VCS Module

VMD0050

Estimation of Baseline Carbon Stock Changes and Greenhouse Gas Emissions in Tidal Wetland Restoration and Conservation Project Activities (BL-TW)

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Sectoral Scope 14

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1 SOURCES

This module is one of numerous modules that constitute the VCS approved methodology *VM0007 REDD+ Methodology Framework* (*REDD+ MF*).

This module is based on the following methodology:

- *VM0033 Methodology for tidal wetland and seagrass restoration*

This module uses the latest version of the following modules and tools:

- *Module M-TW VMD0051 Methods for monitoring of carbon stock changes and greenhouse gas emissions and removals in tidal wetland restoration and conservation project activities*
- *Module CP-AB VMD0001 Estimation of carbon stocks in the above- and belowground biomass in live tree and non-tree pools*
- *Module BL-PL VMD0006 Estimation of baseline carbon stock changes and greenhouse gas emissions from planned deforestation/forest degradation and planned wetland degradation*
- *Module BL-UP VMD0007 Estimation of baseline carbon stock changes and greenhouse gas emissions from unplanned deforestation and unplanned wetland degradation*
- *Module E-BPB VMD0013 Estimation of greenhouse gas emissions from biomass and peat burning*
- *Module E-FFC VMD0014 Estimation of emissions from fossil fuel combustion*
- *Module X-STR VMD0016 Methods for stratification of the project area*
- *Module VMD0019 Methods to project future conditions*
- *Module BL-ARR VMD0041 Estimation of baseline carbon stock changes and greenhouse gas emissions in ARR project activities*
- *Module VMD0045 M-ARR Methods for monitoring greenhouse gas emissions and removals in ARR project activities*
- CDM tool *AR-Tool14 Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*

2 SUMMARY DESCRIPTION OF THE MODULE

This module provides procedures for the establishment of a WRC baseline scenario for tidal wetlands and it provides procedures to estimate soil emission reductions and removals generated by WRC project activities implemented on tidal wetlands, i.e. Restoration of Wetland Ecosystems (RWE) and Conservation of Intact Wetlands (CIW) project activities.

It also provides procedures for the accounting of the effect of submergence and erosion on the tidal wetland SOC pool.

3 DEFINITIONS

In addition to the definitions set out in the VCS Program document *Program Definitions* and VCS methodology VM0007 *REDD+ MF*, the following definitions apply to this module:

Aerobic Environment
An aerobic environment – in the context of this module – is defined as an ecosystem that does not meet the definition of a wetland.

Allochthonous Soil Organic Carbon
Soil organic carbon originating outside the project area deposited within the project boundary (compare to *unreactive allochthonous soil organic carbon*, below)

Autochthonous Soil Organic Carbon
Soil organic carbon originating or forming in the project area (e.g., from vegetation)

Carbon Preservation Depositional Environment (CPDE):
Type of sub-aquatic sediment deposition environment that impacts the amount of deposited organic carbon that is preserved. Carbon preservation is affected by mineral grain size, sediment accumulation and burial rates, O_2 availability in the overlying water column and sediment hydraulic conductivity.

Deltaic Fluidized Mud
A Carbon Preservation Depositional Environment (CPDE) type. This subaquatic depositional environment is characterized by sediment accumulation rates generally greater than 0.4 g sediment per cm^2 per year in deltaic settings, consisting primarily of fluidized (unconsolidated) fine-grain materials. Surface sediments may be re-suspended by waves and tides, but deposited organic matter will be buried. Examples of these can be found in the Amazon and Mississippi deltas.

Extreme Accumulation Rate
A Carbon Preservation Depositional Environment (CPDE) type. This subaquatic depositional environment is characterized by accumulation rates generally greater than 1 g sediment per cm^2 per year resulting in rapid and long-term burial of deposited sediments. Examples of these systems can be found in the Ganges-Brahmaputra and Rhone river deltas.

Impounded Water
A pool of water formed by a dam or pit

Mangrove
A subset of wetlands dominated by mangrove plant species, which are shrubs or trees that grow in coastal saline or brackish water

Marsh
A subset of wetlands characterized by emergent soft-stemmed vegetation and shrubs adapted to saturated soil conditions[1]

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[1] There are many different kinds of marshes, ranging from the prairie potholes to the Everglades, coastal to inland, freshwater to saltwater, but the scope of this methodology is limited to tidal marshes. Salt marshes consist of salt-tolerant and dwarf brushwood vegetation overlying mineral or organic soils.

Mineral Soil

A soil that does not meet the definition of an organic soil

Mudflat

A subset of tidal wetlands consisting of soft substrate and a near absence of emergent vegetation

Normal marine

A Carbon Preservation Depositional Environment (CPDE) type. This is a depositional environment that does not meet the definition of the other four defined conditions (i.e., *deltaic fluidized mud*, *extreme accumulation rate*, *oxygen depletion zone*, or *small mountainous river*). Normal marine environments typically have low sedimentation rates and high O_2 availability in overlying sediments.

Open Water

An area in which water levels do not fall to an elevation that exposes the underlying substrate

Organic Soil

Soil with a surface layer of material that has a sufficient depth and percentage of organic carbon to meet an internationally accepted threshold (e.g., host-country, FAO or IPCC) of organic soil. Where used in this methodology, the term *peat* is used to refer to organic soil.

Oxygen (O_2) Depletion Zone

A Carbon Preservation Depositional Environment (CPDE) type. This is a depositional environment with low O_2 levels in water overlying sediments due to restricted hydrologic circulation or impaired water quality that leads to hypoxic or anaerobic conditions (including euxinic and semi-euxinic).

Salinity Average

The average water salinity value of a wetland ecosystem used to represent variation in salinity during periods of peak CH_4 emissions (e.g., during the growing season in temperate ecosystems)

Salinity Low Point

The minimum water salinity value of a wetland ecosystem used to represent variation in salinity during periods of peak CH_4 emissions (e.g., during the growing season in temperate ecosystems)

Seagrass Meadow

An accumulation of seagrass plants over a mappable area. 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.

Small Mountainous River

A Carbon Preservation Depositional Environment (CPDE) type. This is a depositional environment from which the sediment is supplied from small mountainous rivers, most commonly found in tectonically active margins and small steep gradients. Sediment accumulation rates are generally greater than 0.27 g sediment per cm^2 per year. Examples of these systems can be found in the rivers flowing from the island of Taiwan and the Eel river of California.

Tidal Wetland

A subset of wetlands under the influence of the wetting and drying cycles of the tides (e.g., marshes, seagrass meadows, tidal forested wetlands and mangroves). Subtidal seagrass meadows are not subject to drying cycles, but are still included in this definition.

Tidal Wetland Restoration
Re-establishing or improving the hydrology, salinity, water quality, sediment supply and/or vegetation in degraded or converted tidal wetlands. For the purpose of this methodology, this definition also includes activities that create wetland ecological conditions on uplands under the influence of sea level rise or activities that convert one wetland type to another or activities that convert open water to wetland.

Unreactive Allochthonous Soil Organic Carbon
The portion of soil organic carbon originating outside the project area and deposited in the project area that would be stable over the project period regardless of depositional environment. In practice, it is the portion of allochthonous soil organic carbon associated with and stabilized by soil minerals.

Water Table Depth
Depth of subsoil or above-soil surface of free water, relative to the soil surface.

Acronyms

ARR	Afforestation, Reforestation and Revegetation
CIW	Conservation of Intact Wetlands
CPDE	Carbon Preservation Depositional Environment
GHG	Greenhouse Gas
REDD	Reducing Emissions from Deforestation and forest Degradation
RWE	Restoration of Wetlands Ecosystems
SOC	Soil Organic Carbon
VCS	Verified Carbon Standard
WRC	Wetlands Restoration and Conservation

For definitions of VCS AFOLU project categories refer to the *VCS Standard.*

4 APPLICABILITY CONDITIONS

This module applies to tidal wetland restoration and conservation project activities, as defined in *REDD+ MF*. This module is applicable under the same applicability conditions outlined in *REDD+ MF* for WRC project activities.

5 PROCEDURES

5.1 General

5.1.1 General Procedures

Emissions in the baseline scenario of WRC project activities in tidal wetlands are attributed to carbon stock changes in biomass carbon pools, soil processes, or a combination of these. In addition, where relevant, emissions from fossil fuel use and biomass burning may be quantified.

For REDD-CIW and stand-alone CIW project activities, procedures for biomass, fossil fuel use and biomass burning are provided in Modules *BL-UP* and *BL-PL*, in combination with Modules *CP-AB, E-FFC* *and E-BPB*. When using Module *CP-AB*, for non-tree biomass, project proponents may apply default values for carbon stocks in herbal biomass in tidal wetlands provided in Module *BL-ARR*.

For ARR-RWE project activities, procedures for biomass and biomass burning are provided in Module *BL-ARR*. For ARR-RWE and stand-alone RWE project activities, procedures for fossil fuel use are provided in Module *E-FFC*. The net GHG emissions from fossil fuel use in the baseline scenario is then calculated as:

$$GHG_{BSL\text{-}fuel} = \sum_{i}^{M_{BSL}} \sum_{t}^{t*} E_{FC,i,t} \quad \textbf{(1)}$$

Where:

$GHG_{BSL\text{-}fuel}$	Net CO_2e emissions from fossil fuel use in the baseline scenario up to year $t*$; t CO_2e
$E_{FC,i,t}$	Net CO_2e emissions from fossil fuel combustion in stratum i in year t (from Module *E-FFC*); t CO_2e
i	1, 2, 3 …M_{BSL} strata in the baseline scenario
t	1, 2, 3, … $t*$ years elapsed since the project start date

When using Modules *CP-AB* and *BL-ARR*, note must be taken of procedures provided in Section 5.2.

This module provides accounting procedures for mineral wetland soils. Accounting procedures for organic soils (also those existing in tidal wetlands) are provided in Module *BL-PEAT*.

5.1.2 Baseline Scenario

Assessing GHG emissions in the WRC baseline scenario consists of determining GHG emission proxies/parameters and assessing their pre-project spatial distribution, constructing a time series of the chosen proxies/parameters for each stratum for the entire project crediting period and determining annual GHG emissions per stratum for the entire project crediting period.

To project the future GHG emissions in each stratum for each projected verification date within the project crediting period under the baseline scenario, the project proponent must apply the latest version of Module *VMD0019 Methods to Project Future Conditions*. When applying Steps 13 and 14 of *VMD0019* (version 1, issued 16 November 2012, the version of the module current as of the writing of this methodology), the project proponent must use the guidance for sea level rise provided in Module *X-STR*, from which both location-specific and process-specific variables can be derived.

Four driving factors are likely to be relevant for GHG accounting in the baseline scenario, and are relevant for use of Module *VMD0019*. Each factor affects the evolution of the site over a 100-year period. These include:

- 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 as likely 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 – In order 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 area. Current development patterns and plausible future land use changes must be mapped to a scale sufficient to estimate GHG emissions from the baseline scenario. Particular attention must be paid to existing or future construction of barriers to tidal and/or river hydrology and sediment supply from rivers and/or along the coast, as well as barriers that will impair wetland capacity to migrate landwards with sea level rise. In the case of abandonment of pre-project land use in the baseline scenario, the project proponent 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.

Infrastructure impediments to tidal hydrology – In order to derive trends in tidal wetland evolution, the baseline scenario must take into account the current and historic layout of any tidal barriers and drainage systems. The tidal and/or river 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, current and planned 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 project start date. 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 flows and prevent natural sedimentation patterns. The effect of historic, existing and planned tidal and/or river barriers and drainage structures on tidal and/or river hydrology and sediment supply (from rivers or along the coast), as well as barriers that will impair wetland capacity to migrate landwards with sea level rise, 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 performed on the basis of hydrologic modeling using the total tidal volume, soil erodibility and/or 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 (e.g., 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, a 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 human land use (e.g., pasture, lawn, landscaping).

Climate variables – Consistent with the sea level rise guidance provided in Module *X-STR*, areas of inundation and erosion/sedimentation within the project area must be considered in relation to the above three factors. Expected changes in freshwater delivery associated with changes in rainfall patterns must be considered, including expected human responses to these changes. Project proponents must account for the possibility of non-human induced elevation of non-vegetated wetlands to build vegetated wetlands. Deltaic systems with high sediment load from rivers often do this naturally, and this must be counted as part of the baseline.

To model a spatial trend in drainage, the project must reference a period of at least 10 years and it must take into account long-term average climate variables (over 20+ years prior to the project start date from two climate stations nearest to the project area).

The project proponent must, for the duration of the project crediting period, reassess the baseline scenario every 10 years. Based on the reassessment criteria specified in *REDD+ MF*, the revised 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.

5.1.3 Proxy Areas

Proxy areas can be used to determine proxies for GHG emissions (see Section 5.3.1). Proxy areas 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. For criteria for applicability of proxy areas, refer to Section 1.3 of Module *BL-PL*, noting the following:

- Substitute ‘deforestation’ with ‘conversion.’
- Omit bullet seven which states the following conditions must be met:
    - The forest types surrounding the proxy area or in the proxy area prior to deforestation must be in the same proportion as in the project area (±20%).
    - Soil types that are suitable for the land-use practice used by the agent of deforestation in the project area must be present in the proxy area in the same proportion as the project area (±20%). The ratio of slope classes “gentle” (slope <15%) to “steep” (slope ≥15%) in the proxy areas must be (±20%) the same of the ratio in the project area.
    - Elevation classes (500m classes) in the proxy area must be in the same proportion as in the project area (±20%).

5.2 Accounting for Submergence and Erosion

The consequences of submergence and/or erosion of a given stratum due to sea level rise or other factors (e.g., wave action due to boats) are:

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

Regarding (1) above, since the above-ground carbon stocks in tree and shrub biomass in the baseline scenario will be low, this methodology does not provide procedures for accounting of biomass loss due to sea level rise or erosion in the baseline scenario, which is conservative.

Note that for stand-alone WRC project activities, as per *REDD+ MF*, accounting for tree and shrub biomass is omitted.

Regarding (2) above, the project proponent may apply models or other quantification methods (see Module *X-STR* and below) to assess the time and rate of submergence and/or erosion of the project area.

Simple dynamic models, such as the Marsh Equilibrium Model[2], exist that describe the capacity of tidal wetlands to build vertically with sea level rise based upon wetland surface elevation relative to tides, rate of sea level rise, mineral and organic sedimentation, soil compaction and soils organic matter decomposition.

For areas that submerge without erosion, the loss of SOC may be assumed to be insignificant. It is assumed that, upon submergence without erosion, soil carbon is not returned to the atmosphere unless site-specific scientific justification is provided.

In areas with wave action, there may be a net loss of soil material in cases where erosion exceeds deposition, which would lead to carbon removal. In the baseline scenario, assuming that all carbon is re-sedimented and stored (and not oxidized) is conservative. However, in most cases a portion of this carbon will return to the atmosphere. Procedures are provided in Section 5.3.3 to estimate this quantity.

Restoration and conservation 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 must be quantified and justified in the project description:

- The point in time when submergence and/or erosion begins
- The amount of carbon that erodes
- The percent of the eroded soil carbon that is returned to the atmosphere

5.3 Assessing Soil GHG Emissions in the Baseline Scenario

5.3.1 General

Net GHG emissions in the WRC baseline scenario on tidal wetland are estimated as:

$$GHG_{BSL-TW} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_{BSL}} (A_{BSL,i,t} \times GHG_{BSL-TW,i,t}) \quad \textbf{(2)}$$

Where:

$GHG_{BSL\text{-}TW}$	Net GHG emissions in the WRC baseline scenario on tidal wetland up to year *t**; t CO_2e
$GHG_{BSL\text{-}TW,i,t}$	GHG emissions in the WRC baseline scenario on tidal wetland in stratum *i* in year

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[2] Morris *et al* 2012

	t; t CO_2e ha^{-1} yr^{-1}
$A_{BSL,i,t}$	Area of stratum i in year t in the baseline scenario; ha
i	1, 2, 3 …M_{BSL} strata in the baseline scenario
t	1, 2, 3, … t^* years elapsed since the project start date

Net GHG emissions from tidal wetland soil in the baseline scenario are estimated as:

$$GHG_{BSL\text{-}TW,i,t} = GHG_{BSL\text{-}soil\text{-}CO2,i,t} - Deduction_{alloch} + GHG_{BSL\text{-}soil\text{-}CH4,i,t} + GHG_{BSL\text{-}soil\text{-}N2O,i,t} \quad \textbf{(3)}$$

For organic soils where $t > t_{PDT\text{-}BSL,i}$:

$GHG_{BSL\text{-}TW,i,t} = 0$

For mineral soils where $t > t_{SDT\text{-}BSL,i}$:

$GHG_{BSL\text{-}TW,i,t} = 0$

Where:

$GHG_{BSL\text{-}TW,i,t}$	GHG emissions from the tidal wetland 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}
$GHG_{BSL\text{-}soil\text{-}CO2,i,t}$	CO_2 emissions from the tidal wetland SOC pool in the baseline scenario in stratum i in year t; t CO_2e ha^{-1} yr^{-1}
$GHG_{BSL\text{-}soil\text{-}CH4,i,t}$	CH_4 emissions from the tidal wetland SOC pool in the baseline scenario in stratum i in year t; t CO_2e ha^{-1} yr^{-1}
$GHG_{BSL\text{-}soil\text{-}N2O,i,t}$	N_2O emissions from the tidal wetland SOC pool in the baseline scenario in stratum i in year t; t CO_2e ha^{-1} yr^{-1}
$t_{PDT\text{-}BSL,i}$	Peat depletion time in the baseline scenario in stratum i in years elapsed since the project start date (from Module *X-STR*); yr
$t_{SDT\text{-}BSL,i}$	Soil organic carbon depletion time in the baseline scenario in stratum i in years elapsed since the project start date (from Module *X-STR*); yr
i	1, 2, 3 …M_{BSL} strata in the baseline scenario
t	1, 2, 3, … t^* years elapsed since the project start date

CO_2 emissions from the tidal wetland SOC pool in the baseline scenario may occur *in situ* or indirectly following soil erosion or exposure to an aerobic environment through excavation as defined in Equation 4. For strata with *in-situ* emissions (with or without drainage), follow procedures in Section 5.3.2. For strata where soil erosion occurs, procedures in Section 5.3.3 must be used. For strata where soil is exposed to an aerobic environment through excavation, procedures in Section 5.3.4 must be used. For strata with *in-situ* emissions, CH_4 and N_2O emissions may be conservatively set to zero or may be estimated using procedures in Sections 5.3.5 and 5.3.6, respectively. For strata where soil erosion occurs, or soil is exposed to an aerobic environment through excavation or drainage, CH_4 and N_2O emissions are conservatively set to zero.

$$GHG_{BSL\text{-}soil\text{-}CO2,i,t} = GHG_{BSL\text{-}insitu\text{-}CO2,i,t} + GHG_{BSL\text{-}eroded\text{-}CO2,i,t} + GHG_{BSL\text{-}excav\text{-}CO2,i,t} \quad \textbf{(4)}$$

Where:

$GHG_{BSL\text{-}soil\text{-}CO2,i,t}$	CO_2 emissions from the tidal wetland SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$	CO_2 emissions from the tidal wetland SOC pool of *in-situ* soils in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$GHG_{BSL\text{-}eroded\text{-}CO2,i,t}$	CO_2 emissions from the eroded tidal wetland SOC pool in the baseline scenario in stratum *i* in year *t* ; t CO_2e ha^{-1} yr^{-1}
$GHG_{BSL\text{-}excav\text{-}CO2,i,t}$	CO_2 emissions from the tidal wetland SOC pool of soil exposed to an aerobic environment through excavation in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}

GHG emissions from disturbed carbon stocks in stockpiles (originating from piling, dredging, channelization) exposed to aerobic decomposition must be accounted for in the baseline scenario. Such stockpiles must be identified in the stratification of the project area and accounting procedures provided in Section 5.3.4 must be used.

The baseline scenario may involve the construction of levees to constrain flow and flooding patterns, the construction of dams to hold water, and/or upstream changes in land surface leading to intensified run-off. In such cases, the project proponent must account for hydrological processes that lead to increased carbon burial and GHG reductions within the project area using procedures provided in Section 5.3.2.

Estimation of GHG emissions and removals from the SOC pool is based on either various proxies (e.g., carbon stock change, water table depth) or through the use of literature, data, default factors or models.

The subsections below provide guidance with respect to the methods which may be used to estimate net GHG emissions from soil in the baseline scenario. Project proponents may choose the method that is most suitable to their project circumstances and data availability. However, default factors and emissions factors cannot be used in the presence of published data.

Use of proxies

Proxies (as defined in VCS document *Program Definitions*) may be used to derive values of GHG emissions. The project proponent must demonstrate that such proxies are strongly correlated with the value of interest and that they can serve as an equivalent or better method (e.g., in terms of reliability, consistency or practicality) to determine the value of interest than direct measurement of the value itself. Such proxies must have been developed and tested for use in a proxy area (see Section 5.1.2).

Use of models

The project proponent may apply deterministic models (models as defined in VCS document *Program Definitions*) to derive values of GHG emissions. In addition to the VCS requirements for selection and use of models, modeled GHG emissions and removals must have been validated with direct measurements from a proxy area (see Section 5.1.2).

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. Such 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 default 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.

The default factors in Sections 5.3.2.3, 5.3.3.3, 5.3.4.3, 5.3.5.4 and 5.3.6.4 are subject to periodic re-assessment per the requirements for periodic assessment of default factors set out in VCS document *Methodology Approval Process*.

IPCC default factors[3] may be used as indicated in this methodology. Tier-1 values may be used, where relevant indicated in the procedures below, but their use must be justified as appropriate for project conditions.

5.3.2 CO$_2$ Emissions from Soil – *in situ*

CO$_2$ emissions from *in-situ* soil exposed to an aerobic environment through drainage ($GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$) may be calculated directly or may be calculated from estimates of the initial amount of carbon that is exposed ($C_{BSL\text{-}soil,i,t}$) and the percentage of the exposed carbon that is returned to the atmosphere ($C\%_{BSL\text{-}emitted,i,t}$) as defined in Equation 5.

Estimates of $C_{BSL\text{-}soil,i,t}$ or $C\%_{BSL\text{-}emitted,i,}$ following aerobic exposure based on the extrapolation of $C\%_{BSL\text{-}emitted,i,t}$ over the project crediting period must account for tendency of organic carbon concentrations to approach steady-state equilibrium in mineral soils. For this reason, a complete loss of soil organic carbon may not occur in mineral soils. Likewise, $C\%_{BSL\text{-}emitted,i,}$ may not reach 100%. This steady-state equilibrium must be determined conservatively, e.g. by assuming that $C_{BSL\text{-}soil,i,t}$ at steady state will be zero or that $C\%_{BSL\text{-}emitted,i,}$ will be 100%. In case of alternating mineral and organic horizons that are exposed, CO$_2$ emissions must be determined for all individual horizons.

CO$_2$ emissions from *in-situ* soils may be estimated using:

1) Proxies
2) Published values
3) Default factors and emission factors
4) Models

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[3] 2013 Supplement to the 2006 Guidelines: Wetlands

5) Field-collected data, or

6) Historical or chronosequence-derived data

$$GHG_{BSL\text{-}insitu\text{-}CO2,i,t} = 44/12 \times C_{BSL\text{-}soil,i,t} \times C\%_{BSL\text{-}emitted,i,t} / 100 \quad \textbf{(5)}$$

$$C_{BSL\text{-}soil,i,t} = C\%_{BSL\text{-}soil,i,t} \times BD \times Depth\_i,_{i,t}\ x\ 10 \quad \textbf{(6)}$$

Where:

$GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$	CO_2 emissions from the *in-situ* tidal wetland SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$C_{BSL\text{-}soil,i,t}$	Soil organic carbon stock in *in-situ* tidal wetland soil material in the baseline scenario in stratum *i* in year *t*; t C ha^{-1}
$C\%_{BSL\text{-}emitted,i,t}$	Organic carbon loss due to oxidation, as a percentage of C mass present in *in-situ* tidal wetland soil material in the baseline scenario in stratum *i* in year *t*; %
$C\%_{BSL\text{-}soil,i,t}$	Percentage of carbon of *in-situ* tidal wetland soil material in stratum *i* in year *t*; %
BD	Soil bulk density; kg m^{-3}
$Depth\_i_{\ i,t}$	Depth of the *in-situ* exposed soil in stratum *i* in year *t*; m

In certain cases, allochthonous soil organic carbon may accumulate in the project area. Procedures for the estimation of a deduction factor for allochthonous soil organic carbon are specified in Section 5.3.2.7.

5.3.2.1 Proxy-based approach

CO_2 emissions may be estimated using proxies such as water table depth, soil subsidence and carbon stock change (where such proxies meet the guidance set out above). Where the project proponent uses a proxy, such emissions are represented by the following equation:

$$GHG_{BSL\text{-}insitu\text{-}CO2,i,t} = f\ (\text{GHG emission proxy}) \quad \textbf{(7)}$$

Water table depth

Water table depth may be used as a proxy for CO_2 emissions for mineral and organic soils where the project proponent is able to justify their use as described in Section 5.3.1.

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

- 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 (e.g., rainfall, temperature and humidity)
- Planned water management activities documented in existing land management plans, predating consideration of the proposed project activity, and

- Potential offsite influences (e.g., 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

Soil subsidence of organic soils may be used as a proxy for CO_2 emissions from the SOC pool, see Section 5.3 in Module *BL-PEAT*.

Carbon stock change

Carbon stock change may also be used as a proxy for CO_2 emissions from the SOC pool, using the equation below:

$$GHG_{BSL\text{-}insitu\text{-}CO2,i,t} = 44/12 \times -(C_{BSL\text{-}soil,i,t} - C_{BSL\text{-}soil,i,,(t\text{-}T)}) / T \qquad \textbf{(8)}$$

Where:

$GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$	CO_2 emissions from the tidal wetland SOC pool of *in-situ* soils 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 *in-situ* tidal wetland soil material 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 start of the project activity
T	Time elapsed between two successive estimations ($T = t_2 - t_1$)

5.3.2.2 Published values

Peer-reviewed published data may be used to generate a value for $GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$, $C_{BSL\text{-}soil,i,t}$, $C\%_{BSL\text{-}emiitted,i,t}$, $C\%_{BSL\text{-}soil,i,t}$, *BD* or *Depth*, based on values from the same or similar systems as those in the project area, based on the guidelines set out in Section 5.3.1.

5.3.2.3 Default factors and Emission factors

For tidal marsh and mangrove systems, a default factor for $GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$ may be used in the absence of data suitable for using the published value approach, using the value provided in the equation below:

$$GHG_{BSL\text{-}insitu\text{-}CO2,i,t} = -1.46^{(4)} \text{ t C ha}^{-1} \text{ yr}^{-1} \times 44/12 \qquad \textbf{(9)}$$

The above default factor may only be applied to areas with a crown cover of at least 50 percent. By contrast, for areas with a crown cover of 15 percent or less, this value may be assumed to be insignificant

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[4] This default factor (within Equation 12) was derived from the median rate of the literature synthesis of Chmura *et al*. 2003. The synthesis included studies worldwide, including those on marshes and mangroves. The median was used as the best estimate of central tendency because the data were not normally distributed.

and accounted for as zero. In the baseline scenario, for areas with a crown cover between 15 and 50 percent, a linear interpolation may be applied.

In the absence of data suitable for using the published value approach, the most recently published IPCC emission factors[5] may be used to estimate CO_2 emissions from the SOC pool (See Section 5.3.1), except for tidal marsh and mangrove systems.

A default factor may be used for mineral soils for the percent carbon at a steady-state equilibrium attained 20 years following exposure to an aerobic environment in the absence of data suitable for using the published value approach, i.e., at steady state:

$$C\%_{BSL\text{-}soil,i,t} = C\%_{BSL\text{-}soil,i,20} \tag{10}$$

Where:

$C\%_{BSL\text{-}soil,i,t}$	Percentage of carbon of *in-situ* tidal wetland soil material in stratum *i* in year *t*; %
$C\%_{BSL\text{-}soil,i,20}$	Percentage of carbon in *in-situ* tidal wetland soil material at steady-state equilibrium 20 years following exposure to an aerobic environment in stratum *i* in year 20; %

The project proponent may assume that percent carbon declines from the initial value ($C\%_{BSL\text{-}soil,i,0}$) (derived through field data collection, or other methods in this section) to the following default steady-state equilibrium at a linear rate over a twenty year period following exposure.

$$C\%_{BSL\text{-}soil,i,20} = 1.6\ \%\ ^{(6)} \tag{11}$$

The project proponent may justify a lower percent carbon steady state for the baseline scenario based on appropriate scientific research.

5.3.2.4 Modeling

A peer-reviewed published model may be used to generate a value of $GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$, $C_{BSL\text{-}soil,i,t}$, $C\%_{BSL\text{-}emitted,i,t,}$, $C\%_{BSL\text{-}soil,i,t}$, *BD* or *Depth* in the same or similar systems as those in the project area based on the guidelines set out in Section 5.3.1.

5.3.2.5 Field-collected data

Soil coring may be used to generate a value of $C_{BSL\text{-}soil,i,t}$, $C\%_{BSL\text{-}soil,i,t}$, *BD* or *Depth*. For the baseline scenario, soil cores must be collected within 2 years prior to the project start date. Where the project proponent uses an installed reference plane for the baseline scenario, it must have been installed at least 4 years prior to the project start date, which is good practice to ensure that a reliable average accumulation rate is obtained.

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[5] 2013 Supplement to the 2006 Guidelines: Wetlands

[6] This is the mean value of resampled cultivated and drained mineral soils (from Table 2 in David *et al*. 2009).

5.3.2.6 Historical data or chronosequences

$C_{BSL\text{-}soil,i,t}$, $C\%_{BSL\text{-}emitted,i,t}$, *BD* or *Depth* in the baseline scenario may be calculated using either historical data collected from the project area (as described in Module *M-TW*) or chronosequence data collected at similar sites (as described in Section 5.3.1). Refer also to the instructions set out in Section 5.3.1.

5.3.2.7 Deduction for allochthonous carbon

A deduction from the estimate of CO_2 emissions from the SOC pool may be applied in the baseline scenario to account for the percentage of sequestration resulting from allochthonous soil organic carbon accumulation. 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.

$$Deduction_{alloch} = GHG_{BSL\text{-}insitu\text{-}CO2,i,t} \times (\%C_{alloch} /100) \quad ^{(7)} \qquad \textbf{(12)}$$

Where:

$Deduction_{alloch}$	Deduction from CO_2 sequestration in the tidal wetland 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}
$GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$	CO_2 emissions from the tidal wetland SOC pool of *in-situ* soils in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$\%C_{alloch}$	Percentage of the total soil organic carbon that is allochthonous; %
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 in the baseline scenario.

For strata with organic soils or seagrass systems,[8] $Deduction_{alloch} = 0$.

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

1) Published values
2) Field-collected data, or
3) Modeling

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[7] Estimation may be made for total or recalcitrant allochthonous carbon. This equation only applies if $GHG_{BSL\text{-}soil\text{-}CO2,i,t}$ is negative (sequestration).

[8] For seagrass systems, this zero deduction may only be used when the 'layer with soil organic carbon indistinguishable from the baseline SOC concentration' method is used with field-collected data on carbon stock changes (Duarte *et al.* 2013, Greiner *et al*. 2013)

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 5.3.1.

Field-collected data

For this method, the allochthonous carbon percentage is estimated using default values (listed below) and values measured through analysis of field-collected soil cores (for soil carbon or organic matter), sediment tiles (for deposited sediment carbon or organic matter), or through collection of suspended sediments in tidal channels or sediments deposits in tidal flats (for sediment carbon or organic matter).

For the following equation, $\%C_{soil}$ may be measured directly or derived from $\%OM_{soil}$ using the equations in Module *M-TW*. $\%C_{autoch}$ is derived from $\%OM_{autoch}$ (defined below) using the equations in Module *M-TW*.

$$\%C_{alloch} = 100 \times (\%C_{soil} - \%C_{autoch}) / \%C_{soil} \qquad \textbf{(13)}$$

Where:

$\%C_{alloch}$	Percentage of the total soil organic carbon that is allochthonous; %
$\%C_{soil}$	Percentage of soil that is organic carbon; %
$\%C_{autoch}$	Percentage of soil that is autochthonous organic carbon; %

For the following equation, $\%OM_{soil}$ may be estimated directly using loss-on-ignition (LOI) data or indirectly from $\%C_{soil}$ using the equations below. $\%OM_{depsed}$ may be estimated directly using loss-on-ignition (LOI) data, indirectly from $\%OM_{soil}$ using the equations below, or by using the default value given below.

$$\%OM_{autoch} = (\%OM_{soil} - \%OM_{depsed}) / (1 - (\%OM_{depsed} / 100)) \qquad \textbf{(14)}$$

Where:

$\%OM_{autoch}$	Percentage of soil that is autochthonous organic matter; %
$\%OM_{depsed}$	Percentage of deposited sediment that is organic matter; %
$\%OM_{soil}$	Percentage of soil that is soil organic matter; %

The following equations may be used to derive $\%OM_{soil}$ from $\%C_{soil}$ and $\%OM_{depsed}$ from $\%C_{depsed}$, respectively. Alternatively, an equation developed using site-specific data may be used or an equation from peer-reviewed literature may be used if the equation represents soils from the same or similar systems as those in the project area.

For marsh soils[9]:

$$\%OM_{soil} = (-0.4 + \sqrt{(0.4^2 + 4 \times 0.0025 \times \%C_{soil}}) \Big/ (2 \times 0.0025) \qquad \textbf{(15)}$$

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[9] Craft *et al.* 1991

$$\%OM_{depsed} = (-0.4 + \sqrt{(0.4^2 + 4 \times 0.0025 \times \%C_{depsed}})) \Big/ (2 \times 0.0025) \quad \textbf{(16)}$$

For mangrove soils[10]:

$$\%OM_{soil} = (\%C_{soil} - 2.8857) / 0.415 \quad \textbf{(17)}$$

$$\%OM_{depsed} = (\%C_{depsed} - 2.8857) / 0.415 \quad \textbf{(18)}$$

For seagrass soils with %OM < 20 percent[11]:

$$\%OM_{soil} = (\%C_{soil} + 0.21) / 0.4 \quad \textbf{(19)}$$

$$\%OM_{depsed} = (\%C_{depsed} + 0.21) / 0.4 \quad \textbf{(20)}$$

Where:

$\%C_{soil}$	Percentage of soil that is organic carbon; %
$\%C_{depsed}$	Percentage of deposited sediment that is organic C; %

In all cases, the following default factor may be used for the determination of $\%OC_{depsed}$:

$\%C_{depsed} = 1.5$ [12]

Alternatively, $\%C_{depsed}$ may be calculated as [13]:

$$\%C_{depsed} = 0.086 \times SA + 0.05 \quad \textbf{(21)}$$

Where:

SA	Average Surface Area of the sediment; m^2g^{-1}

Modeling

A quantitative model may be used to estimate the percent of allochthonous soil organic carbon where such model meets the guidelines set out in Section 5.3.1. 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 as the project area. 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.

5.3.3 CO_2 Emissions from Eroded Soil

For each stratum *i* at time *t* the project proponent must determine if soil erosion occurs.

CO_2 emissions from eroded soil material ($GHG_{BSL\text{-}eroded\text{-}CO2,i,t}$) may be calculated directly or may be calculated from estimates of the amount of carbon that is eroded ($C_{BSL\text{-}eroded,i,t}$) and the percentage of the eroded carbon that is returned to the atmosphere ($C\%_{BSL\text{-}emitted,i,t}$).

Project proponents can use any combination of the following methods to calculate these terms:

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[10] Kauffman *et al*. 2011, Howard *et al*. 2014
[11] Fourqurean *et al*. 2012 as summarized in Howard *et al.* 2014
[12] Mayer 1994 Figure 4
[13] Mayer 1994 Figure 4 and surface area laboratory procedures

1) Proxies
2) Published values
3) Default factors
4) Models
5) Field-collected data, or
6) Historical or chronosequence-derived data

$$GHG_{BSL\text{-}eroded\text{-}CO2,i,t} = 44/12 \times C_{BSL\text{-}eroded,i,t} \times C\%_{BSL\text{-}emitted,i,t} / 100 \qquad \textbf{(22)}$$

Where:

$GHG_{BSL\text{-}eroded\text{-}CO2,i,t}$	CO_2 emissions from the eroded tidal wetland SOC pool in the baseline scenario in stratum *i* in year *t* ; t CO_2e ha^{-1} yr^{-1}
$C_{BSL\text{-}eroded,i,t}$	Soil organic carbon stock in eroded tidal wetland soil material in the baseline scenario in stratum *i* in year *t*; t C ha^{-1}
$C\%_{BSL\text{-}emitted,i,t}$	Organic carbon loss due to oxidation, as a percentage of C mass present in eroded tidal wetland soil material in the baseline scenario in stratum *i* in year *t* (14); %

$$C_{BSL\text{-}eroded,i,t} = C\%_{BSL\text{-}eroded,i,t} \times BD \times Depth\_e_{i,t} \times 10 \qquad \textbf{(23)}$$

Where:

$C\%_{BSL\text{-}eroded,i,t}$	Percentage of carbon of tidal wetland soil material eroded; %
BD	Soil bulk density; kg m^{-3}
$Depth\_e_{i,t}$	Depth of the eroded area from the surface to the surface prior to erosion in stratum *i* in year *t*; m

5.3.3.1 Proxy-based approach

CO_2 emissions from eroded soil may be calculated using proxies (where such proxies meet the guidance set out in Section 5.3.1). Where the project proponent uses a proxy, such emissions are represented by the following equation:

$$GHG_{BSL\text{-}eroded\text{-}CO2,i,t} = f \text{ (GHG emission proxy)} \qquad \textbf{(24)}$$

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[14] To ensure a conservative outcome, emissions must be estimated for a 5-year time period following the initial year of erosion.

5.3.3.2 Published values

Peer-reviewed published data may be used to generate a value for $GHG_{BSL\text{-}eroded\text{-}CO2,i,t}$, $C_{BSL\text{-}eroded,i,t}$, $C\%_{BSL\text{-}emiitted,i,t}$, $C\%_{BSL\text{-}eroded,i,t}$, BD or $Depth$, based on values from same or similar systems as those in the project area, based on the guidelines set out in Section 5.3.1.

5.3.3.3 Default factors

For tidal marsh and mangrove systems, a default factor may be used in the absence of data suitable for using the published value approach, using the values provided below for the specified carbon preservation depositional environment (CPDE) as defined in Chapter 3:

If there is connectivity between the eroded area and a river-estuary system:[15]

If CPDE is "Normal Marine" or "Deltaic fluidized muds", then $C\%_{BSL\text{-}emitted,i,t} = 80\%$[16] **(25)**

If CPDE is "O_2 depletion", then $C\%_{BSL\text{-}emitted,i,t} = 53\%$[17] **(26)**

If CPDE is "Small Mountainous Rivers", then $C\%_{BSL\text{-}emitted,i,t} = 39\%$[18] **(27)**

If CPDE is "Extreme accumulation rates", then $C\%_{BSL\text{-}emitted,i,t} = 49\%$[19] **(28)**

If there is no connectivity between the eroded area and a river-estuary system and erosion mass is greater in the baseline scenario than the project scenario, then it is conservative to assume net zero emissions from eroded strata in the baseline scenario and the project scenario.

If there is no connectivity between the eroded area and a river-estuary system and erosion mass is the same or lower in the baseline scenario than the project scenario:

$$C\%_{BSL\text{-}emitted,i,t} = 100\% \tag{29}$$

The project proponent may justify a greater $C\%_{BSL\text{-}emitted,i,t}$ for the baseline scenario based on appropriate scientific research. Normal Marine CPDE with data showing very low sediment accumulation rates (less than 0.002 g cm^{-2} yr^{-1}) may use a $C\%_{BSL\text{-}emitted,i,t}$ value of 98.5%.[20]

5.3.3.4 Modeling

A peer-reviewed published model may be used to generate a value of $GHG_{BSL\text{-}eroded\text{-}CO2,i,t}$, $C_{BSL\text{-}eroded,i,t}$, $C\%_{BSL\text{-}emitted,i,t}$, $C\%_{BSL\text{-}eroded,i,t}$, BD or $Depth$, in the same or similar systems as those in the project area based on the guidelines set out in Section 5.3.1.

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[15] Connectivity occurs when eroded carbon is delivered into river-estuary systems that transport materials seaward by continual resuspension, coastal margins and embayments with sufficient wave energy to continually re-suspend sediments into an aerobic water column, or subaquatic environments with low organic carbon content and course-grained sediments that maintain aerobic conditions in the upper soil profile.

[16] Blair and Aller 2012

[17] Blair and Aller 2012

[18] Blair and Aller 2012

[19] Blair and Aller 2012

[20] Mean value from figure 9 in Blair and Aller 2012

5.3.3.5 Field-collected data

Soil coring may be used to generate a value of $C_{BSL\text{-}eroded,i,t}$, $C\%_{BSL\text{-}eroded,i,t}$, *Depth* or *BD* as outlined in Module *M-TW*. For the baseline scenario, soil cores must be collected within 2 years prior to the project start date. Where the project proponent uses an installed reference plane for the baseline scenario, it must have been installed at least 4 years prior to the project start date, which is good practice to ensure that a reliable average accumulation rate is obtained.

Field collected data may be used generate a value of *Depth* as outlined in Module *M-TW*.

5.3.3.6 Historical data or chronosequences

$C_{BSL\text{-}eroded,i,t}$, $C\%_{BSL\text{-}emiitted,i,t}$, $C\%_{BSL\text{-}eroded,i,t}$, *BD* or *Depth* in the baseline scenario may be calculated using either historical data collected from the project area (as described in Module *M-TW*) or chronosequence data collected at similar sites (as described in Section 5.3.1). Refer also to the instructions set out in Section 5.3.1.

5.3.4 CO_2 Emissions from Soil Exposed to an Aerobic Environment Through Excavation

For each stratum *i* at time *t* the project proponent must determine if piled-up soil[21] exposed to an aerobic environment exists within the project boundary.

CO_2 emissions from soil exposed to an aerobic environment through excavation ($GHG_{BSL\text{-}excav\text{-}CO2,i,t}$) may be calculated directly or may be calculated from estimates of the initial amount of carbon that is exposed ($C_{BSL\text{-}excav,i,t}$) and the percentage of the exposed carbon that is returned to the atmosphere ($C\%_{BSL\text{-}emitted,i,t}$) as defined in Equation 30.

Estimates of $C_{BSL\text{-}excav,i,t}$ following the aerobic exposure event based on the extrapolation of $C\%_{BSL\text{-}emitted,i,t}$ over the project crediting period must account for tendency of organic carbon concentrations to approach steady-state equilibrium in mineral soils. For this reason, a complete loss of soil organic carbon may not occur in mineral soils. This steady-state equilibrium must be determined conservatively.

Project proponents can use any combination of the following methods to calculate these terms:

1) Proxies
2) Published values
3) Default factors
4) Models
5) Field-collected data, or
6) Historical or chronosequence-derived data

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[21] "Piled up soil" refers to a body of soil material accumulated in piles or layers as a result of excavation.

$$GHG_{BSL\text{-}excav\text{-}CO2,i,t} = 44/12 \times C_{BSL\text{-}excav,i,t} \times C\%_{BSL\text{-}emitted,i,t} / 100 \tag{30}$$

$$C_{BSL\text{-}excav,i,t} = C\%_{BSL\text{-}emitted,i,t} \times BD \times Depth\_ex_{\,i,t} \times 10 \tag{31}$$

Where:

$GHG_{BSL\text{-}excav\text{-}CO2,i,t}$	CO_2 emissions from the tidal wetland SOC pool of soil exposed to an aerobic environment through excavation in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}
$C_{BSL\text{-}excav,i,t}$	Soil organic carbon stock in tidal wetland soil exposed to an aerobic environment through excavation in the baseline scenario in stratum *i* in year *t*; t C ha^{-1}
$C\%_{BSL\text{-}emitted,i,t}$	Organic carbon loss due to oxidation, as a percentage of C mass present in excavated tidal wetland soil material in the baseline scenario in stratum *i* in year *t*; %
$C\%_{BSL\text{-}excav,i,t}$	Percentage of carbon of tidal wetland soil material excavated; %
BD	Soil bulk density; kg m^{-3}
$Depth\_ex_{\,i,t}$	Depth of the piled-up tidal wetland soil material due to excavation in stratum *i* in year *t*; m

5.3.4.1 Proxy-based approach

CO_2 emissions from excavated soil may be calculated using proxies (where such proxies meet the guidance set out in Section 5.3.1). Where the project proponent uses a proxy, such emissions are represented by the following equation:

$$GHG_{BSL\text{-}excav\text{-}CO2,i,t} = f\text{ (GHG emission proxy)} \tag{32}$$

5.3.4.2 Published values

Peer-reviewed published data may be used to generate a value for $GHG_{BSL\text{-}excav\text{-}CO2,i,t}$, $C_{BSL\text{-}excav,i,t}$, $C\%_{BSL\text{-}emitted,i,t,}$, $C\%_{BSL\text{-}excav,i,t}$, *BD* and *Depth* based on the average rate of excavated soil CO_2 emissions in the same or similar systems as those in the project area, based on the guidelines set out in Section 5.3.1.

5.3.4.3 Default factors

A default factor for $C\%_{BSL\text{-}excav,i,t}$ may be used for the percent carbon at steady-state equilibrium 20 years following exposure to an aerobic environment in the absence of data suitable for using the published value approach, using the value for $C\%_{BSL\text{-}soil,i,20}$ provided in Section 5.3.2.3.

5.3.4.4 Modeling

A peer-reviewed published model may be used to generate a value of $GHG_{BSL\text{-}excav\text{-}CO2,i,t}$, $C_{BSL\text{-}excav,i,t}$, $C\%_{BSL\text{-}emitted,i,t,}$, $C\%_{BSL\text{-}excav,i,t}$, *BD* or *Depth* in the same or similar systems as those in the project area based on the guidelines set out in Section 5.3.1.

5.3.4.5 Field-collected data

Soil coring may be used to generate a value of $C_{BSL\text{-}excav,i,t}$, $C\%_{BSL\text{-}excav,i,t}$, *BD* or *Depth* as outlined in Module *M-TW*. For the baseline scenario, soil cores must be collected within 2 years prior to the project start date. Where the project proponent uses an installed reference plane for the baseline scenario, it must have been installed at least 4 years prior to the project start date, which is good practice to ensure that a reliable average accumulation rate is obtained.

5.3.4.6 Historical data or chronosequences

$C_{BSL\text{-}excav,i,t}$, $C\%_{BSL\text{-}emitted,i,t}$, *BD*, or *Depth* in the baseline scenario may be calculated using either historical data collected from the project area (as described in Module *M-TW*) or chronosequence data collected at similar sites (as described in Section 5.3.1). Refer also to the instructions set out in Section 5.3.1.

5.3.5 CH_4 Emissions from Soil – *in situ*

CH_4 emissions in the baseline scenario may be conservatively excluded.

CH_4 emissions from soils may be estimated using:

1) Proxies
2) Field-collected data
3) Published values
4) Default factors
5) Models, or
6) IPCC emission factors

Where the project proponent accounts for CH_4 emissions in the baseline scenario, the options described in the sections below may be applied to estimate such emissions.

5.3.5.1 Proxy-based approach

Where relevant, CH_4 emissions from organic soil may be estimated using proxies such as water table depth and vegetation composition (where such proxies meet the requirements set out in Section 5.3.1). Where the project proponent uses a proxy, such emissions are represented by the following equation:

$$GHG_{BSL\text{-}soil\text{-}CH4,i,t} = f\,(\text{GHG emission proxy}) \times CH4\text{-}GWP \qquad \textbf{(33)}$$

Where:

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

5.3.5.2 Field-collected data

Field-collected data may also be used to estimate CH_4 emissions (see Module *M-TW*).

5.3.5.3 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 set out in Section 5.3.1.

5.3.5.4 Default factor

For tidal wetland systems, a default factor[22] may be used in the absence of data suitable for using the published value approach for the estimation of $GHG_{BSL\text{-}soil\text{-}CH4,i,t}$. Where the salinity average or salinity low point is >18 ppt, the project proponent may apply a default emission factor of:

$$GHG_{BSL\text{-}soil\text{-}CH4,i,t} = 0.011 \text{ t } CH_4 \text{ ha}^{-1} \text{ yr}^{-1} \times CH4\text{-}GWP \quad \textbf{(34)}$$

Where the salinity average or salinity low point is ≥ 20 ppt, the project proponent may apply a default emission factor of:

$$GHG_{BSL\text{-}soil\text{-}CH4,i,t} = 0.0056 \text{ t } CH_4 \text{ ha}^{-1} \text{ yr}^{-1} \times CH4\text{-}GWP \quad \textbf{(35)}$$

Procedures for measuring the salinity average or salinity low point are provided in Module *M-TW*.

The project proponent must not use the default value of 0.011 t CH_4 ha^{-1} yr^{-1} for the baseline scenario and 0.0056 t CH_4 ha^{-1} yr^{-1} for the project scenario to create a difference in emissions and claim an emission reduction. The use of the default factor is intended for projects that restore salinity levels from fresh/brackish to much higher levels that inhibit CH_4 emissions.

5.3.5.5 Modeling

A peer-reviewed published model which meets the guidance set out in Section 5.3.1 may also be used to estimate CH_4 emissions from the SOC pool.

5.3.5.6 Emission factors

The emission factors provided are to be used for the tidal wetland systems covered in this methodology (see Chapter 3), thus only in cases where there is tidal connectivity. In cases where the land does not meet the definition of tidal wetland, the most recently published IPCC emission factors or Tier-1 emissions factors may be used to estimate CH_4 emissions from the SOC pool, but must be applied conservatively, following the guidance set out in Section 5.3.1, including accounting for local salinity and vegetative cover conditions.

5.3.6 N_2O Emissions from Soil *in situ*

N_2O emissions in the baseline scenario may be conservatively excluded.

N_2O emissions from soils may be estimated using:

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[22] Taken from Poffenbarger *et al*. 2011

1) Proxies
2) Field-collected data
3) Published values
4) Default factors
5) Models, or
6) IPCC emission factors

Where the project proponent accounts for N_2O emissions in the baseline scenario, the options described in the sections below may be applied to estimate such emissions.

5.3.6.1 Proxy-based approach

Where relevant, N_2O emissions may be estimated using proxies such as water table depth and vegetation composition (where such proxies meet the guidance set out in Section 5.3.1). Where the project proponent uses a proxy, such emissions are represented by the following equation (note that the determination of the similarity of systems must include the nitrogen levels of the systems):

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = f\,(N_2O \text{ emission proxy}) \times N2O\text{-}GWP \quad \textbf{(36)}$$

Where:

$GHG_{BSL\text{-}soil\text{-}N2O,i,t}$	N_2O emissions from the tidal wetland SOC pool in the baseline scenario 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}
$N2O\text{-}GWP$	Global warming potential for N_2O; dimensionless

5.3.6.2 Field-collected data

Field-collected data may be used to estimate N_2O emissions (see Module *M-TW*).

5.3.6.3 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 5.3.1. Note that determination of the similarity of systems must include the nitrogen levels of the systems.

5.3.6.4 Default factors

The following default factors[23] may be used for the estimation of $GHG_{BSL\text{-}soil\text{-}N2O,i,t}$ in the absence of data suitable for using the published value approach. Use of a default factor is only permitted for the systems listed below, and no default factors may be used where the project area receives hydrologically direct

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[23] Taken from Smith *et al*. 1983.

inputs from a point or non-point source of nitrogen such as wastewater effluent or an intensively nitrogen-fertilized system.

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

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.000157 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times N2O\text{-}GWP \quad \textbf{(37)}$$

For open water systems where the salinity average or salinity low point is >5 and ≤18 ppt:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.00033 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times N2O\text{-}GWP \quad \textbf{(38)}$$

For other open water systems:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.00053 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times N2O\text{-}GWP \quad \textbf{(39)}$$

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

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.000487 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times N2O\text{-}GWP \quad \textbf{(40)}$$

For non-seagrass wetland systems where the salinity average or salinity low point is >5 and ≤18 ppt:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.000754 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times N2O\text{-}GWP \quad \textbf{(41)}$$

For other non-seagrass wetland systems:

$$GHG_{BSL\text{-}soil\text{-}N2O,i,t} = 0.000864 \text{ t } N_2O \text{ ha}^{-1} \text{ yr}^{-1} \times N2O\text{-}GWP \quad \textbf{(42)}$$

Procedures for measuring the salinity average and salinity low point are set out in Module *M-TW*.

5.3.6.5 Modeling

A peer-reviewed published model which meets the requirements set out in Section 5.3.1 may also be used to estimate N_2O emissions from the SOC pool.

5.3.6.6 Emission factors

The emission factors provided are to be used for the tidal wetland systems covered in this methodology (see Chapter 3), thus only in cases where there is tidal connectivity. In cases where the land does not meet the definition of tidal wetland, the most recently published IPCC emission factors or Tier-1 emissions factors may also be used to estimate N_2O emissions from the SOC pool, but must be applied conservatively following the guidance set out in Section 5.3.1.

6 DATA AND PARAMETERS

6.1 Data and Parameters Available at Validation

Data / Parameter	$E_{FC,i,t}$
Data unit	t CO_2e
Description	Net CO_2e emissions from fossil fuel combustion in stratum *i* in year *t*
Equations	1

Source of data	Module *E-FFC*
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Module *E-FFC*
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$A_{BSL,i,t}$
Data unit	ha
Description	Area of stratum *i* in year *t* in the baseline scenario
Equations	2
Source of data	Module *X-STR*
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Module *X-STR*
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$
Data unit	t CO_2e ha^{-1} yr^{-1}
Description	CO_2 emissions from the SOC pool of *in-situ* soils in the baseline scenario in stratum *i* in year *t*
Equations	4, 5, 7-9, 12
Source of data	Estimated using methods described in Sections 5.3.2.1, 5.3.2.2, 5.3.2.3 and 5.3.2.4
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$Deduction_{alloch}$
Data unit	t CO_2e ha^{-1} yr^{-1}
Description	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
Equations	3, 12
Source of data	Estimated using methods described in Section 5.3.2.7
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$C\%_{BSL\text{-}soil,i,t}$
Data unit	%
Description	Percentage of carbon of *in-situ* tidal wetland soil material in stratum *i* in year *t*
Equations	6, 10
Source of data	Estimated using methods described in Section 5.3.2
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	BD
Data unit	kg m^{-3}
Description	Soil bulk density
Equations	6, 23, 31
Source of data	Direct measurements, or from a relationship with organic carbon content provided by the scientific literature.

Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Mass of soil material after drying per volume of soil material, based on commonly accepted procedures by the scientific community.
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$Depth\_i_{i,t}$
Data unit	m
Description	Depth of *in-situ* exposed soil in stratum *i* in year *t*
Equations	6
Source of data	Estimated using commonly accepted procedures by the scientific community and taking note of requirements in Section 5.3.2
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See "Source of Data" above
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$GHG_{BSL\text{-}soil\text{-}CH4,i,t}$
Data unit	t CO_2e ha^{-1} yr^{-1}
Description	CH_4 emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*
Equations	3, 33-35
Source of data	Estimated using methods described in Sections 5.3.5.1 and 5.3.5.4
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$GHG_{BSL\text{-}soil\text{-}N2O,i,t}$
Data unit	t CO_2e ha^{-1} yr^{-1}
Description	N_2O emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*
Equations	3, 36-42
Source of data	Estimated using methods described in Sections 5.3.6.1 and 5.3.6.4
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$t_{PDT\text{-}BSL,i}$
Data unit	yr
Description	Peat Depletion Time in the baseline scenario in stratum *i* in years elapsed since the project start
Equations	N/A
Source of data	Module *X-STR*
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Module *X-STR*
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$t_{SDT\text{-}BSL,i}$
Data unit	yr
Description	Soil organic carbon depletion time in the baseline scenario in stratum *i* in years elapsed since the project start date
Equations	N/A
Source of data	Module *X-STR*
Value applied	N/A

Justification of choice of data or description of measurement methods and procedures applied	See Module *X-STR*
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$C_{BSL\text{-}soil,i,t}$
Data unit	t C ha^{-1}
Description	Soil organic carbon stock in *in-situ* tidal wetland soil material in the baseline scenario in stratum *i* in year *t*
Equations	5, 6, 8
Source of data	Estimated using methods described in Section 5.3.2
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$C\%_{BSL\text{-}soil,i,20}$
Data unit	%
Description	Percentage of carbon in *in-situ* tidal wetland soil material at steady-state equilibrium 20 years following exposure to an aerobic environment
Equations	10, 11
Source of data	Estimated using methods described in Section 5.3.2
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$\%C_{alloch}$
Data unit	%
Description	Percentage of the total soil organic carbon that is allochthonous
Equations	12, 13
Source of data	Estimated using methods described in Section 5.3.2.7
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$\%C_{soil}$
Data unit	%
Description	Percentage of soil that is organic carbon
Equations	13, 17, 19
Source of data	Direct measurements or may be derived from direct measurements of soil organic matter. These measurements may be made using samples collected as described in Section 5.3.2.7 or indirectly from the soil organic matter percentage determined through loss-on-ignition as described in Section 5.4.1 in Module *M-TW*.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Source of data above
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$\%OM_{depsed}$
Data unit	%
Description	Percentage of deposited sediment that is organic matter
Equations	14, 18, 20

Source of data	May be estimated directly using loss-on-ignition (LOI) data, indirectly from soil carbon percentage as described in Section 5.3.2.7, or from the default value provided in Section 5.3.2.7. These measurements may be made using samples collected on sediment tiles or through collection and carbon analysis (see Section 5.3.2.7) of suspended sediments in tidal channels or sediments deposits in tidal flats.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	LOI may be assessed using standard laboratory procedures
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	N/A

Data / Parameter	$\%OM_{soil}$
Data unit	%
Description	Percentage of soil that is soil organic matter
Equations	14, 17, 19
Source of data	Direct measurements based on loss-on-ignition or may be derived from direct measurements of soil carbon. These measurements may be made using samples collected as described in Section 5.3.2.7 or indirectly from the soil carbon percentage as described in Section 5.3.2.7.
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 Kauffman *et al*. 2011, and for seagrass soils by Fourqurean *et al*. 2012 as summarized in Howard *et al*. 2014.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	N/A

Data / Parameter	$\%C_{depsed}$
Data unit	%
Description	Percentage of deposited sediment that is organic C
Equations	18, 20, 21
Source of data	May be estimated directly or indirectly from soil organic matter percentage as described in Section 5.4.1 of Module *M-TW*.

	These measurements may be made using samples collected on sediment tiles or through collection and carbon analysis (see Section 5.3.2.7) of suspended sediments in tidal channels or sediments deposits in tidal flats.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	The default factor is derived from the mean value of total refractory background organic carbon concentration from figure 4 in Mayer 1994.
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	SA
Data unit	m^2g^{-1}
Description	Average Surface Area of the sediment
Equations	21
Source of data	Laboratory procedures described in Mayer 1994
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$GHG_{BSL\text{-}eroded\text{-}CO2,i,t}$
Data unit	t CO_2e ha^{-1} yr^{-1}
Description	CO_2 emissions from the eroded SOC pool in the baseline scenario in stratum i in year t
Equations	4, 22, 24
Source of data	Estimated using methods described in Section 5.3.3, 5.3.3.1, 5.3.3.2 and 5.3.3.4
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions

Comments	N/A

Data / Parameter	$C\%_{BSL\text{-}emitted,i,t}$
Data unit	%
Description	Organic carbon loss due to oxidation, as a percentage of C mass present in *in-situ* tidal wetland soil material in the baseline scenario in stratum *i* in year *t* (Section 5.3.2) Organic carbon loss due to oxidation, as a percentage of C mass present in eroded tidal wetland soil material in the baseline scenario in stratum *i* in year *t* (Section 5.3.3) Organic carbon loss due to oxidation, as a percentage of C mass present in excavated tidal wetland soil material in the baseline scenario in stratum *i* in year *t* (Section 5.3.4)
Equations	5, 22, 25-31
Source of data	Estimated using methods described in Sections 5.3.2, 5.3.3 and 5.3.4
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	The default factors provided in Section 5.3.3.3 are the mean values for the specified CPDE, published in Figure 9 of Blair and Aller (2012).
Purpose of Data	Calculation of baseline emissions
Comments	$C\%_{BSL\text{-}emitted,i,t}$ in this module and $Rate_{Closs\text{-}BSL,i,t}$ in Module *X-STR* are different parameters with different units but relating to the same process of soil organic carbon loss.

Data / Parameter	$C_{BSL\text{-}eroded,i,t}$
Data unit	t C ha^{-1} yr^{-1}
Description	C mass present in eroded tidal wetland soil material in the baseline scenario in stratum *i* in year *t*
Equations	22, 23
Source of data	Estimated using methods described in Section 5.3.3.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions

Comments	N/A

Data / Parameter	$C\%_{BSL\text{-}eroded,i,t}$
Data unit	%
Description	Percentage of carbon of tidal wetland soil material eroded
Equations	23
Source of data	Estimated using methods described in Section 5.3.3.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$Depth\_e_{\ i,t}$
Data unit	m
Description	Depth of the eroded area from the surface to the surface prior to erosion in stratum *i* in year *t*
Equations	23
Source of data	Estimated using methods described in Section 5.3.3
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$GHG_{BSL\text{-}excav\text{-}CO2,i,t}$
Data unit	t CO_2e ha^{-1} yr^{-1}
Description	CO_2 emissions from the SOC pool of tidal wetland soil exposed to an aerobic environment in the baseline scenario in stratum *i* in year *t*
Equations	4, 30, 32

Source of data	Estimated using methods described in Sections 5.3.4, 5.3.4.1, 5.3.4.2 and 5.3.4.4
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$C_{BSL\text{-}excav,i,t}$
Data unit	t C ha^{-1} yr^{-1}
Description	Soil organic carbon stock in tidal wetland soil exposed to an aerobic environment through excavation in the baseline scenario in stratum *i* in year *t*
Equations	30, 31
Source of data	Estimated using methods described in Section 5.3.4
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$C\%_{BSL\text{-}excav,i,t}$
Data unit	%
Description	Percentage of carbon of tidal wetland soil material excavated
Equations	31
Source of data	Estimated using methods described in Section 5.3.4
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$Depth\_ex_{i,t}$
Data unit	m
Description	Depth of piled-up soil material due to excavation in stratum *i* in year *t*
Equations	31
Source of data	Estimated using methods described in Section 5.3.4
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	*CH4-GWP*
Data unit	Dimensionless
Description	Global Warming Potential of CH_4
Equations	33-35
Source of data	IPCC
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	*N2O-GWP*
Data unit	dimensionless
Description	Global warming potential for N_2O
Equations	36-42
Source of data	IPCC
Value applied	N/A
Justification of choice of data or description of	N/A

measurement methods and procedures applied	
Purpose of Data	Calculation of baseline emissions
Comments	N/A

6.2 Data and Parameters Monitored

N/A

7 REFERENCES AND OTHER INFORMATION

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DOCUMENT HISTORY

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