ISOMETRIC

Enhanced Weathering in Agriculture 1.0.0 Protocol

Public Consultation Summary

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Context

Isometric held a public consultation on its Enhanced Weathering in Agriculture 1.0.0. Protocol to receive stakeholder input on this protocol and associated modules.

The public consultation was announced on the 2nd of February, 2024. The period of consultation lasted 30 days, with the final day as the 4th of March, 2024.

After the initial public consultation, the feedback received was considered for incorporation into the Protocol and associated modules. All stakeholders have received responses to the submitted feedback.

This document summarizes the feedback received during the public consultation and the revisions included as a result of the comments. Content in italics and brackets are excerpts from the public consultation version of the protocol to give the reader necessary context behind the comment.

We thank all participants for their time.

Summary of feedback received

Section	Comment	Resolution
Enhanced Weathering in Agriculture 1.0.0		
General	Note that [geostandards] are better known outside geology as Certified Reference Materials (CRMs).	Changed: All references to geostandards are now referred to as CRMs. Thank you for pointing out this terminology difference.
General	Why such limited guidance on baseline [soil organic carbon measurements]? I struggle to understand how any EW project developer could reasonably characterize a baseline soil C stock with only the info provided. Note ofc a stock is different than point values. I don't understand what value point values by themselves provide at all, hence I'm assuming what you really want is baseline stocks, but that's kinda the point of my comment - the guidance def doesn't provide enough detail to ensure project developers can actually quantify stock with any certainty. Unless I missed something, which is very possible, since the protocol is big and complex, there's no guidance on stratification, sample plan design, and other key topics that would allow a project developer to characterize baseline SOC stocks. But again I'm very open to having misinterpreted the protocol - correction is welcome.	No change: This protocol is not intended to provide guidance on detecting modest changes in soil organic carbon inventories over a reporting period. Additionally, any changes to soil organic carbon are not included in any carbon accounting framework and will not be credited. This is because soil organic carbon inventories are generally much more transient than the carbon storage resulting from enhanced weathering. The measurements of soil organic carbon required under this protocol are meant to provide only a coarse estimate at the organic carbon inventories. SOC measurements on the scale of individual samples may also provide important context for changes in soil properties, such as cation exchange capacity. Project proponents are always free to conduct more expansive soil organic carbon quantification.
General	Clarify aqueous sampling frequency	No change: The authors refer the commenter to section 9.3.5.1, where it is stated that porewaters

		should be sampled at a frequency appropriate for the local water budget, which must be justified in the PDD
General	Clarify baseline vs. post-deployment sample density	No change: The authors refer to sections 9.3.4.2.2, where we provide guidance for determining the number of samples for statistical significance based on in-field heterogeneity, as determined during baseline sampling; section 9.3.4.3 where we set the minimum required baseline sample density; and section 9.3.4.5, where we state that the number of samples taken should be determined based on the statistical considerations outlined in 9.3.4.2.2.
General	Maybe this should only be called "secondary phases". The formation of secondary iron and aluminum hydroxides will remove OH- from the solution, shifting the soil pH to more acidic conditions, thereby contributing to the re-equilibration of CO_2 as noted below.	No change: No text was attached to this comment, so it is unclear exactly what text the commenter is referring to here. The phases required for explicit consideration are carbonates and clay minerals. Other minor phases that form will presumably modify the alkalinity budget as observed in aqueous phase measurements.
General	Should this not also include monitoring of Ni and Cr concentrations in the agricultural products?	No change: Direct monitoring of metal concentrations in agricultural products may be appropriate in some cases and with some feedstocks.
General	Should this also include a consideration of enhanced carbon sequestration within soils? Even if it is considered as a co-benefit CDR that is separate from ERW. Goll et al. 2021, Nat Geo, provide a good review of the potential whole ecosystem co-benefit: https://doi.org/10.1038/s41561-021-00798-x	No change: While we appreciate this perspective, we feel that, given the early stage of EW, it is imperative to concentrate resources around building consensus on the key drivers of CDR in the pathway. Enhanced carbon sequestration in soils is its own exciting research path that requires further research, and while the two pathways may overlap in the future, we will not be crediting based on SOC at this time.
General	Heavy metal - can you start with measuring the initial feedstock and model from there rather than measuring soils/water?	No change: Project proponents may use initial metal concentrations in soil and in the feedstock as the basis for creating a monitoring plan. In some cases where pre-existing metal concentrations and feedstock metal concentrations do not pose a risk of exceeding any regulatory limit, project proponents may justify a limited monitoring scheme.
General	Any further feedback on the ability to	No change:

	stack an SOC project (e.g. under CAR-SEP) with a ERW project under Isometric? Essentially doing 2 different projects on the same physical area, ensuring that we determine how to appropriately attribute emissions and ensure we aren't double counting (or double penalizing)?	Co-located soil-organic carbon projects and enhanced weathering projects are not explicitly disallowed by the Isometric Standard. This would not be considered "double counting" because the carbon atoms being counted in each project belong in distinct carbon reservoirs (organic vs. inorganic reservoirs). We will note that increases in soil organic carbon can increase the cation exchange capacity and increase the post-weathering temporal lag associated with cation sorption. However, this should be accounted for within Isometric's EW MRV framework.
General	It's clear that efforts have been made here to ensure that carbon credits are based on cumulative CDR within the accounting period, by discounting sorbed cations that will likely leave the soil column and lead to further CDR at some point in the future. This is a robust and conservative approach. However, I wonder if any proponents could execute this protocol and turn a profit. CDR based on Year 1 alkalinity fluxes could well be in the kg per hectare range and would likely be insufficient to cover the associated costs of sampling and analysis.	No change: We appreciate that this is a challenge of enhanced weathering. Cation sorption may, however, result in a significant delay to producing a climate benefit. Using a depth horizon (e.g., 30 cm or alternative depth if justified) is a compromise meant to balance the very real time-lags associated with cation sorption with operational concerns.
1.0 Summary	[Silicate weathering naturally sequesters approximately 1 Gt of CO_2 per year] This is about 4x too high, I would use Gaillardet 99 and references therein	Changed: Thank you for pointing out this error. The text now reads 0.1Gt per year and the references have been updated.
1.0 Summary	I hadn't seen reference 12 before and I'm glad it has been published as I think this is a really important area to consider in EW, I'm a bit skeptical of the model though.... (or I'm bad at maths, which is also fine!) Take global runoff every year - which is 40 trillion m^3 = 40e15 L Then pump 21 Gt of CO_2 into it as bicarbonate (upper estimate in paper): mass ratio change from CO_2 to HCO_3^- = 61/44 = 1.38 21Gt * 1.38 = 28.98 Gt of HCO_3^- in solution (~29e15 g)	No change: Thank you for your comment and for taking the time to do these calculations. As this model is presented in a peer-reviewed scientific article that was not authored by Isometric, this is outside of the scope of protocol revisions. We encourage you to discuss this with the authors of the paper.

	which is equivalent to 29e15/61 = 4.83e14 moles of HCO_3^- river alkalinity is usually in micromoles for rivers so 4.83e14 * 1e6 = 4.83e20 micromoles of HCO_3^- divide micromol by amount of water to derive simple concentration 4.83e20 micromol/40e15 L = > 12000 micromoles/L I don't think there is a river on Earth with this alkalinity, and the reason for that is because it would be extremely saturated with respect to calcite and precipitate copious amounts of calcite and other carbonate minerals. Conduct the exercise above with Gaillardet '99s prediction of current CO_2 consumption by weathering (0.3Gt or so) and you get a global average alkalinity of about 200 umol/L, which is pretty believable. As I mentioned earlier, I have probably made a mistake somewhere - I just thought the CO_2 consumption was really high in the paper compared to the status quo and it had me worried! Discussion appreciated	
1.0 Summary	Why is BET required? It is nice to have as a parameter, but a specialist measurement to make. It is useful to some reactive transport models, but not for much else.	No change: BET is required because it is critical for modeling of initial feedstock weathering rates
1.0 Summary	[*Silicate weathering naturally sequesters approximately 1 Gt of* CO_2 *per year*] This number seems higher than the literature it references. Gaillardet et al 1999 calculated 0.1 GtC/y. A more up-to-date estimate is Moon et al. 2014 (https://doi.org/10.1016/j.gca.2014.02.033) with ~0.3 $GtCO_2$/y. 0.3 $GtCO_2$/y is also the number used in IPCC AR6 WGI (pg 599).	Changed: Thank you for pointing out this error. The text and references have been updated accordingly.
1.0 Summary	[*in accordance with recommendations by the IPCC*]	Changed: The word “recommendations" has been

	This requires a precise reference of the IPCC report, including the page number, or rephrasing without the word "recommendations". From my understanding (and having read good chunks of the different IPCC reports), IPCC does not make specific policy or technological recommendations, as it is outside of their remit.	removed and the IPCC report that states the necessity of CDR approaches for limiting warming to 1.5 C has been cited.
1.0 Summary	[*cropland covers approximately 38% of Earth's surface*] should be "land's surface"	Changed: Text now reads "cropland covers 38% of land surface on Earth". Thank you for the correction.
1.0 Summary	Total agricultural land is 38%, however, the majority of this is livestock farming. Presumably, "Agricultural EW" protocol described here focuses on croplands, and different considerations would be needed for application in livestock farming areas? If so, then it would be more accurate to cite 6% of global land surface area being used for crop agriculture as applicable here. See for example: https://ourworldindata.org/land-use#half-of-the-world-s-habitable-land-is-used-for-agriculture	Changed: This protocol covers livestock farming in addition to cropland. Differences in agricultural practices in pasture- and cropland will be accounted for in the PDD, where the project proponent must identify crop type, soil amendments, tillage depth, etc. Information such as crop yield, productivity, and resilience will not be relevant in pastureland. Clarifying text was added to the document to reflect this point.
1.0 Summary	The Isometric methodology for Enhanced Weathering on Agricultural land v1.0 Summary.0 is a stepwise change in available methodologies and protocols by which project developers can expand the nascent technology of ERW. The methodology likely represents the most scientifically rigorous methodology to quantify CO_2 sequestration from ERW available. This is a necessary step in making the sequestrations and reductions from ERW verifiable and defensible, seeding strong confidence in the technology. We can see a scenario where the methodology could be overly prescriptive in certain areas that would lead to limitations in the amount of scale possible from this methodology. Additionally, the methodology could be bolstered with more prescriptive detail in other areas to constrain potential project developers. There is no doubt that this methodology has the potential to be a good springboard for credible sequestration from ERW,	No change: We thank you for the comment, and your time and input thus far. Our goal is to produce the most scientifically rigorous enhanced weathering protocol that can operate in the marketplace. We appreciate your input throughout the protocol as we work toward this goal.

	adapting along with the science; more understanding comes with scale, both in acres deployed and the number of project developers vying to use it. This last point is where some of the critiques from our experience as a nature-based solutions project developer come from, the goal to see the methodology strike a balance between rigor and ease of use. Keeping its scientific credibility while growing to a truly impactful scale.	
4.0 Applicability	Add reference to requirements of Section 5 of the protocol and 3.7 of the Isometric Standard to provide more guidance than the general statement	Changed: References to these sections were added to this line. Thank you
4.0 Applicability	[Maintaining net neutral or positive crop yield] may be difficult to achieve on a yearly basis due to natural fluctuations. We suggest writing "Projects are eligible if they demonstrate a sustained or increased crop yield over the long term."	Changed: Thank you for this note. We have amended this to exclude projects that result in a "sustained net decrease on crop yields"
4.0 Applicability	[*alkaline feedstock is defined as silicate rock containing alkaline elements (i.e. Ca, Mg)*] alkaline earth metals	Changed: Now reads "feedstock is defined as silicate rock containing alkaline earth and alkali metals (i.e. Ca, Mg, K, and Na)"
4.0 Applicability	[*the project [must] lead to no net harm to the environment and society*] Good to highlight this, but can you list some examples that might be applicable to ERW? e.g., dust pollution, accumulation of poisonous metals	No change: Several of the potential areas of impact are outlined in the following section, Section 5.0
4.0 Applicability	[*projects that lead to a net decrease on crop yields [are not eligible for crediting under this protocol]*] good point, had not thought of this!	No change: Thank you for your comment. The purpose of this applicability condition is to avoid any potential market leakage and/or land use change as a result of enhanced weathering
5.0 Environmental & Social Safeguarding	Suggest to also refer to Isometric Standard 3.7 here re: overarching principles	Changed: References to this section were added to this line. Thank you
5.0 Environmental & Social Safeguarding	[*provide evidence that the project will do no net environmental or social harm.*] The wording may need adjusting here. This rule requires proponents to provide evidence that the project will not harm the environment or social systems - i.e.	Changed: We appreciate this feedback. This phrase has been reworded to “does not disproportionately harm underserved or marginalized communities” in the social safeguarding context and language has been added to further clarify guidelines for

	proponents are required to prove a negative, which is scientifically unsound.	environmental safeguarding.
5.1 Overarching Principles	[*These safeguards encompass a wide range of considerations, including environmental protection, social equity, community engagement and respect for cultural values*] Cool this is being highlighted	No change: Thank you for this feedback
5.1.1 Environmental Impact Mitigation Strategies	What is required in the 'tailored mitigation plans'? Referring back to the Isometric standard, it appears that this will likely be plans resulting from the EIA. Concern is that as stated here, the mitigation plan definition is very vague, and therefore, very difficult to verify aside from simply checking that one exists and using any expert judgment to determine if it might be 'adequate'. Recommend more guidance on this if possible.	No change: We appreciate this feedback. An EIA is suggested but not required in the Isometric Standard (unless required by local regulations). We have added text that mitigation plans must be developed by subject matter experts but we will not be prescriptive as to what must be included in mitigation plans, which will vary from project to project.
5.1.1 Environmental Impact Mitigation Strategies	Refer to the requirements in Isometric Standard 3.5 for more guidance	Changed: References to this section were added to this section. Thank you.
5.2 Environmental Safeguards	[*It is important to note, however, that any project with pre-existing heavy metal contamination which further aggravates soil contamination, will not meet the criteria for this protocol.*] This stipulation would effectively preclude ERW projects on serpentine soils (which constitute about 3% of the Earth's land area), because baseline soil nickel and chromium concentrations will likely be naturally high, and most feedstocks sourced from the local area will probably also contain fairly high levels of Ni and Cr. I'm not convinced that this makes sense. Most ERW projects are likely to increase soil Ni and Cr to some degree, so would it not make more sense to set proportional limits that relate to the pre-deployment concentrations?	No change: Please see Section 5.2 Environmental Safeguards for guidance on pre-existing heavy metal contamination
5.2 Environmental Safeguards	[*EW of alkaline feedstock can be associated with the release of metals such as nickel (Ni) and chromium (Cr), which may pose an environmental risk.]*	No change: Toxicity is not an inherent property of metals. All metals have the potential to be toxic in sufficient doses. The goal of this section is to highlight that project

	I think as these are referred to as heavy metals after this it is worth defining them as such here. I've always preferred 'toxic metals', as 'heavy metals' can be ambiguous, but accept that it's the norm	proponents must identify and mitigate any risks that may result from a particular choice of feedstock in a particular location. This will vary from project to project
5.2 Environmental Safeguards	Would also worry about biodiversity within the fields/ hedgerows	Change: Thank you for this comment. This protocol is not meant to be prescriptive in measuring biodiversity metrics. However, we added text to require that potential risks to biodiversity be identified and eliminated when possible. If risks to biodiversity cannot be eliminated, the PDD must take appropriate steps to monitor ecosystem health.
5.2 Environmental Safeguards	[*Regulations: in the absence of local regulations, either EU, WHO or EPA regulations must be followed* *Please specify the criteria to be used in the choice of regulation to use*.] Please specify the criteria to be used in the choice of regulation to use. Note that no regulations exist which encompass or include soils that naturally contain elevated metal concentrations (see also below).	Changed: We will now require PDDs to justify which set of standards they choose to adhere to, but will not set requirements behind their choice.
5.2 Environmental Safeguards	A careful definition of what is meant by "[heavy metal] contamination" is needed here. Having considered this, a distinction needs to be made between natural (geogenic) and anthropogenic metal soil enrichment. Naturally occurring high metal concentration is NOT contamination. In the case of adding CDR materials to soil in areas with naturally high background concentrations, this may temporarily increase the already high local natural background, but using phytoremediation practices with hyperaccumulator plants to remove heavy metals as a remediation strategy will remove that which is added, and return the soil to the same or lower than original local background values in soils. This case needs to be allowed for and included.	Changed: Thank you for raising this distinction. We have rephrased this sentence to reflect this point: "If pre-existing heavy metal concentrations exceed applicable regulatory limits or guidance..."
5.2 Environmental Safeguards	The Feedstock Module could be more prescriptive in order to preempt much of the testing described in section 5. There is	No change: Using both baseline soil metal concentrations and feedstock metal

	potential to model the maximum concentration of metals through testing of the feedstock and soils to be spread. Eliminate any concerns ahead of sampling and greatly reduce the need for ongoing sampling of soils and waters.	concentrations is an acceptable way to justify a high likelihood of compliance with applicable soil metal and a limited monitoring scheme. However, this ongoing soil metal concentrations will likely be ancillary data collected from ICP measurements collected to monitor feedstock weathering.
5.2.1 Water Resource Management	The water resource management section provides very vague requirements that must monitor and manage impacts on water quality and guarantee that aquatic ecosystems and biodiversity remain unharmed and preserved. This will be difficult to verify without more guidance on what is required. This could include specific measurements and monitoring. Or, referring back to the EIA and its mitigation plan, or a biodiversity certification, for example.	Changed: Your point is well taken. This section has been deleted in favor of strengthening further guidance on environmental safeguards in other sections of this protocol.
5.2.1 Water Resource Management	[*Appropriate measures must be implemented to guarantee that aquatic ecosystems and biodiversity remain unharmed and preserved*] Is it really possible to "guarantee" that absolutely no harm is done? There may be a better way to word this that requires a more feasible but nonetheless strong commitment from proponents.	Changed: This point is well taken. The wording in this section has been change to: "Appropriate measures must be implemented to protect aquatic ecosystems and biodiversity"
5.3.1 Food Supply and Agricultural Impacts	Table 4 summarizes the measurements required for soil quality assessments, and it is recommended that this term alone is used throughout the protocol to avoid confusion. In this sense, Table 4 usefully defines what soil quality means.	Changed: Mentions of soil health have been replaced with soil quality. Thank you for pointing out this inconsistency.
5.3.1 Food Supply and Agricultural Impacts	Section 5.3.1 could be more prescriptive, including metrics that would need to be monitored to reduce the potential for food supply impacts and increase the understanding of co-benefits.	No change: We are generally in favor of researching and collecting data on crop yields and co-benefits. It is our experience that this data is viewed as sensitive by some landowners and farmers, and requiring this data may limit the adoption of this carbon removal technology. We fully support project proponents collecting this data.
5.3.2 Community Health and Safety	Could you please help define the limits of community to be considered for 'other potential health risks'? For example, projects that are undertaken in a rural setting on private land have very little	Changed: Thank you for this feedback. Your point is taken that parts of this section are ill defined; we are deleting this section from the protocol and will be strengthening the social safeguards in the Isometric Standard

	potential to affect any 'community' just by proximity. How far from the application site should this be considered? For food contamination, this is probably much clearer and can be incorporated into monitoring. What would the burden of proof look like for drinking water? For example agricultural runoff is not going to form a drinking source in most locations	and other parts of this protocol.
5.3.2 Community Health and Safety	[Affecting access to clean water and safe food] shouldn't really be happening in the first place. Providing alternatives to clean food and drinking water in the event of EW contaminating such things is dangerous. I recommend removing this	Changed: Thank you for this feedback. Your point is taken that safeguards are put in place to prevent harm, not address it after the fact. We are removing this section from the protocol and will be strengthening the social safeguards in the Isometric Standard and other parts of this protocol.
5.3.2 Community Health and Safety	I would perhaps also add a guideline for particulate pollution - i.e., kantzas paper has particle sizes of 10s of micron, easily transported by light breezes	No change: Project proponents are required to identify and mitigate any likely areas of material harm with respect to human and environmental health and to follow all applicable laws and regulations. We expect that in some cases this will include particulate matter. This will be addressed on a project by project basis.
5.3.2 Community Health and Safety	How is community defined and how extensive of a program is required? Further, the section also says Project Proponents are responsible for “testing water and food for heavy metal contamination.” How much food? And what if the crops in the project are not food crops?	Changed: Thank you for this feedback. Your point is taken that parts of this section were poorly defined; we are removing this section from the protocol and will be strengthening the social safeguards in the Isometric Standard and other parts of this protocol.
5.4 Monitoring and Adaptive Management	Best practices' is a new phrase that opens up a vague requirement that will be difficult to verify. Recommend removing this and referencing the required EIA mitigation and monitoring plans or something more concrete.	Changed: Thank you for bringing this to our attention, we agree this phrase is vague and does not set a burden of proof. We have deleted this phrase and strengthened language and requirements elsewhere.
5.4 Monitoring and Adaptive Management	[*This involves collecting data on soil and water quality, biodiversity indicators, and agricultural activity*] This is a vague requirement. Where will this be specified? If it is specified in the EIA and associated Mitigation & Monitoring Plan, then refer directly to that. Otherwise, it can open a new requirement that is difficult to verify.	No change: We appreciate this feedback. It is not our intention to be prescriptive in mitigation plan requirements but provide guidance for appropriate monitoring practices if necessary.
5.4 Monitoring	What biodiversity indicator metrics are	Change:

and Adaptive Management	expected and required?	Thank you for this comment. This protocol is not meant to be prescriptive in measuring biodiversity metrics. However, we added text to require that potential risks to biodiversity be identified and eliminated when possible. If risks to biodiversity cannot be eliminated, the PDD must take appropriate steps to monitor ecosystem health.
5.5 Co-benefits and Opportunities	The last paragraph on N2O emissions is good content, but leaves out any suggestion or link to how these benefits are addressed. Suggest referring to Section 7 guidance on how N2O emissions changes are accounted for in the LCA i.e. 7.1.1.2 and 7.1.1.6?)	No change: Thank you for your feedback. At this time, we are not factoring avoided N2O emissions into LCA calculations, as scientific consensus on the magnitude of this change and appropriate measurement techniques at the deployment scale are still being developed. Please note that this section has been moved to Section 1.1.
5.5 Co-benefits and Opportunities	Unsure why Taylor is being cited [in relation to crop yield] (ref 13), that's a modeling paper?	Changed: Thank you for pointing out this error. The reference to Taylor has been removed and a more appropriate citation has been added. Please note that this section has been moved to Section 1.1.
5.5 Co-benefits and Opportunities	[*Because EW can increase both soil nutrients and crop resilience, increased yields may help to alleviate global food insecurity if deployed at scale*] This is quite a leap?	No change: There is growing evidence of the agronomic benefits of enhanced weathering (e.g., Beerling, et al. 2023, PNAS), including >10% yield increases for maize and soybeans as described in the above research article. This is still an active area of research, however, higher crop yields with a similar amount of land and agricultural resources could indeed help to alleviate food insecurity. Please note that this section has been moved to Section 1.1.
5.5 Co-benefits and Opportunities	Co-benefits will likely be a main driver of scaling ERW. Creating a methodology devoted to tracking them will likely drive adoption and scale.	No change: See above comment regarding research on co-benefits. Please note that this section has been moved to Section 1.1.
6.2.2 Site Visits	for EW, there are many locations involved - from the rock dust production to all of the fields where applied. This requirement [*A site visit must occur at least once every two years at each location*] should be clarified.	Changed: Added the following text for clarification: Agricultural fields being used as a control, treatment, or deployment plot must be visited at least once every two years
6.2.2 Site Visits	[*A site visit must occur at least once every 2 years at each location.*] How was 2 years decided on? I would	No change: We direct the commenter's attention to the following text in this section "Project validation and verification must incorporate

	recommend at least one visit during wet season and another during dry (or a winter + summer visit) at least once during the project's initial deployment phase	site visits to project facilities in accordance with the requirements of ISO 14064-3, 6.1.4.2, including, at a minimum, site visits during validation and initial verification to the project site(s)." This is in addition to the two year visit frequency. Site visits are just one of several factors meant to ensure strict adherence to Isometric's protocol. More details of the verification process are described in section 6.2 of this protocol and the Isometric Standard.
6.4 Additionality	Additionality timeframe - how does the 2 year review of additionality interact with the 5 year crediting period under a protocol?	Changed: This provision has been removed and will now default to the 5 year crediting period.
6.4 Additionality	Reassessing additionality on at least a two year basis could be overly frequent. Increasing the detail in the scenarios that could challenge additionality, potentially into a checklist, could ease this burden.	Changed: Upon review, we agree with the commenter that a 2 year frequency is likely unnecessary for enhanced weathering. This is now only required at the initial verification and when any substantive changes to operations occur. This will now default to a 5 year verification period.
6.5.1 Reporting of uncertainty	[*Projects must report a list of all input variables used in the net* CO_2*e removal calculation and their uncertainties, including…values of measured parameters from process instrumentation, such as truck weights from weigh scales, electricity usage from utility power meters and other similar equipment*] It is often impossible to gather this information from supply chain partners. Could there be a look up table approach?	No change: Emissions factors for feedstock would have to be considered case by case to understand what life cycle stages and emissions sources are included. However, it is likely that emission factors would include all embodied emissions associated with production of basalt.
6.6 Data Sharing	The list of required data sharing is good. I notice it does not include things like evidence for the env / soc safeguards, supporting documentation for measurements (calibrations, QA/QC from labs, etc.), permits, contracts, and other info that must be shared with Isometric/ VVB. Should it? Obviously proprietary info like contracts will not be made public.	Changed: Thank you for pointing this out. We had added 'proof of approval for necessary permits' and 'supporting documentation for measurements taken, such as calibration certificates' to this list. We have also specified that "evidence and data related to… environmental and social safeguards monitoring" is included in the required data sharing.
7.1 Systems Boundary & GHG Emission Scope	[*Life cycle embodied emissions associated with equipment, such as coring equipment, and consumables*] Please suggest data sources for these	No change: Embodied emissions can be calculated based on the number/ weight of each product or material and a corresponding EPD or representative emission factors from

	types of data. They are generally not reported by manufacturers	EPD, life cycle analyses or emissions factors databases. Further information can be found in the 'Embodied Emissions Accounting' module.
7.1 Systems Boundary & GHG Emission Scope	[*Embodied, energy use and transport emissions associated with sampling the alkaline feedstock to measure the physical and geochemical characteristics necessary for weathering determinations*] Including sending samples for analysis and the analytical process itself?	Changed: Yes, this would be included within the system boundary to be assessed in the GHG accounting. The following is now included in the text: "Emissions for processes within the system boundary must include all GHG SSRs from the construction or manufacturing of any project-specific physical site and associated equipment, closure and disposal of each site and associated equipment and operation of each process (including feedstock production, transport, spreading and sampling for MRV) to include embodied emissions of consumables in the process."
7.1 Systems Boundary & GHG Emission Scope	I am not aware of data sources on consumables and equipment related to measurements. Unclear how this data would be gathered. Can you provide guidance or tables?	No change: We refer the commenter to the embodied emissions module. Additionally, our science team can field specific LCA questions on a case by case basis.
7.1 Systems Boundary & GHG Emission Scope	None of the equipment and machinery is constructed solely for our rock powder production, this is all already in place. I'm wondering how to handle this, and if some of the suggested emission factors for basalt operations that Isometric suggest already include these anyway...?	No change: Emissions factors for feedstock would have to be considered case by case to understand what life cycle stages and emissions sources are included. However, it is likely that emission factors would include all embodied emissions associated with production of basalt. If not, a proportional approach can be taken based on the estimated design life of equipment and machinery and the relative proportion of this that is used for the project.
7.1 Systems Boundary & GHG Emission Scope	Table 1 indicates quarrying emissions would occur before the reporting period. These could occur within the reporting period too, as rock dust is produced and delivered continuously.	No change: In a project's life, rock will be spread on a field only once. The emissions related to project establishment (e.g., quarrying, crushing, spreading, etc.) must be accounted for by a reporting period in which 50% of total feedstock weathering potential has been realized. After this point, the PDD may choose to end the project and not claim any additional removals.
7.1 Systems Boundary & GHG Emission Scope	[GHG emissions must be accounted for *Flight, car, bus travel required for the project operations, including contractors and suppliers required on site*]	No change: Yes, this section accounts for all emissions necessary for the project establishment, including checking on contractual issues.

	so this would e.g. include visits from us to the farm before / during the monitoring process to check contractual issues …?	
7.1 Systems Boundary & GHG Emission Scope	[*Crushing activities including the following emissions sources*] Is this not meant to say grinding? crushing is size reduction to gravel sized particles, as I'm aware most EW practices I've seen grind their feedstocks to much finer particle sizes (<100 micron). This is an important distinction because the relationship between energy use and particle size (as a consequence of crushing/grinding) is exponential, i.e., it doesn't take a lot of energy to crush something, but takes a hell of a lot to grind something to a fine powder! Drying energy is also a beast and glad it's in there For reference, basalt has a work index of 18kWh/tonne, which is pretty high! Higher than cement clinker https://www.911metallurgist.com/blog/table-of-bond-work-index-by-minerals	Changed: Indeed, this should include grinding as well. Now reads "crushing and grinding."
7.1.1.3 Considerations for Waste Input Emissions	please check definitions of 'waste', 'biproduct' and 'tailings'	Changed: This has now been changed to crushed residue rather than mine tailings.
7.1.1.3 Considerations for Waste Input Emissions	Just to follow up on this - tailings are different to crushed residues/bi-products. Tailings have different legal implications in different countries because they are usually classed as waste and may contain contaminants from chemical processing (e.g. metal mining). As such they are distinct from crushed residues from the aggregate industry.	Changed: Addressed in previous comment. Now reads "crushed residue."
7.1.1.3 Considerations for Waste Input Emissions	Suggest adding in the example in last paragraph that also any other specific processing of the tailings (such as screening, drying) and loading for transport should also be accounted for	Changed: Thank you for pointing this out. Yes, waste processing emissions for EW projects should be included in the GHG assessment. This language will be added to this section.

7.1.1.3 Considerations for Waste Input Emissions	Any further commentary on rock dust as a waste product and how that is handled in LCA?	No change: We refer the commenter to the section titled "Considerations for Waste Input Emissions." In the cases outlined in this section, the emissions associated with rock extraction may be omitted from an LCA with sufficient proof.
7.1.1.3 Considerations for Waste Input Emissions	Does [system inputs considered as waste products] consider, and does it include manures or not?	Changed: This is not meant to include manures. This section is meant to pertain to feedstocks that are waste products of other processes, such as mine tailings. We have added "(e.g., alkaline feedstocks)" to the introductory sentence to add clarity.
7.1.1.3 Considerations for Waste Input Emissions	In practice waste inputs from mines is often not a practical feedstock and almost certainly needs GHG assessments that include material processing and handling. The material won't be cleaned, homogen[ized] and sized unless the material sees additional processing due to the ERW project.	No change: We thank you for the comment, and agree with the assessment offered in this comment. The emissions of extraction (quarrying or mining) can only be excluded if they are shown to be true waste. In this case, the GHG assessment must still include all transportation and processing that wouldn't have otherwise occurred.
7.1.1.5 Considerations for Project Activities Integrated into Existing Practices	[*Emissions associated with project activities that replace similar activities in the business as usual case (e.g., rock spreading in place of liming) may be omitted from the GHG assessment*] Does this extend to the fact that liming can act as a significant CO_2 sink? i.e., the project's additionality arguments must show an improvement in alkalinity export vs liming, lots of evidence to show that this is a CO_2 sink now when previously it was thought of as a source (and probably is in some specific places)	No change: We thank the reviewer for the comment. The counterfactual of lime application is a crucial component of determining the overall climate benefit of an enhanced weathering project. In Isometric's enhanced weathering protocol, we consider the impact of counterfactual liming practices using control areas that are maintained using business-as-usual practices.
7.4.1 Calculation of CO_2e Removal, RP	[*All crediting projects must design a sampling plan that directly measures the initial weathering of alkaline feedstock through soil sampling.*] Is this 'soil and/or pore water sampling' to align with below?	Changed: Yes, in terms of the actual CDR calculation, though we note that some level of both soil and aqueous sampling will be required for both determinations. Text was edited for clarity.

7.4.1 Calculation of CO_2e Removal, RP	Soil sampling to 30 cm will not be feasible in many locations. There is an exception provided, but this may be more the rule. Perhaps reconsider this requirement.	No change: Thank you for this note. At this point we will maintain soil sampling to a depth of 30 cm, with deviations possible with appropriate explanation in the PDD. This may be revised in the future as more data becomes available.
7.4.1 Calculation of CO_2e Removal, RP	Please define here or elsewhere what statistically significant is (i.e. with a 95% confidence interval based on a two sided t-test). This also occurs elsewhere (7.4.1.1, etc.). I now see this is defined in 9.3.4. Suggest referencing that here	No change: This detail is included elsewhere in the protocol in a section titled "Statistical requirements for crediting." And indeed, an alpha value of 0.05 (95% confidence) is required.
7.4.1 Calculation of CO_2e Removal, RP	ref 22 refers to organic carbon methods - is this appropriate for this [soil sampling depth requirement]?	No change: This reference is meant to demonstrate standard agronomic sampling depth of 30 cm.
7.4.1 Calculation of CO_2e Removal, RP	Our suggestion would be that [plant biomass uptake of base cation] loss be considered de minimis across both scenarios. The data collection is inherently complex, variable, and costly. The assumption is also that both scenarios will be managed for maximum crop health, meaning that the project is not likely to see any delta in these results.	No change: This is an active area of research, but the most recent research suggests that it is not de minimis. Kantola et al. 2023 in Global Change Biology measured this amount to be approximately 5%, but this will certainly vary based on the particulars of the project. In addition to this scientific context, the Cascade Working Group has reached a similar conclusion that, at this early stage in the field, biological uptake should be directly measured.
7.4.1.1 Determination 1	Are the reference test methods (ISO 10694, etc.) ones that are commonly used by agricultural soil testing labs? Might consider providing an 'or equivalent' of 'or similar' to enable companies to use other methods or allow for newer testing approaches.	Changed: We have added clarifying text that ISO protocols are examples, not specific requirements. There has been some confusion throughout the protocol with methodologies such as ISO methodologies. We intend to provide these as example methodologies, and not required methodologies. We will insert a "e.g.," before ISO methodologies that are meant as examples.

7.4.1.1 Determination 1	This is not an appropriate standard [*Thermo-gravimetric analysis -- [ASTM D8474-22]*] for TGA analysis. This standard is about characterization of black carbon, not carbonates. Carbonates decompose in specific temperature ranges, and their detection is only reliable via TGA if done in combination with MS or FTIR (i.e., TGA-MS or TGA-FTIR). If no suitable standard exists, citing a reputable journal article would be a good alternative.	Change: A citation for a recent paper applying TGA-MS has been added.
7.4.1.1 Determination 1	This is an incorrect standard, this is not at all about calcimetry. A correct standard for calcimetry can be ISO 10693:1995. Note that this is a standard for soil analysis and based on the volumetric method. There are also pressure-calcimeters, I am not sure if a standard exists for that.	Changed: The authors thank the reviewer for pointing out this error. The recommended ISO standard has been edited.
7.4.1.1 Determination 1	Concentrations alone are not sufficient to quantify plant export of treatment versus control. The biomass yield needs to be included to calculate mass exported of each element, and then the net difference between treatment and control can be calculated.	No change: We agree with the commenter here. This is indeed a requirement of the protocol. Measurement of these parameters is required in both the treatment and the control. The control is the basis for the counterfactual carbon drawdown.
7.4.1.1 Determination 1	[*Some project areas may have soil conditions where carbonate precipitation is not likely and not observed above analytical detection limits (e.g., low pH soils).*] Even a "low pH soil" can be sitting atop B and C subsoil horizons that are less acidic and where carbonates do exist/form.	No change: The authors agree that this is a possibility and it is one of the reasons that characterization of baseline field heterogeneity is emphasized in the approach taken by this protocol. We note that this section comments only on the number of SIC analyses that must be conducted by a project proponent and all projects are required to characterize SIC to at least some extent that is justified by site-specific soil characteristics.
7.4.1.1 Determination 1	Quantify total plant biomass rather than root:shoot	Changed: Root:shoot ratio has been removed from the required measurements for plant uptake.

7.4.1.1 Determination 1	Rephrasing of strong acid correction description	Changed: Text now reads "approximation based on soil pH and pCO_2".
7.4.1.1 Determination 1	[*Plant samples must be analyzed for C, N, Na, K, Mg and Ca concentrations*] Why are C and N measurements a requirement? This is interesting for research purposes, but I don't understand where this is used in the CDR calculation	No change: For biomass uptake to be extrapolated over a growing area, there needs to be an accounting of the cation to biomass ratio. Taking direct measurements of biomass carbon and nitrogen is the most direct way to determine this ratio.
7.4.1.1 Determination 1	We believe that it is not good to allow negative values for CO_2e (NetNewCarbonate), as this could increase CDR without the mechanism being clear, as to how the spreading of alkaline rocks leads to dissolution of existing carbonates	No change: We appreciate the commenter's perspective on this topic. CO_2e NetNewCarbonate is a measure of changes in soil inorganic carbon in a reporting period, which may be positive, negative, or neutral. If this value is negative, indicating dissolution of carbonates in the soil column, this is important for carbon accounting.
7.4.1.1 Determination 1	Is there a reason why combustion methods for SIC determination are excluded here? They are more easily automated and can be more accurate than calcimetry, particularly in soils with high organic matter.	Changed: It is our intention to provide acceptable analytical methods rather than prescribe a single required method. This has been explicitly added in the text; combustion is now listed.
7.4.1.1 Determination 1	[*Where data is available, project proponents may choose to use fertilizer application rates as a proxy for non-carbonic acid weathering*] This is probably sufficient to address the nitric acid, but what if the feedstock contains a lot of sulphur, which can be converted to H_2SO_4 fairly rapidly?	Changed: This section now explicitly requires justification to treat nitric acid as the only non-carbonic acid present, including measurements of total sulfur in the feedstock. Thank you for bringing this to our attention.

7.4.1.1 Determination 1	[*Total amount of new biomass produced must be considered for plant uptake (C, N, cations concentrations)*] Provide guidance on how this should be assessed for perennial crops.	No change: This is an important detail that should be justified on a project specific basis within the context of the crop being grown. Generally speaking, biomass that is removed from a perennial crop in a given reporting period should be included in this accounting.
7.4.1.1 Determination 1	[*data should include root:shoot ratio, total shoot mass, total plant mass and cation concentrations*] The issue here is that obtaining accurate root mass and representative cation concentrations in roots is difficult / almost impractical in real field situations. Also, for most crops, only part is removed at harvest and the rest may return to the soil. This is especially the case for roots. The actual mass removed from the site in a particular situation and the concentration in that material would be more appropriate?	No change: This requirement has been shown to and discussed with several enhanced weathering suppliers who are willing to incorporate this into their operations. The goal is to conduct limited sampling within a small area where feedstock has been spread, and compare this to that of a corresponding section in the control. This section is not meant to be overly prescriptive. Project proponents must justify their approach in the PDD.
7.4.1.1 Determination 1	I am a little confused, because in section 9.3.4.6.5 you state that secondary minerals do need to be evaluated through XRD analyses - despite not being used for CDR estimation?	Change; We have updated Table 4 to show that this is recommended for all sampling events, not required. Though information on secondary silicates is not used in the CDR quantification at this time, this is an active area of research and we recommend that these analyses are conducted on a research basis. As shown in Table 4, this is a recommendation rather than a requirement. We note that information on secondary carbonate formation is used in the CDR quantification and must be determined using the methods prescribed.
7.4.1.1.2 Aqueous Phase Checks for Determination 1	[*If the mean calculated CDR of aqueous measurements does not fall within the 95% confidence interval of CDR calculated by Equation 3, an audit must be conducted and project proponents will work with Isometric to determine a conservative solution.*] Given the wide range of different measurements required for the two approaches, and the associated propagated uncertainties, is it likely that these two CDR values will be comparable within the 95% level? The field data I've seen indicate low CDR estimates	No change: Tracing the fate of newly added alkalinity from enhanced weathering is an active area of research, and multiple studies have highlighted discrepancies between the CDR based on solid and aqueous measurements (with soil-based techniques typically yielding higher values than porewater-based techniques). Presumably these discrepancies are the result of cation sorption that occurs in soils with high cation exchange capacity and low base cation saturation. The goal of the current structure of Determinations 1 and 2 are to give project proponents flexibility on which type of

	derived from pore water samples, and much higher estimates from solid-phase analyses (even where sorption etc is discounted). For this reason, I feel that Determination 1 is effectively the same as Determination 2.	measurement they optimize operations for, while still having some redundancies in the derived CDR.
7.4.1.1.3 Alternative Methods and Approaches for Determination 1	typo - delete repeated word	Change: Thank you for bringing this to our attention, we have fixed this typo.
7.4.1.2 Determination 2	[Project proponents using determination 2 for credits must still consider and quantify plant uptake if nutrient uptake below this depth is appreciable.] It is very difficult to measure nutrient uptake from below 30 cm, and what is defined as "appreciable"?.	Changed: We take the commenter's point here. We have clarified this requirement as follows: "Project proponents using Determination 2 for credits must still consider and quantify plant uptake if roots extend below the depth of porewater sampling."
7.4.1.2 Determination 2	If the goal [of the term $CO_2e_{Aqueous, RP}$] is to quantify cation fluxes, direct measurement (e.g. by ICP) is the simplest, most accurate and least error-prone method. DIC and pH measurements are time-sensitive, in part due to the lability of inorganic carbon in the aqueous phase. I appreciate that you have specified this as an alternative in 7.4.1.2.1, but I would argue that characterising the carbonic acid system is the alternative, if the aim is to measure base cations.	Changed: As this commenter has pointed out, this protocol allows for multiple approaches when quantifying carbon dioxide in aqueous samples. Project proponents may take an ICP approach or an alkalinity titration approach. As the commenter points out, DIC and pH can be time sensitive, however, they are time sensitive in a way that will ultimately lead to more conservative estimates of CDR. For example, microbial activity in aqueous samples will lead to remineralization of organic carbon and decrease the pH of the sample (thus decreasing observed CDR). Given that these are both generally accepted quantification methods, we have added the following text: "There are two generally accepted approaches for determining aqueous phase alkalinity export: direct measurements of cation and anion concentrations (e.g., ICP) or measurement of at least two carbonic acid system variables in solution."

7.4.2 Calculation of CO_2e Counterfactual, RP	Would the counterfactual also need to take into consideration any CDR that is occurring in the BAU case for the silicate rock source? Consider the example of waste tailings such as basalt dusts stored at a quarry in waste piles	No change: Thank you for your feedback. We have added text stating that the BAU of waste silicate rock must be considered if the feedstock is a waste product that is not processed any further pursuant to project activities.
8.0 Feedstock Characterization	More prescription in the Alkaline Feedstock Characterization could eliminate some testing needs in environmental protections.	No change: Using both baseline soil metal concentrations and feedstock metal concentrations is an acceptable way to justify a high likelihood of compliance with applicable soil metal and a limited monitoring scheme. However, this ongoing soil metal concentrations will likely be ancillary data collected from ICP measurements collected to monitor feedstock weathering.
9.3.1 In-field Monitoring Approach	The two in-field monitoring approaches should be introduced before their first mention in section 7.4.	No change: We appreciate this feedback and will take this into account as we evaluate the structure of this protocol
9.3.1.1 2-Plot	[*The 2-plot approach should be generally thought of as a flat, per-area sampling scheme.*] The meaning here is unclear.	No change: As opposed to the 3-plot where sampling resources are generally concentrated in smaller area, the 2-plot approach calls for a uniform sampling rate, thus a "flat, per-area sampling scheme"
9.3.1.2 3-Plot	The figure in 9.3.1 for 3-plot does not match this description of the number of samples (i.e. 9 samples for control and treatment and hundreds for deployment). Is this meant to say the same sample density or same number of samples? If so, the figure should be modified to avoid confusion	No change: Unless otherwise specified, the same number of samples must be taken from the control, treatment, and deployment plots. We note that the images on the field are meant to represent crops on an agricultural field, not samples.
9.3.1.2 3-Plot	What can you share about a 5 km^2 sampling footprint? Is there an opportunity to expand this? If so, what would need to be shown?	No change: 5 km^2 was selected somewhat arbitrarily and is based on the scale at which microclimatic variation may be expected (e.g. references 37 and 38). Project areas can exceed 5 km^2, but will need to designate additional control plots for every additional 5 km^2.
9.3.1.2 3-Plot	Why this specific [project area] size? I see the justification provided but it's very general. Shouldn't this max size be a product of actual spatial variability expected on that specific project?	No change: In the current version of the protocol, 500 hectares is the limit for a single control and treatment plot. For project areas exceeding 500 hectares, multiple control areas will be

		required, although the overall control area fraction of 5% is the same. The primary motivation is to avoid situations where project area separated by multiple kilometers may be subject to different environmental factors that may influence weathering (e.g., precipitation). This is meant to provide some conservative guardrails on the representativeness of control and treatment areas.
9.3.1.2 3-Plot	The five square kilometer limitation for deployment seems to be a major limitation to scaling a project. Homogeneity of the evaluation area with the deployment area is important, but could be regulated by environment, soil types, etc. Allowing for more deployment acres and reducing the cost of MRV associated with them.	Changed: The 500 hectare guideline is not meant to limit projects to this size. Rather, projects must have an additional control plot for each additional 500 hectares of total project area. This section was clarified to better reflect this.
9.3.1.4 Treatment (2-plot)	In some applications we have observed, application rates are customized based on local pH, which can vary across a deployment plot significantly. Thus, application rate would not be the same. There should likely be consideration for this	No change: Application of feedstock to the treatment area must be uniform within a project area, but can vary across projects. A project can be subdivided and vary application as the project proponent sees fit.
9.3.1.5 Treatment (3-plot)	See note above regarding application rate. Same applies for 3-plot treatment	No change: see previous response
9.3.1.7.2 3-Plot	Concerning paragraph 9.3.1.7.2, we are wondering how closely geographically the different areas of the 3-plot approach have to be to be considered belonging to the same field. Would it be allowed under Isometric to have a deployment field and then separately (e.g. 10 km away) a treatment and control plot that represents the same climate and related parameters but is not directly connected?	No change: Yes, it is acceptable for segments of one plot to be discontiguous, so long as they are representative of each other in accordance with the parameters outlined in this protocol. There is no prescriptive distance for this aspect of the project design.
9.3.2 Field Management	What is the relevance of turbidity in the irrigation system?	Changed: Now recommended. Turbidity is recommended for fluid measurements, including irrigation source, as it may influence other aqueous measurements such as conductivity.
9.3.2 Field Management	Can you provide guidance on how and why turbidity should be determined as well?	No change: Turbidity is included for fluid measurements due to its potential influence on other aqueous measurements such as conductivity. It is recommended as an additional check measurement and can be

		determined using a turbidity sensor. Note that this has been changed from a requirement to a recommendation and its use as a check measurement has been clarified in the text.
9.3.2 Field Management	The requirements in this section (i.e., Field Management) will prove difficult to identify/obtain/report on and may not necessarily be imperative with the proper checks and balances placed on the core data associated with CDR. (Edited)	No change: Thank you for this comment. This information may be available from the farmers stewarding the project land. Project proponents are encouraged to consult farmers and relevant stakeholders for this information. Instances where this data cannot be obtained may be justified in the PDD.
9.3.3 Climactic Monitoring	[*This protocol requires that 1 rain gauge is installed per 500 hectares.*] Where has this requirement come from? Is there a citation for this? Do we expect rainfall to vary on a 500 ha scale?	No change: Rainfall can potentially vary at the kilometer scale (see refs. 37 and 38).
9.3.4.1 Sampling Requirements	[*Given the complexity of determining the depth at which CO2 can be reasonably considered captured, as well as the operational difficulty of deep soil sampling, this protocol sets a universal recommended sampling depth of 30 cm*] An alternative would be to specify which soil horizon the sample needs to reach. In the US this information can be estimated from SSURGO data. This would allow for regional differences in soil texture and depth. For example, in clayey soils with a hard plow pan, the sample should not need to extend below the plow pan and taking a deeper sample would be operationally difficult. In more sandy soils, the samples can and should be deeper than clay soils	No change: This is a valid point. At this time, we will maintain a recommended sampling depth of 30 cm. Deviations from this depth may be justified in the PDD, and Isometric will work with the PDD to identify reasonable exceptions, such as the one you described.
9.3.4.1 Sampling Requirements	[*to minimize spatial noise, soil samples typically consist of 10-20 composited soil cores*] Does this mean that for a 1000 ha site that 10,000 cores would need to be taken?	Changed: The following text was added "For a soil sample to be representative of a collection area, multiple soil cores must be taken to account for field heterogeneity. To minimize spatial noise, soil samples typically consist of 10-20 composited soil cores. It is strongly recommended [but no longer required] that soil samples be composed of 10-20 soil cores randomly or arbitrarily distributed about a sample coordinate. While this is a recommendation, project proponents are

		encouraged to consider increasing the number of composited cores per sample, especially in fields that have been characterized with a high level of spatial heterogeneity. The overall compositing procedure must be reported and justified in the PDD.
9.3.4.1 Sampling Requirements	I am not familiar with exact typical tilling depths, and it presumably depends on the type of agriculture but 30cm seems potentially shallow enough where some feedstock could make it through physically below this depth, without weathering. Is there any requirement to assess the potential presence of feedstock below the defined EW horizon during the deployment?	Changed: Thank you for this comment. Common tillage practices are unlikely to exceed 30 cm, but we will add language around mandating a deeper sampling depth if this were to be the case.
9.3.4.2.1 Statistical Requirements for Crediting	Statistical guidance can be put into place to ensure that an area larger than 5 km^2 is homogeneous with sample plots.	No change: At this early stage in the industry, we have made the decision that MRV and sampling requirements in this protocol will scale linearly with deployment size. We expect that this will change in future versions as understanding increases and uncertainty in some of the underlying dependencies improves.
9.3.4.2.1 Statistical Requirements for Crediting	What does it mean with: the decrease of cations has to be statistically significant between the beginning and the end of the reporting period? I think you forgot to make the point. If there is a rock dissolving in that upper layer, I would rather expect that the cation content first increases and gradually decreases once there is no more input. How is this related to the control?	No change: This metric encompasses cations in the soil and feedstock mixture after the feedstock is added. In an idealized system, bulk cation abundance (soil and feedstock) will decrease (in monotonic fashion) as the feedstock weathers and cations percolate through the soil in groundwater. This decrease must be statistically significant for crediting.
9.3.4.4.1 Soil-based Determination of Alkalinity Added	[We] presently take [our] first few samples before application and post application 6-12 months later (used for T1 CDR calculations/determining application rate). Additional sampling required immediately after application is likely cost prohibitive for developers. How is “immediately” defined? Immobile trace element concentrations will be the same whether testing immediately after application or 6-12 months later. Section 9.3.4.5 also mentions sampling before and shortly after application. However, it is suggested with "should." Is "immediately" also a suggestion?	Changed: This immediate sampling requirement has now been clarified to be a recommendation. Project proponents may use an immobile chemical tracer of feedstock application rate (along with its ratio to alkalinity) at some later point to quantify potential and realized weathering at that point.

9.3.4.4.3 CDR Potential	As commented in the Feedstock Characterization Module - [Equation 15] represents max CDR potential if all the cations are carbonated, become carbonate minerals - eg CaO dissolves, becoming Ca2+ counterbalanced by 2HCO3- (representing 2 CO2 removed). If then the Ca reacts with a carbonate to form CaCO3, one CO2 is permanently stored but a second one was again lost. However, so far this protocol targets storage as bicarbonates dissolved in the ocean as end step - so then there should be a factor 2 added (see Renforth 2019)	Change: We thank the commenter for pointing this out. We have updated this equation to the form of Epot used in Renforth (2019). The primary difference in this corrected form of the equation is that it includes the greek letter eta, which represents the molar ratio of CO_2 to divalent alkalinity.
9.3.4.5 Post-application Monitoring	[*At a minimum, project proponents should conduct soil sampling shortly before rock application, shortly after rock application, and annually thereafter*] Why shortly after rock application as well? What purpose does that serve?	Changed: We have clarified here and elsewhere in the protocol that sampling shortly after feedstock application to confirm the application rate is a recommendation and not a requirement.
9.3.4.5 Post-application Monitoring	[*Project proponents must analyze (on average) a minimum of 1 sample per hectare of project area, however, in cases of extreme heterogeneity, a higher average sampling density may be needed to achieve statistical significance.*] Is this referring to the 2-plot model only?	No change: This guideline is for the entire project area. An average of 1 sample per hectare will be maintained in the 3-plot model, with the treatment plot being sampled more densely and the deployment plot less densely.
9.3.4.5 Post-application Monitoring	[The post-application monitoring section] could stand to be more prescriptive. Sampling is a major expense, and as written, sampling after each of these events could amount to dozens of sample periods per season.	No change: At this early stage in the industry, there are many open questions and active areas of scientific research in enhanced weathering. We anticipate that the minimum sampling requirements outlined in this protocol will decrease as early stage enhanced weathering deployments decrease the uncertainty in the underlying geochemistry.
9.3.4.6.1 Soil Characterization	I am not sure that all of the reference methods listed are all commonly used by typical agricultural soils testing labs. Might consider providing an 'or equivalent' of 'or similar' to enable companies to use other methods or allow for newer testing approaches.	Changed: There has been some confusion throughout the protocol with methodologies such as ISO methodologies. We intend to provide these as example methodologies, and not required methodologies. We will insert a "e.g.," before ISO methodologies that are meant as examples.
9.3.4.6.1 Soil Characterization	Soil testing methods in agricultural labs are regional and have been developed specifically to represent the soils in that area. In the US, labs use either a 1:1 or 1:2	Changed: This is a great point, and something that we have been actively discussing with our VVB partners. We agree that regionally specific

	ratio of soil to water or dilute calcium chloride, rather than the 1:5 ratio in the ISO method. Requiring usage of uncommon methods may be unnecessarily onerous on suppliers. An added benefit to using regional methods is that the results will be trusted by regional farmers and agronomists and can be compared to other pH amendments that they have used in the past.	standards and methodologies should be allowed. We will change the text to reflect explicit acceptance of regional methodologies for soil analyses. Added to several sections, for example: "Some agronomic soil testing facilities may use regionally specific methodologies that deviate from the standards listed above. Such methodologies are generally permissible, but require approval by Isometric. Such alternative methods must be approved by Isometric and justified in the PDD."
9.3.4.6.1 Soil Characterization	Barium chloride methods have been phased out in US soil testing labs because of the generation of large amounts of liquid waste to be treated. Unlike other methods that can be contracted to commercial labs for <$10/sample, this would require building an internal lab or finding a commercial lab willing to do a low-demand method. (https://www.umkc.edu/finadmin/docs/chem-treatment-protocols.pdf)	Changed: There has been some confusion throughout the protocol with methodologies such as ISO methodologies. We intend to provide these as example methodologies, and not required methodologies. We will insert a "e.g.," before ISO methodologies that are meant as examples.
9.3.4.6.1 Soil Characterization	Make bulk density requirement explicit	Changed: Bulk density added as a requirement in soil characterization measurements.
9.3.4.6.2 Determination of Weathering	Add EPA soil digestion method	Changed: The method recommended has been switched from EPA Method 3050B to EPA Method 3052.
9.3.4.6.2 Determination of Weathering	[*(adapted from Reershemius et al. 2023)*] The reference for this paper appears to be missing from the bibliography.	Changed: Citation has been added Thank you for pointing this out, we will surely include this citation in the Relevant Works.
9.3.4.6.3 Cation Exchange and Base Saturation	[*list of potential methods that can be used to isolate the exchangeable fraction.*] Mehlich-3 is by far more common in the Eastern US and some parts of the Midwest (https://acsess.onlinelibrary.wiley.com/doi/full/10.1002/saj2.20354)	Changed: Mehlich-3 added to the list of potential extraction procedures. Thank you for the comment. We note that this list is not exhaustive and represents a subset of methods that are permissible for extraction procedures.
9.3.4.6.3 Cation Exchange and Base Saturation	Tipper et al. (2021), PNAS have shown that NH4Cl determination can inadvertently dissolve calcite, biasing CEC determination: https://doi.org/10.1073/pnas.2016430118 It may therefore be worth recommending avoiding this technique if there are	Changed: The text now reads "Note that this method has been shown to dissolve calcite, which may bias CEC determinations (Tipper et al. 2021). This method is not recommended for use with carbonate-rich soils." Thank you for bringing this to our attention.

	carbonate minerals present in the soils.	
9.3.4.6.5 Secondary Mineral Formation	This standard [*X-ray Diffraction -- [ASTM D 934-52]*] is from 1960, and not exactly related to soil analysis. A more recent and suitable standard should be selected, and if not such standard exists, then either reputable journal articles or books or manuals should be referred to	No change: This method is given as an example of an acceptable method. Any method must be justified in the PDD, and project proponents may submit their own methods for approval.
9.3.4.6.5 Secondary Mineral Formation	Loss on ignition is not a reliable method to quantify carbonate formation, as there is overlap in mass loss with certain organic compounds and with mineral dehydroxylation.	Changed: LOI has been removed from the list of possible analyses.
9.3.4.6.5 Secondary Mineral Formation	[*Project proponents must cross-check their methods with the following standards:* *Calcimetry -- [ISO 23400:2021]* *Thermo-gravimetric analysis -- [ASTM D8474-22]* *X-ray Diffraction -- [ASTM D 934-52]*] Has there been any work to demonstrate that these methods can actually capture secondary mineral formation? Uncertainties for these methods are >1% so it would be difficult to detect a change if the amount of feedstock in the soil is low.	No change: Thank you for your comment. This list is meant to provide guidance for possible measurements rather than strict requirements. We note that the section states that alternative methods may be appropriate and project proponents may justify their use in the PDD. We agree that exact quantification of secondary mineral formation poses a challenge, particularly in the early stages of EW, and we hope that the flexibility given in the determination method will allow for continued innovation and consensus building in this subject.
9.3.4.6.5 Secondary Mineral Formation	So if I understand correctly, EW suppliers should for example carry out XRD analysis to identify the type and quantity of clays in the baseline soil and after deployment, but these data are not used for CDR estimation? Having spoken with secundary clay experts it will indeed be very difficult to see any change in clay contents of a soil, given the large natural heterogeneity in the baseline and the very slow process of the formation of secundary clays.	No Change: Please refer to the above comment.
9.3.4.6.6 Biomass Uptake	Suggest that [biomass uptake] be assumed de minimis between the project and control.	No change: See previous comments raising the same question and refer to Kantola et al. 2023 in Global Change Biology. This should not be considered de minimis.
9.3.4.6.7 Soil Gas	WDXRF can be a suitable alternative method for chemical characterization of soils (and minerals). It should be noted that the digestion procedure for silica and silicates involves the use of HF acid, if	No changez; Thank you for bringing this method to our attention. ICP-MS/ICP-OES is the current standard industry practice and we are not aware of any projects that currently use

	complete dissolution is required, and HF is a very toxic chemical. Therefore it should be discouraged to have HF be used widely, especially in academic labs. As such, WDXRF is a safer and less complex analysis. Also note that WDXRF and EDXRF are not the same, and WDXRF is much more precise for analysis of complex samples.	WD-XRF; thus, it is not included in the protocol at this time. If future projects wishing to use WD-XRF for characterization can demonstrate sufficient resolvability compared to industry standard practice, we will consider adding it to the list of allowable measurements.
9.3.4.6.7 Soil Gas	Are specific methods (reagents) required [for soil based required measurements]? (e.g., can any extractant be used for CEC + base sat?)	No change: We are not requiring a specific method. However, we recommend Project Proponent's consider a variety of factors, including methods available through commercial and academic labs, the analytical precision of a given method, and the potential LCA and environmental implications of using a given method.
9.3.4.6.7 Soil Gas	ICP-OES would not be sufficient for most trace metals	Changed: The authors agree with this comment. The following text was included in this protocol: "It should be noted that the detection limits of these two methods are different, and project proponents should consider the analytical precision required for detection of trace elements when selecting their measurement method. For example, sample analysis via ICP-OES may be appropriate for characterization of major elements, but lacks the analytical precision to accurately account for trace elements that may be used as immobile tracers." There may be some narrow set of circumstances where ICP-OES is an appropriate tool that can be used to quantify some metals with adequate justification. In practice, this is unlikely to be widely adopted for the reasons stated in the question and in the text above.
9.3.4.6.7 Soil Gas	Why does Isometric specifically require Walkley-black, rather than direct combustion method for SOC?	Changed: It is our intention to provide acceptable analytical methods rather than prescribe a single required method. This has been explicitly added in the text; combustion is now listed.
9.3.4.6.7 Soil Gas	If TC and IC are already required soil properties, why also require a separate direct OC measurement? Why Walkley-Black specifically? Most leading soil C efforts have phased out WB and LOI in favor of inferring OC by way of	Changed: It is our intention to provide acceptable analytical methods rather than prescribe a single required method. This has been explicitly added in the text; combustion is now listed. Additionally, we have added

	TC via combustion less IC. Why only required at baseline? I assume that's because you believe the risk to OC stocks during project activities to be de minimis, but I'm not aware of literature that supports that conclusion. I'm not an expert on EW, though. Can you share more about why OC at baseline but then not (required) again thereafter?	requirements for characterization of SOC in post-deployment samples.
9.3.4.6.7 Soil Gas	Why is Walkley-Black method the prescribed method for SOC when Dry Combustion is more accurate (see: https://www.sciencedirect.com/science/article/abs/pii/S0016236111008349 and others)? Furthermore Dry Combustion is listed as the required method for Total Carbon Content)?	Changed: It is our intention to provide acceptable analytical methods rather than prescribe a single required method. This has been explicitly added in the text; combustion is now listed.
9.3.4.6.7 Soil Gas	How is the CEC and the base cation saturation measurement different in this table? As far as I know, base cation saturation is indeed a series of soil extractions followed by chemical analyses with ICP-OES/MS. But the soil's CEC can be measured in a different way?	No Change; These two quantities are separated in the table because they must be reported separately. The measurement techniques listed here are recommendations rather than requirements. Project Proponents may choose methods for each measurement, with justification in the PDD.
9.3.5.1 Porewater Sampling Requirements	[*it is strongly recommended that project proponents install a weighing lysimeter in addition to an in-situ drainage lysimeter*] [Weighing lysimeters] cost $10k each and require digging up a large portion of the field.	No change: We appreciate that weighing lysimeters are not feasible with every project's scope and budget, which is why such an installation is "recommended" and not "required" in the protocol.
9.3.5.1 Porewater Sampling Requirements	Weighing lysimeters are strongly recommended by the protocol, but the high cost of the instruments and artefacts they introduce compared to real undisturbed field conditions are ignored. Differences in hydrology, soil temperature profile, disturbance of soil layers, soil structure etc all affect EW rates and give incorrect estimates.	No change: We appreciate the perspective of the commenter. Weighing lysimeters may cause field disruption and do have considerable cost, however, they also provide a much more precise picture of the water budget in a field. We also note that this recommendation is in addition to other porewater sampling device requirements. Given that this is a recommendation, we leave the decision to include a weighing lysimeter up to the project proponent.
9.3.5.1 Porewater Sampling Requirements	From hands on experience, using both these instruments to collect soil pore water in EW field trials, I'd like to point out that there can be quite a difference in the water samples obtained through these [lysimeter and rhizon] sampling methods	No change: We appreciate this perspective. It is the Project Proponent’s responsibility to choose and justify a rigorous sampling method in the PDD. We have added a requirement that sampling techniques be consistent throughout a project's lifespan.

9.3.5.1.2 Carbonic Acid System Measurements	Add IR and soil gas to allowable pCO_2 measurements	Changed: Infrared spectroscopy is now allowable for pCO_2 measurements.
9.3.5.2 Watershed/Rivers	It would be really useful if you could put here the references to these relevant recent publications [outlining modeling approaches that combine baseline river geochemical data, equilibrium modeling of water chemistry and scenarios of EW inputs]- I only see the one for Harrington 2023?	Changed; a reference has been added for Zhang et al. 2022.
9.3.5.3 Ocean	Clarify carbon isotope recommendation	Changed: All stable isotope measurements are now listed as optional rather than recommended.
9.3.5.3 Ocean	If alkalinity and DIC are measured directly, then anions would not need to be measured? [Ion chromatography] would only be required if a supplier wished to calculate CDR via cation measurements.	Changed: The text has been updated to clarify that anion measurement is only required for projects looking to credit based on porewater cations.
9.4 Missing Data, Outliers, and Unexplained Results	A reference standard exists for determination of outliers that could be referred to here. It is ASTM E178-21. https://www.astm.org/e0178-21.html	Changed: Thank you for bringing this methodology to our attention. This section has multiple aims that include identifying outliers AND adjudication appropriate actions once they are raised. Context and the nature of the outlier are important here. We provide one example, but more importantly, there are likely situations we won't be able to foresee and explicitly address. We went ahead and included a definition of outliers in the text to help project proponents identify when they occur: "For the purposes of this protocol, outliers are defined as data that are more than three standard deviations from the mean (or equivalent percentiles for non-normal distributions)."
13.0 Appendix 2: Monitoring Plan Requirements	ISO standards in the plant biomass uptake section are for soil and water, not plant material	Changed: Clarified in text that this ISO is meant to be a general ICP-MS standard.
13.0 Appendix 2: Monitoring Plan Requirements	Probably also worth mentioning [when to measure soil depth]. I assume baseline would be sufficient.	Changed: This now reads "must be characterized as part of baseline sampling". Thank you for your comment. This has been clarified in the text.
13.0 Appendix 2: Monitoring Plan	Post deployment sampling probably doesn't need to have soil texture	Changed: This now reads "required for baseline samples, recommended for deployment

Requirements		samples". Thank you for your comment. The requirement has been clarified in the text.
13.0 Appendix 2: Monitoring Plan Requirements	[*X-ray diffraction in this context is used largely to detect the formation of clay minerals that were not previously observed in the baseline/control soil samples, or to identify large variations in diffraction peak intensity that may result from substantial increases in clay content]* citation missing	Changed: Thank you for pointing out this error. An appropriate citation has been added (Kahle et al. 2002)
13.0 Appendix 2: Monitoring Plan Requirements	Measuring [soil] texture for all sampling events might be exaggerated as you already ask for secondary clay formation analysis. The amount of sand will not change significantly with the addition of rock powder.	Changed: The text has been updated to require soil texture characterization only in baseline samples.
13.0 Appendix 2: Monitoring Plan Requirements	[*Porewater alkalinity monitoring plan requirements*] I think you mean Total alkalinity and maybe I would revise the unit.	Changed: The unit was changed to mg/L. This is referring to total alkalinity, which is clarified in the description.
13.0 Appendix 2: Monitoring Plan Requirements	confused by the unit [of soil organic carbon] being "Mass per unit area (g/m^2)". Typo?	Changed: We thank the commenter for pointing this out. These units should be weight carbon per weight soil (e.g., g/kg or equivalent). This table has been updated accordingly
Rock and Mineral Feedstock Characterization Module 1.0.0 (formerly the Alkaline Feedstock Characterization Module)		
General	This really needs to tie in with existing protocols for the description of mineral deposits, and with the professional competences of the geologists who describe rocks and minerals. It should use IUGS-approved systematics for the correct naming of a rock. So many papers fail to correctly name the rock that is used that it is impossible to repeat an experiment. This is really important, as suppliers often use a geological name such as basalt incorrectly. Also, the key test that is omitted from Table 1 is Loss on Ignition - a simple test that the supplier can carry out on site. Critically this tells you whether the rock is already weathered, and it is a prerequisite for use of the TAS diagram to correctly name the rock. It also indicates if the calcium in the rock is already carbonated, a correction that is needed to evaluate the CO_2 removal potential. There's a huge amount more that I could say! One	Change: We appreciate this feedback and have updated the name of the module to: Rock and Mineral Feedstock Characterization Module to address this concern.

	thing, do not use the word 'alkaline' to describe rocks. The alkaline rocks are a very specific taxonomic group within petrology, referring to those that contain nepheline and related minerals. It is misleading to use the term in this document.	
1.0 Introduction	[Geotechnical Properties: Assessment of weathering potential, Determine feedstock characteristics Recommended: Various. See Section 3.3.1] But below 4 of them are indicated as required, maybe also reflect this here?	Change: This table has been updated to reflect this, thank you for your comment.
1.0 Introduction	[Required: XRD Mineral mapping with SEM-EDS/EDX (e.g., QEMSCAN)] What I am missing here is more detailed info on what exactly one needs to assess with SEM-EDS? XRD is to understand the mineral content qualitatively and quantitatively, SEM I have used before to check if the crystal structure of any serpentine mineral is not asbestiform - so checking for asbestos. But what other uses might SEM-EDS have?	No Change: These measurements are required for general characterization of the feedstock, beyond the CDR calculation. This module is not specific to Enhanced Weathering.
1.0 Introduction	[*Radiation levels*] will only be a risk with certain and very specific rock types. Suggest that this is only required in cases where there might be a risk, and that this is not required for rock types (based on petrography, XRF, geological maps etc.) that have little to no risk of radiation.	No change: There is text in the module that gives suppliers the option to exclude radiation measurements if they can provide sufficient evidence that it isn't a problem for their feedstock. literature values are sufficient for this.
1.0 Introduction	Why [is dry combustion analysis a] required measurement? S can be obtained to a reasonable level via XRF I think, and these are specialist measurements to take and increase costs a lot. LOI (loss on ignition) is a good indicator of alteration and carbon content which is very easy to make and routinely done with XRF. Suggest LOI should be below 2% for feedstocks. Suggest making people check the LOI of their feedstock and to add in an acid test instead of total carbon (i.e. add dilute (10%) HCL to the feedstock), if it	No change: LOI is not sufficient for carbon analysis, as there are several possible phases/compounds that can be lost on ignition.

	visibly fizzes then carbonate content of the rock is ~1% or above, and shouldn't be used.	
1.0 Introduction	SEM/EDX is very expensive to do and limited to certain areas of the world. Would it be possible to substitute for simple petrography + light microscope?	No Change: These measurements are required for general characterization of the feedstock, beyond the CDR calculation. This module is not specific to Enhanced Weathering.
3.2 Sample Preparation and Handling	[*Sample preparation, identification, sub-sampling and storage should be undertaken in accordance with national standards related to extractive waste, such as those outlined in the CEN/TR 16365:2012 standard*] Are byproducts of mining covered by this? It seems to refer more specifically to waste streams that require a higher level of hazard mitigation	No change: This section is a guidance on sampling best practices, and is meant to generally refer to sampling and handling procedures.
3.3.1 Geotechnical Characterization	[*Required for all feedstocks:* *ISO 17892-1:2014 - Determination of water content* *ISO 17892-2:2014 - Determination of bulk density* *ISO 17892-3:2015 - Determination of particle density* *ISO 17892-4:2016 - Determination of particle size distribution*] Not sure I see the relevance of these geotechnical tests. This doesn't seem useful for enhanced weathering	Changed: These parameters are relevant to assess the quality of the feedstock added and/or are important control variables for weathering. It is important to assess the water content of the feedstock for relating the tonnage of feedstock added to the CDR potential. Particle size distribution is directly related to the weatherability of a feedstock. Bulk density and/or particle density may be used as part of the protocol's quality control checks on the amount of feedstock added (protocol calls for direct comparison of post-deployment analysis with tonnage of rock spread). However, there are ways to do this that don't directly require density. We will make these recommended instead of required for EW projects.
3.4.1 Elemental Characterization	ED-XRD is a method that requires standards to result in accurate quantification, and for complex samples like soils or minerals, there are not suitable standards. The WD-XRF method is far superior, not only because it does not require standards (though standards can be used to improve precision), it results in X-ray data that does not suffer from peak overlap, which happens with ED-XRF.	Changed: WD-XRF has been added to the list of allowable measurements.
3.4.1 Elemental Characterizati	not clear why both [Fusion + Two-Acid Digest / Aqua Regia Digest (with	Changed: This approach is acceptable since all

on	ICP-OES/MS)] are required? One could get Si from XRF and the rest from acid digestion ICP-MS?	relevant elements are still being characterized. We have added an additional option to this list that covers instances where Si concentrations might come from XRF instead of ICP-MS. This level of detail can be described and justified in the PDD.
3.4.1 Elemental Characterization	Is [requiring major and minor elemental compositions, to be analyzed via ED-XRF] redundant if also performing ICP-OES and ICP-MS measures? Could [Ca] be converted to CaO for example?	Changed: One of our expectations for suppliers is that they would undertake a larger number of high-throughput, inexpensive analyses like XRF, and take fewer ICP-MS measurements when characterizing feedstock. Suppliers may, however, opt to characterize feedstock using more resource intensive mass-spec techniques. We will modify the Rock and Mineral Feedstock Characterization Module to reflect this change. XRF is not required if elements are otherwise characterized using mass-spectrometric techniques.
3.4.1 Elemental Characterization	[*Fusion + Multi-Acid (4-Acid) Digest (with ICP-OES/MS)*] I think there might be a mistake here. Do you not mean total fusion OR a multi acid digest which includes an HF step. Total fusion + dissolution in dilute acid + ICP-MS is sufficient	Changed: Thank you for the correction. The text now reads "fusion or multi-acid digestion".
3.4.1 Elemental Characterization	Total fusion doesn't require an aqua regia step to dissolve. Typically the rock would be ignited first to remove organics, then fused and then the bead dissolved in dilute nitric acid.	Changed: Thank you for the correction. The text now reads "fusion or multi-acid digestion".
3.4.1.1 Carbon Dioxide Removal Potential	I am wondering where the factor '2' that takes into account that every Mg2+ or every 2Na+ can remove 2 CO2 has gone (see for example Renforth, 2019) - is it left out on purpose and if yes what is the reasoning?	Change: We thank the commenter for pointing this out. We have updated this equation to the form of Epot used in Renforth (2019). The primary difference in this corrected form of the equation is that it includes the greek letter eta, which represents the molar ratio of CO_2 to divalent alkalinity.
3.4.1.1 Carbon Dioxide Removal Potential	This equation is not correct. Ca and Mg are divalent cations, while Na and K are monovalent cations, so each mol of Ca or Mg can sequester double the moles of CO_2 compared to Na or K, whether in the form of carbonates or bicarbonates. The original Steinour equation is correct, the problem is that authors have made mistakes over the years, and now we can find many incorrect equations in literature.	Changed: We thank the commenter for pointing this out. We have updated this equation to the form of Epot used in Renforth (2019). The primary difference in this corrected form of the equation is that it includes the greek letter eta, which represents the molar ratio of CO_2 to divalent alkalinity.

3.4.1.1 Carbon Dioxide Removal Potential	The way the Steinour equation works is that it assumes carbonate formation (CaCO3, MgCO3, etc.). In ERW, many researchers assume that bicarbonates are the main removal method (Ca(HCO3)2, Mg(CHO3)2, etc.). So in ERW terms, the amount of CO_2 sequestration would be double that of the Steinour equation. Myself, personally, I always think that assuming that only bicarbonates form and that they can go to the ocean and remain dissolved for a long time is overly optimistic. I much rather assume that carbonates are the more reliable product of ERW, so I don't mind using the Steinour equation as a conservative estimate.	Changed: We thank the commenter for pointing this out. We have updated this equation to the form of Epot used in Renforth (2019). The primary difference in this corrected form of the equation is that it includes the greek letter eta, which represents the molar ratio of CO_2 to divalent alkalinity.
3.4.1.1 Carbon Dioxide Removal Potential	I think this should be 1000x instead of 1000/100x.... At least if you enter the values in % and g/mol. With this formula you get a CCP rate of 3-4 kg/t for a typical basalt (which should be more around 300-400 kg/t). In case I'm wrong, can you please let me know what I'm missing? Thanks	Changed: We have added a clarification here. This form of the equation assumes that percentages are entered in the form XX.X% instead of 0.XX. This explains the discrepancy you mention in your comment.
3.4.1.1 Carbon Dioxide Removal Potential	Ok, sorry I found the first error: I did not see that you need to scroll in order to see the full equation. That's very confusing (see picture). Nevertheless, the equation is missing the multiplier 2 accounting for composition of K2O and Na2O and the divalent of Ca2+ and Mg2+ cations.	Changed: Thank you, this has been addressed. The greek letter eta has been added to address the CO2 removal potential of divalent alkalinity.
3.4.1.1 Carbon Dioxide Removal Potential	[*The calculation output is in the form of kg of CO_2 per tonne of waste material*] feedstock, not waste?	Changed: "waste material" to "feedstock"
3.4.3 Radiation Levels	[Project proponents may, in consultation with Isometric, choose to submit this pre-existing data with sufficient justification in the PDD.] With regards to the risk of asbestos for example in altered ultramafic rocks where olivine is partially recrystallised to serpentine, mining companies already have to check for this. So could pre-existing data on asbestos risk also be submitted?	No change: This information should be apparent from the required mineralogy assessments, but additional information may be submitted at the Project Proponent's discretion.
3.4.3 Radiation Levels	[*At a minimum, the project proponent must determine gross alpha and beta activities.*]	No change: Isometric already allows for radiation level tests to be omitted with sufficient justification: "In some cases, there may be

	Suggest limit to known risk feedstocks. I think that is covered by the point below on pre-existing data?	sufficient pre-existing data demonstrating that radioactivity of a certain feedstock is negligible. Project proponents may, in consultation with Isometric, choose to submit this pre-existing data with sufficient justification in the PDD."
3.4.4 Mineralogical Characterization	The ERW standard largely relies on elemental calculations, rather than mineralogical calculations. So as is, I am not seeing how having these precise mineral analyses is going to serve a purpose. I do agree that they are necessary, but it should be made clear for what. For example, mineralogical characterization is needed if future estimates are used as part of an ERW protocol, where it is needed to know what minerals are expected to weather faster, which will weather slower, and which might never weather. For complex rocks like basalt, this is critical.	No change: Mineralogical characterizations are required to understand the properties of the feedstock being spread, including weathering rate and possible risks (such as asbestiform mineral phases).
3.4.4 Mineralogical Characterization	[XRD/SEM/EDS/EDX is] not readily available in developing countries. Suggest allowance of petrography	Change: Petrography is now allowed as part of a suite of mineralogical characterization techniques. Suppliers choosing to use petrography for mineralogical characterization are required to submit the samples to an accredited facility and cross-check results with XRD, SEM-EDS, or geological data.
3.4.5 Feedstock Sourcing from Mining Operations	bi-product is often used for non-primary products rather than a waste stream	No change: This is a term defined for use within the module and doesn't have a material impact on the required characterization.
4.0 Sampling Guidance, Laboratory Requirements, and Data Quality	Typo of “quality”	Change: Thank you for bringing this to our attention, we have fixed this typo.
8.1 Feedstock Measurements	[Dry combustion of total carbon, nitrogen, and sulfur] N was not mentioned earlier on in either Table 1 or the text?	No change: Dry combustion of nitrogen is recommended but not required, which is why it is listed here.
8.1 Feedstock Measurements	[*EPA Method 3050B 1.2*] This method is not a total digestion technique for most samples	Changed: This now reads acid digestion. Thank you!

8.2 Soil Measurements	Laser diffraction is not recommended for soil texture or particle size analysis. Laser diffraction depends on the usage of a suitable dispersant, which will depend on the surface charge of the soil, and will be different for clay vs sand. Laser diffraction also assumes perfectly spherical particles, which we know soil is not. Laser diffraction is typically considered inaccurate above ~1 mm, though testing labs may still report it. Finally, at commercial labs it costs >$150/sample compared to ~$20 for gravimetric/hydrometer testing.	No change: Thank you for your comment. We aim to give a list of methods that could potentially be used for different feedstocks and circumstances. There are situations where laser diffraction is an appropriate analysis and we chose not to exclude it for that reason. All methods selected by a project proponent must be justified in the PDD.
Embodied Emissions Accounting Module 1.0.2		
3.2 Calculation of CO_2eEmbodied, R	Could [you] please provide example datasets / sources that enable the calculation of storage monitoring emissions?	Changed: This is a general embodied emissions accounting module. Storage monitoring emissions are not applicable to enhanced weathering. Have added "where applicable" to this section.
3.2 Calculation of CO_2eEmbodied, R	How should these emissions be handled /accounted for when our product can be considered as waste product (which excludes it from the GHG assessment), or if from a whole mining site with various crushers, conveyor belts, sieves etc. only crusher, conveyor belt and sieve is used for the final product?	No change: If the product is considered a waste product and appropriately evidenced as such, then it can be excluded from the GHG system boundary. We refer the commenter to the section titled "Considerations for Waste Input Emissions."
Energy Use Accounting Module 1.1		
3.2.4 Acceptable Emission Factors and Rates - CO_2eElectricity, R	Could you please provide an example how such a consequential impact analysis might look like?	No change: Should a project be designated as an “intensive facility” which occurs if they are using either >10 GWh per year or require >50 KWh per tonne of CO_2 removal then for non-qualified energy use they must account for their emissions using short run marginal emission rates. These look at the carbon intensity of the marginal power source on the grid which is then used for the project's carbon intensity in a given hour.