

Table 1. Components of the NFZ term balance. Here we present a summary of the carbon fluxes relevant for quantifying ERW in the Near Field Zone and their considerations. Note that the first row describes the integrated weathering flux which integrates the other components listed and is relevant for Endmember Approach 1 (excluding the row on changes to soil organic carbon).

Description of term	Considerations for CDR quantification	Recommendations for near-term path forward
Integrated weathering flux The cumulative weathering signal of the dissolved phase, including the integrated effects of feedstock dissolution, cation sorption, secondary carbonate formation, secondary silicate formation, and alkalinity loss due to biomass uptake.	The integrated weathering flux is only required for the aqueous phase approach and is part of one endmember approach for constraining the NFZ balance. If not measuring the integrated weathering flux, the components of carbon sources and losses must be accounted for individually (see below).	<ul style="list-style-type: none"> • Measure dissolved weathering products directly as they are generated in, and exported from, the NFZ. • Aqueous phase measurements should be taken at the end of the NFZ (or in drainage waters or downstream catchments) in order to calculate a net export flux of weathering products.
Feedstock dissolution The dissolution of minerals in the feedstock after application on the deployment site (potential CDR).	Impacted by temperature, pH, variable water content and fluid residence time, kinetic inhibitors and dissolved phases that enhance rates, the formation of secondary phases, and the impacts of biological processes.	<ul style="list-style-type: none"> • Collect direct empirical measurements that capture alkalinity release in the solid phase via solid-phase, mass balance-based approaches. • It is highly recommended that feedstock application rates be empirically constrained by measuring the soil concentration of an immobile element or isotope ratio before and after feedstock application.
pH/non-carbonic acid weathering Chemical weathering done by acids other than carbonic acid such as sulfuric, nitric, or organic acid, or in low pH soil.	<ul style="list-style-type: none"> • Weathering by non-carbonic acids does not lead to base cations charge-balanced by DIC, but does neutralize acidity that may have otherwise reacted with bicarbonate and caused CO₂ degassing. • In strongly acidic soils (pH < 4.5-5, pCO₂ dependent), the cations released by weathering are charge-balanced by very little bicarbonate. 	<ul style="list-style-type: none"> • Any non-carbonic acid weathering in the NFZ should be removed from netCDR. • Constrain non-carbonic acid weathering directly through aqueous phase measurements or estimate strong acid addition/production, fully discount from netCDR, and account for degassing. • For now, assume organic acids will be degraded following reaction with silicate minerals and generate an equivalent amount of DIC as carbonic acid weathering (Working Group 2). Do not include in the term balance. • To account for low pH weathering, monitor for declines in exchangeable and bound acidity.

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Cation Sorption Adsorption of cations onto soil particle surfaces (e.g., clay minerals, organic matter, mineral oxides).	Cation sorption can act as a transient alkalinity sink; when base cations exchange for acidic cations on exchange sites, the removal of those cations from solution ‘undoes’ any CDR they were driving (or equivalently, the proton release into solution drives CO ₂ evasion). As base cation concentrations in the soil solution decrease or the soil begins to re-acidify, these cations can eventually re-enter the soil solution and drive CDR.	<ul style="list-style-type: none"> • If $CO_2^{e_{NFZ,RP}}$ is constrained by the time-integrated alkalinity flux at or beyond the end of the NFZ, alkalinity loss from cation exchange processes has already been accounted for—no direct measurement of the exchangeable fraction required. • If feedstock dissolution is constrained independently and netCDR in the NFZ is calculated as the sum of sources and sinks, cation exchange capacity and base saturation or exchangeable acidity should be quantified using established methods.
Secondary carbonate formation Precipitation of carbonate minerals (e.g., calcite) in the soil profile.	Secondary carbonate formation in the soil profile and downstream systems can represent a stable (and measurable) store of atmospheric CO ₂ for ERW deployments with non-carbonate feedstocks. However, secondary carbonate formation reduces (and for carbonate feedstocks, negates) potential CDR by removing cations and charge-balancing carbonate alkalinity from solution.	<ul style="list-style-type: none"> • Can be directly monitored through changes in soil inorganic carbon stocks relative to business as usual plots. • Location-specific context will be needed to determine the probability of carbonate formation and how to account for it. • Potential strong acid weathering should be considered if reductions in SIC stocks between reporting periods is observed.
Secondary silicate formation Secondary silicate minerals (e.g., clays), amorphous Si, and Fe/Al oxy-hydroxides can form in many potential deployment sites, though other secondary phases—for example, Ca-phosphates—can be formed in specific systems.	Secondary silicate phases can form quickly (hours to days), and their formation may be spatially and temporally separated from the initial weathering reaction. Their formation will reduce CDR efficiency by removing base cations from solution. It is difficult to identify regimes where secondary silicate or Fe/Al oxy-hydroxide could be assumed to be fully negligible (Working Group 2), and therefore should be accounted for in netCDR.	<ul style="list-style-type: none"> • Potential quantification options may depend on the secondary phase of interest. • It is not recommended that early-stage commercial deployments be required to independently constrain NFZ alkalinity loss through secondary silicate formation due to challenges associated with direct quantification of secondary silicate phases. • Placing bounds on the potential netCDR loss through stoichiometric arguments may be a good place to start.
Biomass uptake of base cations Plants retrieve nutrients from the soil solution, including base cations such as Ca ²⁺ , Mg ²⁺ , K ⁺ , and Na ⁺ ; generally accompanied by a release of protons to maintain charge balance within the plant.	Biomass uptake of base cations ‘undoes’ any CDR that was being driven by the base cations in solution; or equivalently, drives CO ₂ evasion.	<ul style="list-style-type: none"> • Plant uptake should be estimated through direct measurements of the base cation content of relevant biomass, including biomass that is removed from the field. • Sufficient data does not yet exist for use of predictive frameworks to

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		<p>estimate element-specific plant uptake for different crop types under different growing conditions (Working Group 2).</p>
<p>Changes to (soil) organic carbon stocks An increase in soil organic carbon via accumulation or a decrease in soil organic carbon via respiration.</p>	<p>Observations thus far have demonstrated variable responses of SOC to alkaline feedstock addition in field trials, mesocosm studies, and laboratory experiments. Small changes in the balance between photosynthesis and respiration, or a destabilization of existing soil organic carbon stocks, could substantially reduce (or even completely negate) CO₂ uptake by an ERW deployment. There are some soil conditions that are at particularly high risk for SOC loss resulting from an ERW deployment.</p>	<ul style="list-style-type: none"> • ERW intervention's potential impact on soil organic carbon stocks and the net organic carbon balance is nascent, and we do not yet have enough data to consider the potential for SOC mobilization resulting from an ERW deployment to be sufficiently de-risked (Working Group 2). • Deployments should not be undertaken under conditions that have been deemed at 'high risk of substantial SOC loss' until sufficient evidence has been generated to de-risk the impact of an ERW intervention on organic carbon cycling in such systems. • For deployments not considered 'high risk', monitoring of bulk SOC stocks should be implemented on a representative sub-plot within the deployment area and corresponding 'business as usual' or negative control plot. • We do not recommend that any changes to SOC stocks be directly incorporated into netCDR quantification for commercial ERW deployments at this time. • SOC monitoring data should be transparently reported in a timely manner.