^{-1}. This was converted to the recommended value as follows: 1.3 × 0.45 × 0.5 × 10. The factor 0.45 converts organic matter mass to carbon mass; the factor 0.5 is a factor that averages annual peak biomass (factor = 1) and annual minimum biomass (factor = 0, assuming ephemeral aboveground biomass and complete litter decomposition.

	Vegetation cover must be determined by commonly used techniques in field biology. Procedures for measuring carbons stocks in herbaceous vegetation are provided in Section 9.3.6.
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	*%OM*
Data unit	%
Description	Percentage of soil organic matter
Equations	37, 38, 40, 41, 42
Source of data	Own measurements based on loss-on-ignition or may be derived from own measurements of soil carbon. Measured from samples collected in Section 9.3.7 or indirectly from the soil carbon % as described in Section 8.1.4.2.7.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	The equations provided were developed for tidal marsh soils by Craft *et al*., 1991 and for mangrove soils by Allen, 1974.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	

Data / Parameter	$\%C_{soil}$
Data unit	%
Description	Percentage of soil organic C
Equations	39, 40, 41
Source of data	Own measurements or may be derived from own measurements of soil organic matter. Measured from samples collected in Section 9.3.7 or indirectly from the soil organic matter % determined through loss on ignition as described in Section 9.3.6.
Value applied	N/A
Justification of choice of data or description of measurement methods	See under “Source of data”.

and procedures applied	
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	

Data / Parameter	*BD*
Data unit	kg m^{-3}
Description	Dry bulk density
Equations	38, 39, 42, 81
Source of data	Own measurements or, for the determination of allochthonous carbon, may be derived from soil carbon percentage as described in section 8.1.4.2.7.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Mass of soil material after drying to removed water per volume of soil material.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	

Data / Parameter	$\%OM_{depositedsediment}$
Data unit	%
Description	Percentage of organic matter in deposited sediment
Equations	37
Source of data	May be estimated directly using loss-on-ignition (LOI) data or indirectly from soil carbon percentage as described in Section 8.1.4.2.7.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	LOI can be assessed using standard laboratory procedures.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions

Comments	

Data / Parameter	$\%C_{depositedsediment}$
Data unit	%
Description	Percentage of carbon in deposited sediment; %
Equations	36
Source of data	May be estimated directly using loss-on-ignition (LOI) data or indirectly from soil carbon percentage as described in Section 8.1.4.2.7. May be directly measured from samples collected on sediment tiles or through collection and carbon analysis (see Section 9.3.7) of suspended sediments in tidal channels or sediments deposits in tidal flats, or using a default factor of 1.5.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	The default factor is derived from the maximum value (conservative) provided by Andrews *et al.*, 2011.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	

Data / Parameter	$EF_{N2O,burn}$
Data unit	g N_2O / kg $Biomass_{dry}$
Description	Emission factor for N_2O for vegetation burning
Equations	65
Source of data	Project managers may use factors that have been determined for grassland vegetation. A suitable EF_{N2O} value is 0.21, from Table 2.5 of the 2006 IPCC Guidelines for National Greenhouse Inventories.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Nitrous oxide emission factors for the combustion of herbaceous wetland vegetation are not currently available in the literature, but these emissions are expected to be similar to those for grassland vegetation.

Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	$EF_{CH4,burn}$
Data unit	g CH_4 / kg $Biomass_{dry}$
Description	Emission factor for CH_4 for vegetation burning
Equations	66
Source of data	Project managers may use factors that have been determined for grassland vegetation. A suitable EF_{CH4} value is 2.3, from Table 2.5 of the 2006 IPCC Guidelines for National Greenhouse Inventories,
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Methane emission factors for the combustion of herbaceous wetland vegetation are not currently available in the literature, but these emissions are expected to be similar to those for grassland vegetation.
Purpose of Data	Calculation of project emissions
Comments	

9.2 Data and Parameters Monitored

Data Unit / Parameter	$Biomass_{i,t}$
Data unit	kg d.m. ha^{-1}
Description	Aboveground shrub biomass in stratum *i* in year *t*
Equations	65, 66
Source of data	Measured using field collected data at time of burning or conservatively from data collected during a period with greater biomass within year *t*,
Description of measurement methods and procedures to be applied	This value can be obtained from $B_{SHRUB,i,t}$ in AR-ACM0003 where $B_{SHRUB,i,t}$ (shrub biomass per hectare in shrub biomass stratum *i* at a given point of time in year *t*; t d.m. ha^{-1}) is quantified. Convert from t d.m. ha^{-1} to kg d.m. ha^{-1}.
Frequency of monitoring/recording	One time measurement for each burn event
QA/QC procedures to be applied	See Section 9.3.2

Purpose of data	Calculation of project emissions
Calculation method	
Comments	

Data Unit / Parameter	$Rate_{peatloss\text{-}WPS,i,t}$
Data unit	m yr^{-1}
Description	Rate of organic soil loss due to subsidence in the project scenario in stratum *i* in year *t*
Equations	8
Source of data	The rate of organic soil loss due to subsidence must be based on verifiable information and may be derived from: 1. Expert judgment, datasets and/or literature of subsidence involving areas representing conditions similar to the project, based on surface height measurements relative to a fixed reference point in m asl, following methods described in Ballhorn *et al*. 2009 (eg, using poles fixed in the underlying mineral soil or rock, or by remote sensing or similar). Or 2. CO_2 emissions derived from GHG emission proxies (f.e. from VCS methodology *Baseline and monitoring methodology for the rewetting of drained peatlands used for peat extraction, forestry and agriculture based on GESTS* (under development) - Section 8.1.4.2.1), in combination with data on volumetric carbon content of the organic soil. Divide the annual CO_2 emission (t CO_2 ha^{-1}) by 44/12, then divide by volumetric carbon content (g C cm^{-3}) to obtain height loss in m. The project proponent must demonstrate, using expert judgment, datasets and/or scientific literature that the accuracy of the derived rate of organic soil loss is sufficient to fulfill the criteria set out in Section 5.2.2 (Stratification). Similarity of areas must be illustrated (by own measurements, literature resources, datasets or a combination of these) addressing organic soil type, climatic conditions, land use (forestry, agriculture, peat extraction, or abandonment after these activities), and average annual water table depth (±20%). In case of dissimilarity, the project proponent must demonstrate that such difference gives a conservative result for the net GHG benefits of

	the project.
Justification of choice of data or description of measurement methods and procedures applied	See under "Source of data".
QA/QC procedures to be applied	See Section 9.3.2
Purpose of Data	Calculation of the maximum quantity of GHG emission reductions that may be claimed by the project
Calculation method	
Comments	Only for *ex-ante* assessment

Data / Parameter	$C_{WPS\text{-}herb,i,t}$
Data unit	t C ha^{-1}
Description	Carbon stock in herbaceous vegetation in the project scenario in stratum *i* in year *t*
Equations	62
Source of data	Own measurements or default factor
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	A default factor of 3 t C ha^{-1} may be applied for strata with 100% herbaceous cover and applying a 1:1 relationship between vegetation cover and $C_{WPS,\text{-herb},i,t}$ for areas with a vegetation cover <100%. The default may be claimed for one year only during the project as herbaceous biomass quickly reaches steady state. Vegetation cover must be determined by commonly used techniques in field biology. Procedures for measuring carbons stocks in herbaceous vegetation are provided in Section 9.3.6.
QA/QC procedures to be applied	See Section 9.3.2
Purpose of Data	Calculation of project emissions
Calculation method	
Comments	

Data / Parameter	$A_{i,t}$

Data unit	ha
Description	Area of project stratum *i* in year *t*
Equations	27
Source of data	Delineation of strata must be done preferably using a Geographical Information System (GIS), which allows for integrating data from different sources (including GPS coordinates and Remote Sensing data).
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See under “Source of data”.
QA/QC procedures to be applied	See Section 9.3.2
Purpose of Data	Calculation of project emissions
Calculation method	
Comments	

Data / Parameter	$C_{WPS\text{-}soil,i,t}$
Data unit	t C ha^{-1}
Description	Carbon stock in the project scenario in stratum *i* in year *t*
Equations	27
Source of data	Soil coring may be used to generate a value of $C_{WPS\text{-}soil,i,t}$ as outlined in Section 9.3.7.
Value applied	N/A
Description of measurement methods and procedures to be applied	See Section 9.3.7
QA/QC procedures to be applied	See Section 9.3.2
Purpose of data	Calculation of project emissions
Calculation method	
Comments	

9.3 Description of the Monitoring Plan

9.3.1 General

The main objective of project monitoring is to reliably quantify carbon stocks and GHG emissions in the project scenario during the project crediting period, prior to each verification, with the following main tasks:

- Monitoring of project carbon stock changes and GHG emissions
- Estimation of ex-post total net carbon stock changes and GHG emissions, and GHG emissions reductions

The monitoring plan must contain at least the following sections:

- A description of each monitoring task to be undertaken, and the technical requirements
- Parameters to be measured
- Data to be collected and data collection techniques
- Frequency of monitoring
- Quality Assurance and Quality Control (QA/QC) procedures
- Data archiving procedures
- Roles, responsibilities and capacity of monitoring team and management

9.3.2 Uncertainty and quality management

Quality management procedures are required for the management of data and information, including the assessment of uncertainty, relevant to the project and baseline scenarios. As far as practical, uncertainties related to the quantification of GHG emission reductions and removals by sinks should be reduced.

To help reduce uncertainties in the accounting of emissions and removals, this methodology uses whenever possible the proven methods from the GPG-LULUCF, GPG-2000, the IPCC's Revised 2006 Guidelines and peer-reviewed literature. Despite this, potential uncertainties still arise from the choice of parameters to be used. Uncertainties arising from input parameters would result in uncertainties in the estimation of both baseline net GHG emissions and project net GHG emissions - especially when global default factors are used. The project proponent must identify key parameters that would significantly influence the accuracy of estimates. Local values that are specific to the project circumstances must then be obtained for these key parameters, whenever possible. These values should be based on:

- Data from well-referenced peer-reviewed literature or other well-established published sources[24]; or,

[24] Typically, citations for sources of data used should include: the report or paper title, publisher, page numbers, publication date etc. (or a detailed web address). If web-based reports are cited, hardcopies should be included as annexes in the PD if there is any likelihood that such reports may not be permanently available.

- National inventory data or default data from IPCC literature that has, whenever possible and necessary, been checked for consistency against available local data specific to the project circumstances; or
- In the absence of the above sources of information, expert opinion may be used to assist with data selection. Experts will often provide a range of data, as well as a most probable value for the data. The rationale for selecting a particular data value must be briefly noted in the PD.

In choosing key parameters, or making important assumptions based on information that is not specific to the project circumstances, such as in use of default data, project proponents must select values that will lead to an accurate estimation of net GHG emission reductions, taking into account uncertainties.
If uncertainty is significant, project proponents must choose data such that it indisputably tends to under-estimate, rather than over-estimate, net GHG project benefits.
To ensure that carbon stocks are estimated in a way that is accurate, verifiable, transparent, and consistent across measurement periods, the project proponent must establish and document clear standard operating procedures and procedures for ensuring data quality. At a minimum, these procedures must include:

- Comprehensive documentation of all field measurements carried out in the project area. This document must be detailed enough to allow replication of sampling in the event of staff turnover between monitoring periods.
- Training procedures for all persons involved in field measurement or data analysis. The scope and date of all training must be documented.
- A protocol for assessing the accuracy of plot measurements using a check cruise and a plan for correcting the inventory if errors are discovered.
- Protocols for assessing data for outliers, transcription errors, and consistency across measurement periods.
- Data sheets must be safely archived for the life of the project. Data stored in electronic formats must be backed up.

9.3.3 Expert judgment

Expert judgment on selection and interpretation of methods and selection of input data and to fill gaps in the available data, to select data from a range of possible values or on uncertainty ranges is well established in the IPCC 2006 good practice guidance. Obtaining well-informed judgments from domain experts regarding best estimates and uncertainties is an important aspect in various procedures throughout this methodology. Project proponents must use the guidance provided in Chapter 2 (Approaches to Data Collection), in particular, Section 2.2 and Annex 2A.1 of the IPCC 2006 good practice guidance.

9.3.4 Monitoring of project implementation

Information must be provided, and recorded in the project description (PD), to establish that:

1) The geographic position of the project boundary is recorded for all areas of wetland. The geographic

coordinates of the project boundary (and any stratification or buffer zones inside the boundary) are established, recorded and archived. This can be achieved by field survey (eg, using GPS), or by using georeferenced spatial data (eg, maps, GIS datasets, orthorectified aerial photography or georeferenced remote sensing images). The above also applies to the recording of strata.

2) Commonly accepted principles of land use inventory and management are implemented.

- Standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) procedures for inventories including field data collection and data management must be applied. Use or adaptation of SOPs already applied in national land use monitoring, or available from published handbooks, or from the IPCC GPG LULUCF 2003, is recommended;
- Apply SOPs, especially, for actions likely to cause soil disturbances;
- The project plan, together with a record of the plan as actually implemented during the project must be available for validation or verification, as appropriate.

Continued compliance with the applicability conditions of this methodology must be ensured by monitoring that:

- The burning of organic soil as a project activity does not occur.
- Peatland fires within the project boundary do not occur in the project scenario. If they occur as non-catastrophic events as defined in this methodology, they are accounted for by cancelling the *Fire Reduction Premium* for the entire project or the individual sub-project.
- N-fertilizers are not used within the project boundary in the project scenario.

When project proponent chooses to monitor alterations of water table depth at the project boundary to demonstrate no alteration of mean annual water table depths in adjacent areas or that such alteration is limited to levels that do not influence GHG emissions, the project must use water level gauges or vegetation assessments, or a combination of these. Water level gauges must be installed at the project boundary and readings must be compared with the hydrological modeling results or expert judgment on which the establishment of the project boundary was based. The number and spacing of water level gauges must be based on hydrological modeling or expert judgment. Alternatively, where vegetation composition is a proxy for water table depth as described in the VCS methodology *Baseline and monitoring methodology for the rewetting of drained peatlands used for peat extraction, forestry and agriculture based on GESTS* (under development), a vegetation assessment may be done in the zone adjacent to the project boundary. Results for vegetation types adjacent to the project boundary are compared with the vegetation composition in the same area at the project start date. The difference in vegetation composition is significant if this leads to a different correlated water table depth or water table depth class. See the above VCS for procedures.

9.3.5 Stratification and sampling framework

Stratification of the project area into relatively homogeneous units may either increase the measuring precision without increasing the cost unduly, or reduce the cost without reducing measuring precision because of the lower variance within each homogeneous unit. Project proponents must present in the PD an *ex-ante* stratification of the project area or justify the lack of it. The number and boundaries of the

strata defined *ex ante* may change during the Crediting Period (*ex post*).
The *ex-post* stratification must be updated because of the following reasons:

- Unexpected disturbances occurring during the Crediting Period (eg, due to changes in the hydrology, fire, pests or disease outbreaks), affecting differently various parts of an originally homogeneous stratum;
- Management activities (forestry, agriculture, hydrology) that are implemented in a way that affects the existing stratification.

Established strata may be merged if the reasons for their establishment have disappeared.
The sampling framework, including sample size, plot size, plot shape, and determination of plot location must be specified in the PD. Where changes in carbon stocks are to be monitored (eg, in trees), permanent sampling plots must be used, noting the following:

1) To determine the sample size and allocation among strata, this methodology uses the procedures in Section 9.3.5 and the latest version of the CDM tool *Calculation of the number of sample plots for measurements within A/R CDM project activities*. The targeted confidence interval must be 90% or 95%. Where a 90% confidence interval is adopted and the width of the confidence interval exceeds 20% of the estimated value or where a 95% confidence interval is adopted and the width of the confidence interval exceeds 30% of the estimated value, an appropriate confidence deduction must be applied, as outlined in Section 8.4.2.
2) In order to avoid bias, sample plots should be marked inconspicuously.
3) The sample plot size must be established according to common practice in forest, vegetation and soil inventories.
4) To avoid subjective choice of plot locations, the permanent sample plots must be located either systematically with a random start or completely randomly inside each defined stratum. The geographical position (GPS coordinate), administrative location, stratum and stand, series number of each plot, as well as the procedure used for locating them must be recorded and archived. The sampling plots are to be as evenly distributed as possible, where larger strata have more plots than smaller strata. However, remote areas and areas with poor accessibility may be excluded for the location of sampling plots. Such areas must be mapped as separate strata and for these strata accounting of carbon stocks in tree biomass in the project scenario is conservatively omitted (Section 8.2.2).

The choice of monitoring frequency must be justified in the project description.

9.3.6 Sampling of herbaceous vegetation

Aboveground herbaceous mass (herb) is defined as a pool that includes both living plant mass (ie, biomass) and dead plant mass (ie, litter). All living and dead herbaceous mass is clipped above the soil surface from inside each sample frame. Dry mass is determined by either drying the entire wet sample to a constant weight, or drying a subsample of the wet mass to determine a dry-to-wet mass ratio conversion factor. Because aboveground mass can be highly seasonal, the average pool must be calculated from at least two samples representing the minimum and maximum standing stocks. Alternatively, a conservative estimate of the pool may be determined from a sample taken at the time of minimum standing stock.

9.3.7 Soil coring approach for estimating soil carbon

Soil organic carbon may be estimated by determining the organic carbon accumulated above a consistent reference plane and then dividing by the years since the date of the reference plane (for the baseline scenario) or the start of project activities (for the project scenario). The reference plane must be established using a marker horizon (most commonly using feldspar)[25], a strongly contrasting soil layer (such as the boundary between organic and mineral soil materials), an installed reference plane (such as the shallow marker in a surface elevation table)[26], a layer identified biogeochemically (such as through radionuclide, heavy metal, or biological tracers)[27], a layer with soil organic carbon indistinguishable from the baseline SOC concentration (as determined in Section 8.1.4.2.5)[28], or other accepted technologies. Note that feldspar marker horizons should not be used in systems where they are unstable, such as some sandy soils and systems with significant bioturbation. The material below the reference plane may be conservatively assumed to have zero change due to project activities. The material located above the reference plane must be analyzed for total carbon and bulk density. Sediment samples may be collected for the estimation of $\%C_{depositedsediment}$ (see Section 8.1.4.2.7) using sediment tiles,[29] through collection of suspended sediments in tidal channels during a period of high suspended sediment concentration, or by collecting cores of sediment deposits in tidal flats. Total organic carbon must be analyzed directly using CHN elemental analysis or the Walkley-Black chromic acid wet oxidation method, or determined from loss-on-ignition (LOI) data using the equation

$$\%C = 0.04 * \%OM + 0.0025 \times \%OM^2 \text{ (only for marsh soils)}^{30} \quad \textbf{(79)}$$

$$\%C = \%OM \,/\, 1.724 \text{ (only for mangrove soils)}^{31} \quad \textbf{(80)}$$

or through an equation developed using site-specific data. Inorganic carbon should be removed from samples if present in significant quantities, usually through acid treatment (such as sulfurous or hydrochloric acid). Live coarse below-ground tree biomass should be removed from soil samples prior to analysis. Additional live below-ground biomass may be removed or included.

Soil samples collected may be aggregated to reduce the variability.

The mass of carbon per unit area is calculated as follows:.

[25] Cahoon & Turner, 1989
[26] Cahoon *et al.*, 2002
[27] DeLaune *et al.*, 1978
[28] Greinier *et al.*, in press
[29] Pasternack and Brush, 1998
[30] Craft *et al.*, 1993
[31] Allen, 1974

$$C_{WP,SOCacc} = 44/12 \times \sum_{i=1}^{Ndepth} \left(CF_{SOC,sample} \times BD \times Thickness \times 100 \right) \quad \textbf{(81)}$$

Where:

$C_{WP,SOCacc}$	Average accumulation of soil/sediment over reference plane in the project; t CO_2e ha^{-1}
44/12	Ratio of molecular weight of CO_2 to carbon; dimensionless
Ndepth	Number for soil horizons, based on subdivisions of soil cores
CF_{SOC_sample}	Carbon fraction of the sample, as determined in laboratory; %
BD	Bulk density, as determined in laboratory; g cm^{-3}
Thickness	Thickness of soil horizon; cm
100	Conversion factor of g cm^{-3} to Mg ha^{-1}

9.3.8 Monitoring CH_4 and N_2O emissions

Direct measurement of CH_4 and/or N_2O emissions may be made with either a closed chamber technique or a chamber-less technique such as eddy covariance flux. For eddy covariance methods, the guidelines presented in the VCS methodology *VM0024 Methodology for Coastal Wetland Creation* must be followed, with the additional guidance below. Flux measurements are expected to conform to standard best practices used in the scientific community[32]. The basic design of the closed chamber for wetlands requires a base that extends into the soil (5 cm minimum), and a chamber that is placed over the plants and sealed to the base. To prevent the measurement from disturbing CH_4 emissions, the base should be placed at least one day in advance, and the plot should be approached on an elevated ramp or boardwalk when taking samples, although failure to do so is conservative because it will cause higher fluxes. CH_4 flux is calculated as the difference in initial and final headspace CH_4 concentration, without removing non-linear increases caused by bubble (ebullition) fluxes that may have occurred. Initial and final concentrations will be determined as the average of duplicate determinations. Because CH_4 and N_2O emissions can be low from tidal wetlands, it may be necessary to enclose large areas (≥ 0.25 m^2) or lengthen the measurement period to improve sensitivity.

Methane emissions from strata lacking vegetation (<25% cover), such as open water, hollows or ponds, can be dominated by episodic bubble emissions (ie, ebullition). Chambers for open water emissions are typically a single piece that floats such that the bottom extends under the water surface (5 cm minimum). Floating chambers will be deployed for a minimum of 4 days.

Eddy covariance techniques sense total CH_4 and N_2O emissions (diffusive and ebullition) at high temporal resolution; such systems will be deployed for a minimum of 48 hours of useable data.

CH_4 and N_2O emission estimates must be either accurate or conservative. Accurate estimates must account for variation in time caused by changes in plant activity, temperature, water table depth, salinity and other sources of variation, and in space caused by factors such as topography (eg, hummocks versus hollows) or plant cover. A conservative estimate may be based on direct measurements taken at

[32] Oremland, 1975

times and places in which CH_4 or N_2O emissions are expected to be the highest based on expert judgment, datasets or literature.

A conservative estimate of CH_4 or N_2O emissions requires application of the following considerations. Fluxes will be measured in the stratum with the highest emissions. For CH_4, these are likely to be strata in the wettest strata that support emergent vegetation, but may include stagnant pools of water. Eddy flux towers will be placed so that the footprint lies in the stratum with the highest CH_4 or N_2O emissions for 50% of the time. CH_4 fluxes will be measured when the water table is <10 cm from the soil surface, during times of year when emissions are highest, such as the warmest month and/or wettest month. When CH_4 emission rates incorporate measurements from periods of time outside the peak, they will be made at approximately monthly intervals.

In addition to the conservative principles above, there are additional things to consider that are specific to the method applied. In particular, closed chambers will be transparent and deployed in daylight unless it is can be shown that CH_4 emissions are not sensitive to light.

Regardless of method, emissions will be averaged and expressed as daily (24 hour) rates and converted to annual estimates with the following equation:

$$GHG_{WPS\text{-}soil\text{-}CH4,i,t} = GHG_{CH4\text{-}daily,i,t} \times 365 \times VCS_{CH4\text{-}GWP} \quad \textbf{(82)}$$

Where:

$GHG_{WPS\text{-}soil\text{-}CH4,i,t}$	CH_4 emissions from the SOC pool in the project scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$GHG_{CH4\text{-}daily,i,t}$	Average daily CH_4 emissions in the baseline scenario based on direct measurements of stratum *i* in year *t*; mg CH_4 m^{-2} d^{-1}
$VCS_{CH4\text{-}GWP}$	Current VCS value for global warming potential of CH_4; dimensionless
i	1, 2, 3 …M_{WPS} strata in the baseline scenario
t	1, 2, 3, … *t** years elapsed since the project start date

$$GHG_{WPS\text{-}soil\text{-}N2O,i,t} = GHG_{N2O\text{-}daily,i,t} \times 365 \times VCS_{N2O\text{-}GWP} \quad \textbf{(83)}$$

Where:

$GHG_{WPS\text{-}soil\text{-}N2O,i,t}$	N_2O emissions from the SOC pool in the project scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$GHG_{N2O\text{-}daily,i,t}$	Average daily N_2O emissions in the baseline scenario based on direct measurements of stratum *i* in year *t*; mg N_2O m^{-2} d^{-1}
$VCS_{N2O\text{-}GWP}$	Current VCS value for global warming potential of N_2O; dimensionless
i	1, 2, 3 …M_{WPS} strata in the baseline scenario

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

Where the general default factor approach is used for CH_4 emissions (Section 8.1.4.3.4), the salinity average or salinity low point will be measured on shallow pore water (within 30 cm from soil surface) using a handheld salinity refractometer or other accepted technology. The salinity average will be calculated from observations that represent variation in salinity during periods of peak CH_4 emissions (eg, during the growing season in temperate ecosystems or the wet season in tropical ecosystems). When the number of observations during this period is small (fewer than one per month for one year), the salinity low point from these data will be used. The salinity of the floodwater source (eg, an adjacent tidal creek) during this period may be used as a proxy for salinity in pore water provided there is regular hydrologic exchange between the source and the wetland (ie, the source floods the wetland at least on 20% of high tides).

9.3.9 Monitoring of soil subsidence

If soil subsidence, on drained wetlands, is used as a proxy for carbon loss and CO_2 emissions, applied techniques and calculations shall follow international standards of application or local standards as laid out in pertinent scientific literature or handbooks. The lowering of the organic soil surface over time (subsidence) must be measured relative to a fixed point (datum) (eg, using a pole fixed in the mineral subsoil). Dipwells used for water table depth monitoring may be used for subsidence monitoring with the advantage that water table depth and subsidence are monitored at the exact same location. In areas where fire may occur, it is best (also) to place iron poles. If poles are lost due to fire, new poles must be installed. Height losses due to fire must be treated separately from those caused by microbial oxidation of the organic soil in assessing carbon losses. Interpolation of the trend in organic soil height loss over a longer period surrounding the fire event allows for quantifying height loss due to the fire. At least 10 replicate subsidence poles must be evenly distributed per stratum. To prevent disturbance, poles may need to be fenced in. In order to avoid disturbance of the organic soil surface during readings it is advisable to place boardwalks. For remote and inaccessible areas, project proponents may rely on vegetation cover as an indicator for water table depth and associated subsidence rates as supported by data or literature references in a conservative way. The minimum monitoring frequency for soil subsidence is once a year.

Consolidation of the saturated organic soil below the water table may contribute to subsidence over multiple years. Proponents shall conservatively assess the contribution of consolidation to overall subsidence by reference to literature values or expert judgment or demonstrate that consolidation plays an insignificant role in overall subsidence (< 5%).

The calculation of carbon loss rates from subsidence data shall follow pertinent scientific literature (eg, Couwenberg & Hooijer, 2013) and usually requires data on the volumetric carbon content of the organic soil. When subsidence measurements are used to establish emission factors to be associated with other proxies, measurements shall be carried out over a period of at least 24 months to cover intra- and inter-annual variability.

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ANNEX 1: JUSTIFICATION OF STANDARDIZED APPROACH FOR ADDITIONALITY

Introduction and result of the calculations

This methodology demonstrates through extensive data analysis that for tidal wetland restoration activities in the United States of America, the Activity Penetration is 1.08%, which is less than the 5% set as the allowed maximum in the VCS Standard, and therefore "tidal wetland restoration in the USA" is additional.

Activity Penetration is defined as:

$$APy = OAy / MAPy$$

Where:

APy	Activity Penetration of the project activity in year y (percentage)
OAy	Observed adoption of the project activity in year y (eg, total number of instances installed at a given date in year y, or amount of energy supplied in year y)
MAPy	Maximum adoption potential of the project activity in year y (eg, total number of instances that potentially could have been installed at a given date in year y, or the amount of energy that potentially could have been supplied in year y)

For tidal wetland restoration in the USA, these terms are further defined as follows:

OAy	The average annual aggregate reported tidal wetland restoration projects for 2009 - 2012, as reported by the 28 National Estuary Programs (NEPs) and their partners to the U.S. Environmental Protection Agency.
MAPy	The aggregate tidal wetland restoration goals of the 28 National Estuary Programs as detailed in Table A.

Justification of the data set and that all assumptions are conservative

The USA is a developed country where states have equal access to the nation's resources. Factors causing degradation are the same throughout the USA. Climate is not a factor in degradation of tidal wetlands, which occur across all climatic regions in the USA.

No national data sets exist for either tidal wetland loss or restoration in the USA. However, a conservative approximation can be made by examining the data from the 28 National Estuary Programs. The National Estuary Program (NEP) was established under Section 320 of the 1987 Clean Water Act as a U.S. Environmental Protection Agency program to protect and restore the water quality and ecological integrity of estuaries of national significance. The NEP consists of 28 individual estuary programs in the USA. Each NEP has a Management Conference consisting of diverse stakeholders including citizens, local, state and federal agencies, as well as non-profit and private sector interests. They emphasize a collaborative approach to establishing and implementing a locally-based Comprehensive Conservation and Management Plans (CCMP).

The Activity Penetration of tidal wetland restoration in the 28 National Estuary Programs is an appropriate and conservative indicator of Activity Penetration in other estuaries in the USA, for the following reason.

The 28 estuaries covered by NEPs are the most advanced in conservation planning and implementation, including ecological restoration, and as such will have the greatest Activity Penetration rates of estuaries in the USA. Estuaries not among the NEPs will typically have lower adoption rates for tidal wetland restoration. Therefore, full inclusion of the latter estuaries in the assessed data would lead to an even lower Activity Penetration.

That <u>estuaries in NEPs face the same or similar barriers to implementation of tidal wetland restoration projects as estuaries that do not have an NEP is supported by the expert opinion added to this document.</u> The expert also confirms that the rates of restoration in NEPs are greater than the rates of restoration occurring in non-NEP estuaries in the USA.

To undertake tidal wetland restoration requires significant scientific, regulatory, and ecological expertise, substantial financial resources, cooperating partners, and the ability to make long-term commitments. As a participating estuary, each of the 28 NEPs receive strong federal and state financial assistance and programmatic support in these areas - support which non-NEP estuaries do not receive.

Moreover, because the NEPs are collaborative partnerships of agencies, organizations, businesses, and others, the data reported for each NEP represents a comprehensive reporting of the restoration activities undertaken by any of the partners. This results in a higher rate of observed adoption and therefore a higher Activity Penetration than in estuaries without a national estuary program, which is conservative.

All USA estuaries face a common set of barriers to tidal wetland restoration: insufficient funding, willing landowners, community support, and physical and ecological limitations and changes, such as sea level rise.[i, ii] In 2000, recognizing the critical need to provide funding for estuary habitat restoration, including tidal wetlands, and help to counter the mentioned socio-economic factors, the USA Congress passed and President Clinton signed into law the Estuary Act of 2000, which authorized $275 million over five years for restoration activities. [iii] However, Congress failed to appropriate the vast majority of these funds, and a tremendous shortage of project funding persists.

Initially, three years of data, 2009-2011, were determined to be appropriate for analysis for two reasons. First, length of construction of tidal wetland and seagrass projects typically ranges from 1-3 years. A 3-year average of data would capture projects in various stages of completion that made it to completion during the selected years. The data for the NEPs is for completed projects, not those that have been initiated but not yet completed. A 3-year range is more inclusive. The second reason for selection of this time period is that there was a one-time, significant infusion of federal government funding for estuary restoration in 2009. Through the American Recovery and Reinvestment Act of 2009, the National Oceanic and Atmospheric Administration received $165 million for projects which could be completed within 12-18 months. This one time investment in restoration is highly unusual over the past 14 years (since the NEP data was first captured in 2000). Including years that capture this infusion of capital is a conservative approach to estimating activity. The 3-year data period was later expanded to include 2012 as that dataset became available, bringing the final range of analysis to four years of data, from 2009-2012.

Method of analysis

OAy is determined through a systematic review of the data sets provided by the EPA for each of the NEPs. In reviewing each data set, the analysis only includes project acreage resulting from projects, which (1) are not required by any rule, regulation, law, statute, court settlement or other mandatory action; and (2) meet the definition of tidal wetland restoration provided in this methodology. Where a project description included multiple habitat types (eg, tidal wetland, shoreline, agriculture, etc.) and/or the project description included one or more activities in addition to restoration (eg, acquisition, barrier removal, etc.), the entire project acreage was included in determining *OAy*. This is conservative because it will lead to a higher Activity Penetration.

To determine *MAPy*, the Comprehensive Conservation and Management Plans, and other documents from each NEP were assessed to identify, where available, (1) historic loss of tidal wetlands, and (2) specific tidal wetland restoration goals expressed in acres. For NEPs with goal data, the average goal is 59% of the acreage that has been lost. Adopting this average for estimating a goal where data does not exist is conservative. Therefore, where a NEP did not set a restoration goal, the table below calculates a goal of 59% of the acreage of tidal wetlands that have been lost. Moreover, *MAPy* calculated here is conservative because the restoration goals are a subset of the set of restoration (ie, what has been lost that could take place in an estuary). A smaller MAPy yields a higher Activity Penetration.

Table A. Tidal wetland restoration goals of the 28 National Estuary Programs in the USA.

Estuary Program	Tidal Wetland Loss	Tidal Wetland Restoration Goal	Tidal Wetland Acres Restored 2009	2010	2011	2012
Northwest						
Puget Sound Partnership	66,790[iv]	36,900[v]	1,277[vi]	140[vii]	505.4	101
Lower Columbia River Estuary Partnership	9,420[viii]	10,000[ix]	0	0	184	58
Tillamook Estuaries Partnership	3,340[x]	750[xi]	46	44	16	4.4
California						
San Francisco Estuary Partnership	150,000[xii]	100,000[xiii]	1,469	401	3250	983.36
Morro Bay National Estuary Program	No data available	No specific goal[xiv]	0	0	0	0
Santa Monica Bay Restoration Commission	2,000[xv]	1,200[xvi]	0	21	0	0
Gulf Coast						
Coastal Bend Bays and Estuaries Program	24,710[xvii]	n/a	1,597	568	351	72
Galveston Bay Estuary Program	33,400[xviii]	13,600[xix]	158	46.81	407.06	9

Barataria-Terrebonne Estuary Program	294,000[xx]	256,000[xxi]	673.58	n/a	35[xxii]	182[xxiii]
Mobile Bay National Estuary Program	118,000[xxiv, xxv]	1,000[xxvi]	137	0	6.5	2
Tampa Bay Estuary Program	13,378[xxvii]	1,918[xxviii]	142.7	61.28	0	44.54
Sarasota Bay Estuary Program	1600[xxix]	18 acres per year[xxx]	516	0	30	5
Charlotte Harbor National Estuary Program	35,260[xxxi]	50,740[xxxii, xxxiii]	600.5	496	795	140
Southeast						
Indian River Lagoon National Estuary Program	40,420[xxxiv]	10,000[xxxv]	1,395.75	21.26	419	140.3
Mid-Atlantic						
Albemarle-Pamlico National Estuary Program	~100,000[xxxvi]	No goal established[xxxvii, xxxviii]	1.1	4	84.2	.31
Chesapeake Bay Program	203,000[xxxix]	30,000 [xl]	622[xli]	1,005	3,775	n/a
Northeast						
Maryland Coastal Bays Program	54,778[xlii]	10,000[xliii]	64.43	1.8	104	189
Delaware Center for the Inland Bays	2,000[xliv]	4,147[xlv]	26	4	0	0
Partnership for the Delaware Estuary	9,622[xlvi, xlvii, xlviii]	2500/year[xlix]	1.3	6.5	0	0

Barnegat Bay Partnership	1,865 (1995-2007)[l]	No goal established[li]	0	0	0	0
New York-New Jersey Harbor Estuary Program	300,000 - 800,000[lii, liii]	15,200[liv]	11	34	65.8	50
Long Island Sound Study	7,390[lv]	250/year[lvi]	58.65	88	42.56	137.7
Peconic Bay Estuary Program	256[lvii]	266[lviii]	0	0	0	0
Narragansett Bay Estuary Program	306[lix]	No goal established[lx]	63	58	0	0
Buzzards Bay National Estuary Program	3,405[lxi, lxii]	510 [lxiii]	3.74	0	0	0
Massachusetts Bays Program	~22,667[lxiv]	No goal established[lxv]	1442	133	54	21
Piscataqua Region Estuaries Partnership	1,044[lxvi]	300[lxvii]	0	0	12	.05
Casco Bay Estuary Partnership	228[lxviii]	No goal established[lxix, lxx]	0	0	0	21.8

[i] (Vigmostad, Mays, Hance, & Cangelosi, 2005) and all Comprehensive Coastal Management Plans below.
[ii] (Restore America's Estuaries and the Estuarine Research Federation)
[iii] (Congressional Research Service, 2000)
[iv] (Simenstad, 2011)
[v] (Puget Sound Partnership, 2011).
[vi] All 2009 data are from "NEP Project Information and Maps 2000-2009," http://gispub2.epa.gov/NEPMap/archivetree/archivetree.html. (U.S. Environmental Protection Agency). From each table, only tidal wetland restoration projects are counted.
[vii] All 2010, 2011 and 2012 data are from the "NEP Projects Table Tool," http://gispub2.epa.gov/NEPMap/NEPTable_allyears/index.html. (National Estuary Program). From each table, only tidal wetland restoration projects are counted.
[viii] (Johnson, et al., 2003)
[ix] (Johnson, et al., 2003)
[x] (Tillamook Bay National Estuaries Project, 1999, pp. 2-18)
[xi] (Tillamook Bay National Estuaries Project, 1999, pp. 2-20)
[xii] (Monroe, Olofson, Collins, Grossinger, Haltiner, & Wilcox, 1999)
[xiii] (San Francisco Estuary Partnership, 2011)
[xiv] (Morro Bay National Estuary Program, 2010)
[xv] (Santa Monica Bay Restoration Commission, 2008, p. 33)

[xvi] (Santa Monica Bay Restoration Commission, 2008, pp. 33-4)
[xvii] (Coastal Bend Bays Plan, 1998)
[xviii] (The Galveston Bay Plan: The Comprehensive Conservation and Management Plan for the Galveston Bay Ecosystem, 1995)
[xix] (The Galveston Bay Plan: The Comprehensive Conservation and Management Plan for the Galveston Bay Ecosystem, 1995)
[xx] (Barataria Terrebonne National Estuary Program)
[xxi] (Pe, 2012)
[xxii] (CWPPRA). Penchant Basin project creates 35 acres of tidal wetland.
[xxiii] (Louisiana Coastal Wetlands Conservation and Restoration Task Force). The Pen Shoreline project creates 175 acres of tidal wetland.
[xxiv] Mobile Bay National Estuary Program, *Comprehensive Conservation and Management Plan - A Call to Action*.
[xxv] Wallace, "Coastal Wetlands of Alabama."
[xxvi] (100-1000 Restore Coastal Alabama)
[xxvii] (Cicchetti & Greening, 2011)
[xxviii] (Tampa Bay Estuary Program Policy Board, 2010)
[xxix] Sarasota Bay Estuary Program, "Wetlands."
[xxx] Sarasota Bay National Estuary Program, *Sarasota Bay - The Voyage to Paradise Reclaimed*. 50 year time horizon equals 900 acre restoration goal.
[xxxi] Southwest Florida Regional Planning Council and Charlotte Harbor National Estuary Program, *A Watershed Analysis of Permitted Coastal Wetland Impacts and Mitigation Methods Within the Charlotte Harbor National Estuary Program Study Area*.
[xxxii] Charlotte Harbor National Estuary Program, *Committing to Our Future: A Comprehensive Conservation and Management Plan for the Greater Charlotte Harbor Watershed from Venice to Bonita Springs to Winter Haven*.
[xxxiii] (Beever, Gray, Beever, & Cobb, 2011)
[xxxiv] (Steward, Brockmeyer, Gostel, Sime, & VanArman, 2003)
[xxxv] (Steward, Brockmeyer, Gostel, Sime, & VanArman, 2003)
[xxxvi] (Steel, 1991)
[xxxvii] (Carpenter, 2012)
[xxxviii] (Albermarle-Pamlico National Estuary Partnership)
[xxxix] (Chesapeake Bay Program, 2008), 1996-2005. No historic loss data available. Assume 10% of all wetland loss, estimated at 2,030,000 acres.
[xl] (Chesapeake Bay Program, 2000) and (Chesapeake Bay Program). Goal includes tidal and non-tidal wetlands.
[xli] (Chesapeake Bay Program). Data includes tidal and non-tidal wetlands. Web page includes annual data for progress toward goal since 1998.
[xlii] (Bleil, Clearwater, & Nichols, 2004). Loss figures include tidal and non-tidal wetlands.
[xliii] (Bleil, Clearwater, & Nichols, 2004). Goal includes tidal and non-tidal wetlands.
[xliv] (Chapter 1-5 of the Delaware Inland Bays Comprehensive Conservation and Management Plan, 1995)
[xlv] (Delaware Center for the Inland Bays, 2012)
[xlvi] (Kreeger & Homsey, 2012)
[xlvii] (Berger, Sinton, & Radke, 1994). Tidal wetland loss of 2% since 1800s to 1994.
[xlviii] (Adkins J. A., 2012). Lost 6,500 acres 1996-2006. Calculate 1800s tidal wetland extent noting 2% loss, and 1996 tidal wetland extent of ~153,000.
[xlix] (Whalen, Kreeger, Adkins, & Hahn, 2012) Four year time horizon equals 10,000 acre restoration goal.
[l] (Barnegat Bay Partnership, 2011). 8% loss since 1995.
[li] (Hales, 2013)
[lii] (New York - New Jersey Harbor Estuary Program, 1996). Current tidal wetland extent is 205,000 acres. Historic losses of at least 75%.
[liii] (Baron, Weppler, & McDonald, 2009)
[liv] (Baron, Weppler, & McDonald, 2009)
[lv] (Long Island Sound Study, 2003). Used average historic extent figure of 25,000 acres.
[lvi] (U.S. Environmental Protection Agency, Office of Water, 2012) Twenty year time horizon equals 5,000 acre restoration goal.
[lvii] (Peconic Estuary Program, 2001)
[lviii] (Peconic Estuary Program Natural Resources Subcommittee, 2009). Report identifies nine (9) tidal wetland restoration projects. Acreage provided for six totals 177 acres. Estimate acreage for nine is 50% greater, or 266 acres.
[lix] (Tiner, Huber, Nuerminger, & Mandeville, 2004). 1951 -1996.
[lx] (Narragansett Bay Estuary Program, 2012)
[lxi] (Buzzards Bay Project National Estuary Program, 2012). Based on current tidal wetland acreage of 5,107 acres, estimated loss using stated figure of 40-50% loss (used 40%) of wetlands in Massachusetts.
[lxii] (Buzzards Bay Project National Estuary Program, 2002). Identifies 4,351.01 acres of tidally restricted salt marsh.
[lxiii] (Buzzards Bay Project National Estuary Program, 2005) and (Buzzards Bay Project National Estuary Program, 2004)
[lxiv] (Massachusetts Bays Program, 1996). Based on current salt marsh acreage of 34,000 acres, estimated using stated figure of 40-50% loss (used 40%) of wetlands in Massachusetts.
[lxv] (Massachusetts Bays Program, 1996)
[lxvi] (Piscataqua Region Estuaries Partnership, 2010)
[lxvii] (Piscataqua Region Estuaries Partnership, 2010)
[lxviii] (Casco Bay Estuary Partnership, 1996). Mid 1970s to mid 1980s.
[lxix] (Casco Bay Estuary Partnership, 1996)
[lxx] (Casco Bay Estuary Partnership, 2006)

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EXPERT OPINION I

Debbie L. DeVore

Gulf Coast Restoration Program Manager

U.S. Fish & Wildlife Service

Question 1 – To what extent do estuaries without a National Estuary Program face the same barriers to tidal wetland restoration activities as estuaries, which are part of a National Estuary Program? We have identified the following barriers, among others: funding, land ownership/control, political will, a local environment, which encourages partnerships, and social acceptability. Please note that we only need to consider barriers to tidal wetland restoration where it has already been identified as possible in the landscape. <u>Based on your experience and expert judgment, do estuaries in NEPs face the same or similar barriers to implementation of tidal wetland restoration projects as estuaries that do not have an NEP? Please explain.</u>

Answer:

While there are, no doubt, advantages afforded an estuary which has an established National Estuary Program (NEP) this does not preclude or exempt projects in these geographies from many of the same hurdles that projects face in an estuary outside the geographic of an NEP.

For example, funding is commonly the largest limiting factor in bringing a tidal restoration project to implementation, regardless of the project's location. Projects with involvement from an NEP must apply for the same limited funding as any other project (raising the same amount of match, etc.) and be held to the same reporting and fiduciary responsibilities as well. NEP supported projects must also go through the same scrutiny to obtain regulatory permission to conduct work, just as a non-NEP project does.

Both political will and public support for projects are also similar issues faced by projects both within an NEP and outside a NEP geography. In fact, projects with NEP support or in a NEP geography may even sometimes have a bigger stigma as the public may not have a high level of trust for governmental organizations and be much less supportive of their actions. As well, working with landowners (particularly private landowners) may prove more difficult for projects with an governmental agency connection.

Tidal restoration projects and activities, while often a high priority based upon the result of natural resource partners coming together for a common restoration objective, are not necessarily given special preference towards implementation simply because the are facilitated by such a collaboration. These projects are held to the same standards (and hence work through the same barriers and hurdles) as projects in a non-NEP geography.

Question 2 – How likely is it that the rates of restoration in National Estuary Programs are greater than the rates of restoration occurring in non-NEP estuaries in the U.S.? It is our assumption that NEPs will have an overall higher rate of restoration than other estuaries because NEPs benefit from a shared state and federal commitment to estuary health, which may be absent in other estuaries. Moreover, because of the status of being an NEP, they are more likely to receive scarce federal and state resources, as well as funding from other partners. NEPs are multi-stakeholder collaborative efforts that are not found in other estuaries in the U.S. <u>Based on your experience and expert judgment, are NEPs substantially likely to have a higher rate of restoration than non-NEP estuaries? Please explain.</u>

Answer:

Although I may paint a picture of hard times for NEPs above - having to jump through the same regulatory hoops as other projects - that is part of doing business in coastal restoration. NEPs and their restoration partners understand this and support that we should be held to the same regulatory and accountability standards as projects in non-NEP geographies or with no connection to the Program itself. NEPs and their partners do, however, recognize the tremendous benefit to a voluntary, collaborative and strategic approach to tidal restoration (as well as other coastal conservation issues NEPs address). Many funding agencies give credit to project proponents who work as a collective multi-stakeholder partnership. There is an assumption that such a partnership represents an agreed upon set of goals, objectives, implementation procedures and monitoring for a given project. This gives a funding agency a certain level of confidence that the project will be successful and supported at a local level. Project proposals written by NEP partners are also often more well defined and in concert with requested information outlined in a funding opportunity.

To answer you question specifically, yes, I do think NEPs have a higher likelihood of receiving funds for coastal restoration. I say this for a few reasons. In today's world of limited federal and state budgets and fewer dollars to put "on-the-ground" for projects, the conservation community has been pushed to become much more strategic in our thinking. By this I mean that we are looking at how projects fit into the larger watershed or landscape, we strive to accomplish as many partners' goal and objectives as possible, and we must leverage our funds as much as we possibly can. The NEP structure, their associated advisory committees and public outreach capabilities, lends itself to a role in facilitating such a strategic approach.

I worked for the FWS Coastal Program nearly 10 years and can say that for many of the reasons I described above, our Program encourages and actively engages in partnership with our local NEPs. In my tenure with the Coastal Program I have worked with NEPs in both Texas and Florida. When possible, our Program staff serve on technical advisory committees, participate in strategic planning and assist in project implementation. In fact, I was involved in drafting the current Strategic Plan for our southwest Florida focal area where I identified working with the NEPs as a priority for our Program. When appropriate and feasible, the Coastal Program has and continues to invest funding towards projects such as tidal restoration activities.

<u>Original request to expert:</u>

On Wed, Oct 23, 2013 at 4:57 PM, Steve Emmett-Mattox <sem@estuaries.org> wrote:

Dear Ms. Devore,

Restore America's Estuaries is seeking to demonstrate the "additionality" of tidal wetland restoration in the U.S. for the purposes of generating carbon offsets under the Verified Carbon Standard. The VCS revised its rules in 2012 to include a standardized approach to demonstrate additionality. In order to comply with this approach, RAE has assembled a substantial data set and analysis. The data, analysis and discussion are attached. In a recent review by the VCS, they raised two questions that we would like your help in answering. I believe you to be an expert in tidal wetland restoration programs and activities in the U.S., and now seek your opinion on the following:

1 – to what extent do estuaries without a National Estuary Program face the same barriers to tidal wetland restoration activities as estuaries, which are part of a National Estuary Program? We have identified the following barriers, among others: funding, land ownership/control, political will, a local environment, which encourages partnerships, and social acceptability. Please note that we only need to consider barriers to tidal wetland restoration where it has already been identified as possible in the landscape. <u>Based on your experience and expert judgment, do estuaries in NEPs face the same or similar barriers to implementation of tidal wetland restoration projects as estuaries that do not have an NEP? Please explain.</u>

2 – how likely is it that the rates of restoration in National Estuary Programs are greater than the rates of restoration occurring in non-NEP estuaries in the U.S.? It is our assumption that NEPs will have an overall higher rate of restoration than other estuaries because NEPs benefit from a shared state and federal commitment to estuary health, which may be absent in other estuaries. Moreover, because of the status of being an NEP, they are more likely to receive scarce federal and state resources, as well as funding from other partners. NEPs are multi-stakeholder collaborative efforts that are not found in other estuaries in the U.S. <u>Based on your experience and expert judgment, are NEPs substantially likely to have a higher rate of restoration than non-NEP estuaries? Please explain.</u>

And last, please provide an up to date resume/CV, which we will share with the VCS.

Please let me know if you have any questions about this request, and thank you for your timely response.

Cheers,

Steve Emmett-Mattox

Senior Director for Strategic Planning and Programs
Restore America's Estuaries
direct: 720-300-3139
national office: 703-524-0248
sem@estuaries.org
www.estuaries.org

<u>EXPERT OPINION II</u>

Curtis Tanner
Acting Manager, Environmental Restoration and Assessment Division
U.S. Fish and Wildlife Service

18 November 2013

Steve Emmet-Mattox
Senior Director for Strategic
Planning and Programs
Restore America's Estuaries
2300 Clarendon Blvd. Suite 603
Arlington, VA 22201

Dear Steve:

I am writing in response to your September 23, 2013, email requesting my expert opinion regarding tidal wetland restoration and greenhouse gas offsets. As you know, I have over twenty years of experience working on coastal wetland restoration and protection for the U.S. Fish and Wildlife Service. The views expressed in this letter are based on my own experience and perspective, and do not reflect an official agency position. I have attached a copy of my current resume for your use in assessing my credentials.
As I understand it, you are working to establish the viability of tidal wetland restoration as a tool for use in sequestering carbon dioxide to mitigate anthropogenic greenhouse gas emissions. You seek to establish the fact that at a National scale, tidal wetland restoration in the United States is limited in spatial scale and impact. Specifically, "activity penetration", or the prevalence of restoration project implementation relative to the opportunity for tidal wetland restoration, is relatively small. In your assessment of tidal restoration in the U.S., you estimate the "…Activity Penetration is 1.06%, which is less than 5%, and therefore tidal wetland restoration in the U.S. is additional…" as defined by the Verified Carbon Standard. In short, you assert that given the relatively small amount of tidal wetland restoration in the U.S. (as compared to opportunity and demonstrated need), investment in restoration would provide a viable alternative for carbon offset funds. I concur with your assessment.

Your analysis relied upon the most comprehensive data set available at the National level for tidal wetland restoration, accomplishment reporting from the National Estuary Program (NEP). You have specifically requested that I provide an assessment based on my experience and expert judgment whether use of these data are appropriate. First, you have asked whether estuaries covered by the NEP provide a representative sample, facing the same or similar barriers to tidal wetland restoration project implementation. Based on 20+ years of experience working on coastal restoration and protection issues and projects, it is my opinion that tidal wetland restoration is typically limited by a set of barriers common to estuaries throughout the United States; funding, land owner willingness, and social acceptability are nearly universal challenges for all projects and estuaries. Taken together as a whole, the geographic distribution of NEP sites provides a broad cross section of National estuarine ecosystem conditions, encompassing a range of ecological threats, fish and wildlife resource assets, and socio/political contexts. This representative diversity applies to both human and non-human aspects of coastal ecosystems.

Second, you post the question as to whether the rate of restoration derived from analysis of NEP estuaries is representative. As I understand your analysis, if NEP estuaries had a substantially lower rate of restoration than non-NEP estuaries, your activity penetration estimate of 1.06%, as compared the VCS threshold of 5%, could be challenged. Based on my experience derived from project implementation and program management, NEP estuaries likely deliver a higher rate of restoration as compared to non-NEP estuaries, if significant differences do in fact exist. I base this assertion on observations of the opportunity space provided for restoration that NEP designation provides coastal ecosystems. The Clean Water Act directs each NEP to develop and implement a Comprehensive Conservation and Management Plan (CCMP). Agencies including the U.S. Fish and Wildlife Service respond to policies and Congressional funding directives to focus restoration efforts in NEP systems, often in response to the CCMP. NEP designation also works to focus the work of state agency, tribal government, and non-governmental organization partners to address restoration needs defined by the CCMP. In Puget Sound, development and implementation of the CCMP is the role of the Puget Sound Partnership (PSP), a Washington State cabinet-level agency. PSP has led development of the current CCMP for Puget Sound, referenced as the "Action Agenda". PSP's Action Agenda includes specific targets for estuarine restoration required to recover the health of Puget Sound. Other non-NEP coastal ecosystems in Washington State lack this political focus and dedicated state and National funding for tidal wetland restoration.

In summary, while I have not provided a detailed review of your data sources and analysis, I am familiar with the approach you have applied in your analysis. NEP estuaries provide applicable data set for your assessment of activity penetration for restoration. CCMP's for NEP estuaries provide a numeric objective for restoration and thus a quantifiable estimate of opportunity and need.

Accomplishment reporting required by U.S. EPA delivers an accounting of acres restored which can be compared to numeric targets. The 28 NEP systems distributed throughout the United States provide a representative cross section of coastal ecosystems and the challenges and opportunities faced by restoration projects proponents. NEP designation leads to a regional focus of efforts, that delivers activity penetration rates likely equal or greater than that of non-NEP systems.

Thank-you for the opportunity to provide my perspective on your assessment. Please contact me directly if you have questions or if I can be of additional assistance.

Sincerely,
Curtis D. Tanner

Original request to expert:

From: Steve Emmett-Mattox [mailto:sem@estuaries.org]
Sent: Monday, September 23, 2013 1:42 PM
To: 'Tanner, Curtis'
Subject: expert guidance sought, Restore America's Estuaries tidal wetland restoration and ghg offsets

Dear Mr. Tanner,
Restore America's Estuaries is seeking to demonstrate the "additionality" of tidal wetland restoration in the U.S. for the purposes of generating carbon offsets under the Verified Carbon Standard. The VCS revised its rules in 2012 to include a standardized approach to demonstrate additionality. In order to comply with this approach, RAE has assembled a substantial data set and analysis. The data, analysis and discussion are attached. In a recent review by the VCS, they raised two questions that we would like your help in answering. I believe you to be an expert in tidal wetland restoration activities in the U.S., and now seek your opinion on the following:

1 – to what extent do estuaries without a National Estuary Program face the same barriers to tidal wetland restoration activities as estuaries, which are part of a National Estuary Program? We have identified the following barriers, among others: funding, land ownership/control, political will, a local environment, which encourages partnerships, and social acceptability. Please note that we only need to consider barriers to tidal wetland restoration where it has already been identified as possible in the landscape. Based on your experience and expert judgment, do estuaries in NEPs face the same or similar barriers to implementation of tidal wetland restoration projects as estuaries that do not have an NEP? Please explain.

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And last, please provide an up to date resume/CV, which we will share with the VCS.

Please let me know if you have any questions about this request, and thank you for your timely response.

Cheers,

Steve Emmett-Mattox
Senior Director for Strategic Planning and Programs
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