SUMMARY AND RESPONSE TO PEER REVIER COMMENTS

A draft Methodology for *Landfill Gas and Beneficial Use Projects v.2.0* was developed by *Loci Controls, Inc. and the American Carbon Registry* for potential approval by the American Carbon Registry (ACR).

All new methodologies and methodology modifications, whether developed internally or brought to ACR by external parties, undergo a process of public consultation and scientific peer review prior to approval.

The methodology was posted for public comment from July 1, 2020 – September 1, 2020. The methodology was reviewed by an independent panel of experts October 20, 2020 – April 2, 2021. Comments and responses of peer reviewers are documented here.

#	Document Section	Round 1 Reviewer Comment	Round 1 Author Response	Round 2 Reviewer Comment
1	1.3	Footnote about start date and automated collection system is not noted in Summary of Changes document	Revision made to Summary of Changes document	Accepted.
2	4.1	The equations should only account for an increase in efficiency for any new wells that are installed as part of a system, and not the total CH4 from new wells. It seems as though this is handled by updating the calibrated collection efficiency, but I wanted to double check that.	The equations account for only the incremental increase of methane collected due to installation and operation of Automated Collection System (ACS) on existing or new landfill gas collection wells.	Thanks, accepted.
3	Equation 2	I would add this information from subpart HH to parameter S: “Use the year 1960 or the opening year of the landfill, whichever is more recent.” It was unclear to me at first what year S should be (start year of landfill operation vs. start of the baseline 3-year preceding)	Agree to add to definition of the S parameter in Equation 2 the following: “Use the year 1960 or the opening year of the landfill, whichever is more recent.”	Thanks, accepted.
4	Equations 2,3	Are these values the sum of the 3 years or the average? Not sure it matters but would be worth clarifying.	To clarify: Equation 2 calculates G_{CH4} (modeled methane) for the sum of all years from the opening of the landfill to the year of calculation.	Thanks.

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			Equation 3 calculates G_{CH4} (measured methane) for each year and not the sum or average of the years.	
5	Equation 2	Parameter Lo: This variable needs defined or clarified. It is not listed directly in equation HH-1. Is this supposed to be DOC or combination of DOC and other variables in equation HH-1?	Lo is listed in the original Subpart HH of October 30, 2009. Lo can be calculated using EPA's formula of Lo = MCF * DOC* DOCf * F * 16/12. However, the underlying key variables to the calculation are very difficult and unlikely to be practically measured (e.g. waste composition) representatively to make meaningful adjustments to each landfill. EPA has established a Lo for bulk waste of 0.067. The LFG industry uses the same or similar Lo factors and can choose to use their developed Lo in this calculation as reported in the EPA GHG reporting system.	This sounds good, but I would recommend saying that a project can use the default of 0.067 or choose to develop their own Lo. Or at least change the source of data reference in the monitoring parameters table to the 10/30/2009. **Author response**: Yes, we agree. The "source of data" section for the Lo parameter states: "Parameter provided by the responsible party to the EPA GHG Reporting Program in accordance with the provisions of US EPA 40 CFR Part 98: Subpart HH and confirmed by Table HH-1of Subpart HH." Per the description, a default or custom Lo is allowable. The default factor is not required.

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				Accepted
6	Equation 3	If there is a 10% discount for weekly CH_4 for current measured LFG, should there by a discount for historic measured?	The historic methane data to be used is derived from the EPA GHG Reporting Program that requires the responsible party to follow Subpart HH Section 98.344 – Monitoring and QA/QC requirements, and Section 98.345 – Procedures for estimating missing data, and Section 98.346 – Data reporting requirements.	So, section 98.344 requires continuous monitoring? Author response: Yes, that is correct. Accepted
7	5.2.3	How are equipment used to measure historical LFG captured handled for QA-QC?	The historic methane data to be used is derived from the EPA GHG Reporting Program that requires the responsible party to follow Subpart HH Section 98.344 – Monitoring and QA/QC requirements, and Section 98.345 – Procedures for estimating missing data, and Section 98.346 – Data reporting requirements.	Thanks, accepted.
8	5.2.6	Wx – do landfills typically have good historical records of this? What if they don't have it? Also, Source of Data says Subpart HH, but shouldn't it be landfill records?	Large regional landfills that this methodology would apply to typically have high quality historic records that are typically based upon weighed data that is the basis for the operations revenues and is reportable under landfill permits and/or regulations to	Thanks, accepted.

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			the state environmental regulatory agencies. The historic waste data to be used is derived from the EPA GHG Reporting Program that requires the responsible party to follow Subpart HH Section 98.344 – Monitoring and QA/QC requirements, and Section 98.345 – Procedures for estimating missing data, and Section 98.346 – Data reporting requirements. The reference to Source of Data shall be the landfill records as provided by the responsible party to the EPA GHG Reporting Program in accordance with the provisions of US EPA 40 CFR Part 98: Subpart HH.	
9	5.2.6	Parameter A2, A3, A4, A5: Source of data cited is Table HH-3, but that table has collection efficiency %s which are the values for CE2, CE3, etc. This should be source data for coverage area in square meters. Also, how will this be determined? What evidence is expected?	The reference to Source of Data shall be changed to the landfill area records as provided by the responsible party to the EPA GHG Reporting Program in accordance with the provisions of US EPA 40 CFR Part 98: Subpart HH. Confirmation of reporting can be accomplished by viewing engineering records of the landfill and LFGCS build-out.	Thanks, accepted.

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10	5.2.6	Parameter Lo – Source of Data/Description: I would point users directly to Table HH-1 of Subpart HH, similar to parameter K description	The reference to Source of Data shall be changed to: Parameter provided by the responsible party to the EPA GHG Reporting Program in accordance with the provisions of US EPA 40 CFR Part 98: Subpart HH and confirmed by Table HH-1of Subpart HH.	Accepted.
11	5.2.6	Parameter x: Source data should be from landfill, not Subpart HH Parameter T: Source data should be from landfill, not Subpart HH	The reference to source of data for both Parameters x and T shall be changed to "Landfill records as provided by the responsible party to the EPA GHG Reporting Program in accordance with the provisions of US EPA 40 CFR Part 98: Subpart HH and confirmed by Table HH-1of Subpart HH."	Accepted.
12	5.2.6	Parameter HLFGcaptured: Measurement frequency says once per day. Is that a total SCF for a day or one reading of scfm?	The $HLFG_{captured}$ is in units of SCF for each Year. The reference to Source of Data shall be changed to: Parameter provided by the responsible party to the EPA GHG Reporting Program in accordance with the provisions of US EPA 40 CFR Part 98: Subpart HH.	Accepted.

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			The reference to Measurement Frequency shall be changed to "In accordance with requirements of US EPA 40 CFR Part 98: Subpart HH."	
13	A.2	Third paragraph, page 45, cites 10 pipeline projects that have increased collection efficiency, but 9 are cited in paragraph 2 on page 46. Are these talking about two different systems/technologies? Wondering if these two values should be combined (19) to state the total number of pipeline projects that have attempted to increase collection efficiency through some means. That would make it ~32% of current pipeline projects, which seems high for an adoption rate.	These two references are not related, the first on page 45 refers to only about 10 landfills where we are aware that a landfill gas collection system has a higher density of collection wells than is minimum collection well spacing per EPA regulations. These projects also have adopted more accurate gas chromatographs for gas composition measurement, but this process is still manual and relies upon roughly once per month well adjustments. The 9 projects cited in 2nd paragraph on page 46 are projects where the automated collection system has been installed and has improved collection efficiency.	Thank you for this clarification.
14	A.2	For clarity I think it would be helpful if the number landfills, projects, landfills that tried to increase efficiency, landfills with	Of the 65 operational landfill gas to pipeline projects, 10 are known to have greater than minimum collection well density, or 15.4%, and 9 out of	Thanks for this additional information. Should A.2 be updated from 60 to 65 pipeline projects?

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		automated systems, etc. are put into a table to show the %s.	the 65 or 13.8% have used automated gas collection systems. There are approximately 400 operational landfill gas to electricity projects, 0% are known to have greater collection well density than as required to meet regulatory requirements, and 6 projects currently are using automated collection system, or 1.5% market adoption of automated collection control technology on landfill gas to electricity projects.	I do think a simple table outlining what you said in your response would be helpful to visually see the breakdown. Ultimately the %s are what matters, and it is easiest to see in a table. **Author response**: Table 4 has been added to section A.2. Accepted
15	C.2	Calculation of Gch4 shows (20-1-1) and (20-1) for 1995, for example. Shouldn't this be (2014-1995-1) and (2014-1995)? Applies to other years as well.	Either placement of date or numerical year in the formula provides the same result mathematically. We have left the nomenclature as previously stated as this can facilitate partial year verifications without confusion (i.e. per reviewer comment, a six-month partial year verification would need to be noted 2014.5-1995-1)	Understood, thank you for this clarification.
16	C.2	Wx parameter – shouldn't this be the waste disposed in each applicable year (i.e. Wx for 1995 should be waste disposed in	Wx is waste placed each year. The example uses the same waste quantity placed in the landfill each year. Reviewer correctly points out that actual cases will have different	Thanks for clarification. It still makes the example slightly confusing. You could say that Wx is assumed to be 453,590 for every year, including 2014

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		1995?) Why is Wx for 2014 applied to all years?	quantities of waste disposed in accordance with records. This is addressed in calculation description.	in the parameter table on page 51. Similar to description of X parameter in same table. **Author response**: We have changed the parameter to read "For simplicity, all years in this example are assumed to apply 453,590 metric tons (500,000 short tons) per year". Accepted
17	C.2, page 56	Division annotation is different for ACCE2 than the others.	C.2, page 56 changed for consistency of annotation.	Accepted.
18	C.2	I feel like it would be helpful for the case study should be a complete case study with the calculations all the way from start to finish.	To avoid confusion with projects that are not solely applying the requirements for an automated collection system, we have chosen to add the following clarifying language to the introductory section of Appendix C: *"This case study has been included to provide an illustrative example of the application of Equations 2-9 only for projects that install an automated*	Accepted.

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			collection system as a stand-alone project activity."	
19	1.1	Table 1 includes only a partial list of the eligible project activities identified in Section 1.2	Table 1 revised	OK
20	1.2	There is no mention of the eligibility status of landfills that operate as a bioreactor or recirculate leachate through waste. Are landfills employing these practices eligible, and, if so, are they to be treated the same as other landfills?	Section 1.2 revised to state that bioreactor landfills/those that recirculate leachate are not eligible.	OK
21	1.4	The language describing a project's ability to apply for a second (or more) Crediting Period is unclear as to whether Crediting Periods after the first would be subject to the then-current version of this methodology or whether the project could continue to use the methodology version as during the first Crediting Period.	Section 1.4 revised to clarify CP renewals.	OK
22	1.4	How will the start date be determined for projects that have previously generated offsets in a	No, per the ACR Standard, the original start date is valid but, in order to renew a crediting period, revalidation	OK

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		GHG program other than the ACR since those projects are already in operation? There is no time limit specified requiring a project to begin operating under this ACR methodology following expiration of the project's crediting period under a non-ACR methodology. Is the intent to allow projects whose Crediting Period has expired under a non-ACR methodology to begin operating under this methodology at any time after the end of the Crediting Period under their previous methodology?	must occur within one year from the end of the previous crediting period (See Section 6.I of the ACR Standard).	
23	3.1	A project that elects to operate under the ACR protocol following expiration of a Crediting Period under a non-ACR protocol would "have an eligible project activity that was implemented prior to the specified start date". As written, the baseline determination language would require emission reductions from these previous activities to be deducted from the baseline – if that is not the intent,	This is not accurate. Per Footnote 9 of the ACR Standard (Chapter 3 – Table 2): *"All projects transferring to ACR from another GHG program must have a validated/verified Start Date of January 1, 2000, or after and will maintain their original project Start Date. Projects transferring to ACR from another GHG program and that have reached the end of a Crediting Period may apply for an initial*	OK

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		then a statement qualifying this requirement would be appropriate.	*Crediting Period at ACR per ACR Standard requirements. The project must have been successfully validated and/or verified at the previous GHG program."* Regarding crediting period renewals, a revalidation must occur within 1 year of the expiration of the original crediting period whether the project was originally registered with ACR or a different registry.	
24	4.1	Equation 1 should clearly differentiate between the $LFG_{captured}$ quantity for which $\%CH_4$ was measured continuously and the $LFG_{captured}$ quantity for which $\%CH_4$ was measured weekly in a manner similar to the differentiation used for $\%CH_4$. As written, the equation calls for the total $LFG_{captured}$ to be used in both, and in the event a project used more than one method for measuring methane concentrations (e.g., temporary substitute after equipment failure,	The reviewer comment is unclear. The equation presents $LFG_{captured}$ twice as the first clause applies no discount for time periods where continuous methane readings are available. The second only applies to time periods where weekly readings are taken, and a discount is therefore applied. %CH4, weekly is defined as "methane content LFG for duration weekly methane monitoring" and DFweekly is defined as the discount factor for weekly methane content monitoring. Therefore, the equation would provide a correct result as written.	OK

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		upgrade of equipment partway through period, etc.) these quantities would need to be differentiated for the equation to produce a correct result.		
25	4.1	Equation 2 calculates the value G_{CH4} which represents the volume of LFG generated in the landfill during a given year. G_{CH4} is used in Equation 4 to calculate collection efficiency of the gas collection system during the three years prior to installation of the automated collection system, and in Equation 9 to calculate the incremental collection efficiency attributable to the automated collection system. Used in this manner, G_{CH4} is fundamental to establishing both baseline collection efficiency and baseline LFG volume variables that are used to determine the quantity of creditable emissions reductions. An accurate and consistent determination of G_{CH4} is necessary	The calculation of collection efficiency is correct. G_{CH4} that is in the denominator in Equation 4 is the quantity of methane	The authors are correct in their description of collection efficiency as the percentage of generated methane that is collected and the reviewer acknowledges the imprecise language in regards to the initial comment about the portion of methane that would be oxidized absent a collection system being unavailable for collection when that portion of the methane is available for collection. However, the protocol is ultimately concerned with quantifying emissions reductions rather than collection system performance or efficiency.

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		to ensure credited emission reductions are real and additional. The first consideration regarding G_{CH4} is that it is used as the denominator in Equation 4 to determine baseline collection efficiency without application of an Oxidation Factor. Borrowing from the example in Appendix C, G_{CH4} is calculated at 16,804 metric tons of methane for the example year, of which 10,318 metric tons of methane were collected resulting in a baseline collection efficiency of 61.4%. However, some portion of methane generated in a landfill would not otherwise be emitted and is not available for collection due to oxidation (see Equation HH-5 at 40 CFR §98.343 (c)). ERTs are earned for emission reductions that are additional to the baseline level of emission reductions, and this proposed protocol determines the quantity of emission reductions that qualify as additional using the	that is generated by the landfill and therefore available for collection. The Reviewer suggests that an assumed quantity of methane that escapes collection and is oxidized is not available for collection. This is incorrect. The methane that escapes collection is available for collection, but the collection system was unable to collect the methane. The quantity of methane generated and then collected using the manual system and then the ACS must be calculated both based on generated methane that is available to be collected to determine accurately the increment of collection efficiency. Use of the suggested oxidation as unavailable for collection could provide a result of greater than 100% collection efficiency, which is not possible.	The concern is that the current approach does not account for methane oxidation in a manner similar to that of collection efficiency. Table HH-4 and accompanying notes of 40 CFR Part 98 describe the process for determining the appropriate oxidation factor based on the portion of the landfill with different cover types and the resulting methane flux calculation. The oxidation factor is then applied to G_{CH4} in Eqs. HH-5, HH-6, HH-7, and HH-8. Although the increase in collection efficiency due to installation of the automated collection system is the mechanism by which additional emission reductions are obtained, it is the actual increase in emission reductions that must be determined and with the range of potentially applicable oxidation factors

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		difference between baseline collection efficiency and the increased collection efficiency resulting from project activities. Adjusting G_{CH4} by an assumed methane oxidation factor of 0.1 yields a baseline collection efficiency of 10,318 / [16,804 * (1 - .10)] = 68.2% and is a more accurate reflection of the percentage of methane collected that would have otherwise been emitted into the atmosphere. Adjusting G_{CH4} (i.e. methane generation) for methane oxidation in determining baseline emissions is common practice among carbon offset protocols for landfill gas projects and also the method prescribed by the EPA in 40 CFR §98.343. The current proposed protocol understates baseline collection efficiency by not adjusting methane generation (G_{CH4}) for methane oxidation and, as a result, is at risk of issuing offset credits for non-additional emission reductions and	Lo is a measure of the quantity of methane generation potential from a quantity of waste. The use of Lo in this methodology is to establish a consistent Lo for a landfill from year to year that results in a modeled generation of methane that exceeds the measured generation with sufficient margin to assure that measured collected never exceeds the modeled generation.	from 0% to 35%, methane oxidation is a substantial and material factor in determining emission reductions. Like collection efficiency, the oxidation factor may change as areas of the landfill change, and both the baseline and crediting period-year calculations should reflect these changes. The recommendation is that the protocol incorporate methane oxidation in order to represent the change more accurately, presumably an increase, in emission reduction efficiency. **Author Response:** The methodology does incorporate methane oxidation per 40 CFR part 98 and this has been the case since the first version of the methodology. See Equation 1 – "Oxidation Factor" parameter.

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		potentially violating the principle that emission reductions represent real reductions by crediting emission reductions for methane that would not have been emitted due to oxidation. The second consideration with Equation 2 relates to the proposed methodology's novel use of calculated methane generation in determining a baseline level of methane destruction. Equation 2 uses the variable Lo to represent methane generation potential in units of metric tons of methane per metric ton of waste. This variable is commonly used within EPA modeling software, albeit in a slightly different manner than in this methodology (EPA's Landfill Gas Emissions Model (LandGEM) represents the Lo value in units of cubic meters per metric ton of waste, and EPA's LFGcost-Web represents the Lo value in units of cubic feet per ton). In the case of this protocol, Lo represents a	A consistently applied Lo to the calculation of manual versus automated collection, provides a calculated ACSI that is accurate. Lo only provides a reference point to calculate the collection efficiencies for comparison. If Lo is set higher than the example at any level, the Modeled Generation becomes higher, but the Baseline Collection Efficiencies, Updated Baseline Collection Efficiencies and Measure Collection Efficiencies all shift proportionately lower. The collection efficiencies are compared and the AGCI Incremental Collection Efficiency is calculated to be the same percentage regardless of the Lo. Therefore, the concern for accuracy of Lo is irrelevant to the quantifiable outcome of the increased collection efficiency of the ACS. If the nature of the landfill changes drastically and a consistent Lo can no longer be used to represent new conditions, and a substantially changed Lo in a subsequent year of establishing the baseline calibrated	**Reviewer:** The concern with the oxidation factor is that it is not applied to historic measured methane collection in Equation 3 or the historic modeled methane generation rate in Equation 2, and therefore the oxidation factor adjustments are not included in the baseline collection efficiency calculated in Equation 4. The remainder of the protocol conforms in nearly all respects to 40 CFR Part 98 Subpart HH, and it is unclear why oxidation factors are not applied to the baseline efficiency in accordance with Eq. HH-7 and Eq. HH-8. **Author Response:** As Equations 2 and 3 quantify historic modeled and measured methane, the oxidation factors applied would be the same in both equations and would cancel. We believe the application of

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		simplified expression of several variables from Equation HH-1 in 40 CFR §98.343. Specifically, Lo = MCF * DOC * DOC_F * F * (16/12), which, in the example from Appendix C, decomposes to Lo = 1 * 0.2 * 0.5 * 0.5 * (16/12) = 0.0666667, or 0.067. Two of these constituent variables are relevant for this consideration. The first, F (fraction by volume of methane in landfill gas), known from measurement, for precision in calculating the baseline, a default value of 50% (or 0.5) was used in the Appendix C example to determine Lo in calculating G_{CH4} while a 52% value was used ($H\%CH_4$) in Step 2 to calculate historic methane collection. Adjusting G_{CH4} using F = 52% in the calculation of Lo increases Lo to 0.06933 from 0.06667 and G_{CH4} by about 3.5% to 17,389 metric tons in 2014. Use of the default (i.e. measured) methane fraction by volume in landfill gas, F, value of 0.5 has the potential to	collection efficiencies is required to be the baseline collection efficiencies should be adjusted to compensate for the impact on ASCI. For instance, if the landfill switches from bulk MSW to ash residue landfill that results in the Lo for the ash component to go from the bulk MSW of 0.067 to ash residue of 0. The modeled generation rate would decline and the measured collected will likely also decline. The alternatives scenarios are that the modeled and measured (1) decline at the same rate and the ACSI remains the same (most likely scenario), (2) the measured decline is greater than the modeled generated decline and the ACSI declines or (3) the measured decline is less than the modeled generated decline and the ACSI increases. Under scenario 2 and 3, the calibrated collection efficiencies established during the three-year baseline shall be adjusted to compensate for the differences caused by the difference in modeled	the oxidation factor in Equation 1 will suffice. Accepted. --------------- As to Lo, I agree with the authors that it would require a significant change in the composition of waste for this issue to appear, but it is not outside the realm of possibility for a decade-plus project life. I agree with the author's reply that the baseline should be adjusted in response to a documented demonstrable change of some amount (some threshold should be specified) in waste composition, but footnote 6 (perhaps elsewhere as well) does not provide for such an adjustment, as it states "For these projects, equations 2-7 are calculated and validated once and are used for

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		understate the baseline and overstate additional and real emission reductions, and that potential is magnified when the impacts of the second constituent variable of Lo is considered. The second notable constituent variable of Lo, DOC (degradable organic carbon), represents the composition of waste in the landfill, and the EPA provides values for DOC in Table HH-1 of 40 CFR Part 98 Subpart HH. The default value of DOC = 0.20, as provided in Table HH-1 for bulk waste, was used in the Appendix C example. Table HH-1 also provides a value for bulk waste excluding inert material (including recyclable materials) and C&D waste of DOC = 0.31 that will serve as an upper bound for the value of DOC in this discussion. If DOC = 0.31, then Lo = 1 * .31 * .5 * .5 *(16/12) = 0.10333, a 55% increase in Lo over the default assumption. This change in DOC equates to a G_{CH4} value in 2014 of 25,917 metric	and measured generation rates so that the established ASCI performance remain the same as demonstrated by prior years ASCIs.	the duration of the project's crediting period." **Author Response:** Upon further consideration, we have concluded to not require adjustment of Lo for a significant change in baseline waste composition during a limited 10-year project crediting period. The rationale is that any change in waste composition, during the project's crediting period, is unlikely to significantly impact baseline methane generation during a short 10 year crediting period given that most landfills applying this methodology will have many years (sometimes decades) of organic waste in place that will continue to generate methane. A revised baseline would need to occur if/when a project would apply to renew its crediting period (which would happen at the

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		tons of methane generated, a 54% increase in G_{CH4} relative to using Lo = 0.067. Precise measurement of waste composition is unlikely to be available, and less-than-unlikely to be available on an annual basis. The consideration related to the DOC constituent variable in Lo is that waste composition can change over time while the baseline collection efficiency is calculated using a G_{CH4} value that is based on an assumed or estimated waste composition at a fixed point in time. Using a default DOC value of 0.20 is not unreasonable, assuming no waste composition studies are available, but the proposed protocol includes no provision for evaluating changes in waste composition much less offers a mechanism to adjust the baseline for changes in waste composition. A variety of factors could materially change the organic fraction of a waste stream during a project's 10-year crediting		expiration of the project's initial 10-year crediting period). Accepted. It seems worthwhile to point out for the authors' consideration that the protocol contains no guidelines regarding revisions of the baseline upon a project's application for a second 10-year crediting period. Clearly such guidance would not be needed for at least 10 years so they may well not be appropriate at this time, but at such time as they are necessary both modeling inputs to methane generation and treatment of methane collected through use of the automated collection system should be addressed.

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		period, including new recycling policies, increased/decreased recycling participation, adoption of waste disposal technology that is an alternative to landfill disposal (e.g., gasification, pyrolysis, composting, fermentation, etc.), among others. In the event that such factors increased the organic fraction of the waste stream after the 3-year pre-project baseline was established and during the crediting period of the project, the methane generation rate would be greater than in the baseline, and the project would be credited with emission reductions that occurred in part from this increase in methane generation rather than from emission reductions that resulted solely from increased collection system efficiency, thereby receiving credit for some non-additional emission reductions. While based on hypothetical future scenarios, changes in the waste composition present a material risk to		

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		additionality that is not currently addressed in the protocol. Landfill gas projects typically use a dynamic baseline since all the methane they collected and destroy would have been emitted except for the small fraction that would have been oxidized. This proposed protocol adopts a novel approach that provides credit for emission reductions above the level that standard practice would achieve but does so by adopting a baseline that is static with respect to waste composition. To be conservative and provide assurance that credited emission reductions are real and additional, the proposed protocol could be modified to include : A) an equation to calculate the Lo variable that specified use of the measured methane fraction in landfill gas, and provided guidance on selection of an appropriate value for DOC; B) a requirement to review policies and practices that could alter the waste composition		

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		during the project's crediting period (could include new recycling policies, evaluating growth in recyclables relative to growth in waste generation, etc.), C) provide a method to adjust the baseline collection efficiency in response to changes in waste composition that occurred during the crediting period.		
26	4.1	Equation 3 calculates the historic measured methane collected during the three years preceding installation of the automated collection system. There is no guidance regarding the variables $HLFG_{captured}$ and $H\%CH_4$ except the descriptions in Section 5 (see related comments on Section 5). It seems reasonable that these variables be subject to the same discount factor for weekly methane percentage measurements as in Equation 1, or that Equation 1 be used to determine the $HLFG_{captured}$ and	The requirements will be added to Section 5.2.6 by parameter. The historic methane data to be used is derived from the EPA GHG Reporting Program that requires the responsible party to follow Subpart HH Section 98.344 – Monitoring and QA/QC requirements, and Section 98.345 – Procedures for estimating missing data, and Section 98.346 – Data reporting requirements.	OK

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		H%CH_4 portion of this calculation for the three years preceding installation the automated collection system. This equation also assumes, without evidence or adjustment, that all methane captured was combusted, i.e. that combustion equipment was A) operating at all times gas flow measurements were being recorded and B) 100% efficient.		
27	4.1	Equation 11, footnote 6 is somewhat misleading in that it says, "Projects deploying an automated collection system as a stand-alone project activity, shall use the $ICH_{4combusted}$ parameter in Equation 11." since a stand-alone Automated Collection System project will use Equation 11 first with parameter $CH_{4combusted}$ to calculate the CH_{4total} for use in Equation 9, and then use $ICH_{4combusted}$ from Equation 10 the second time Equation 11 is used.	The description of $CH4_{total}$ in Equation 9 states: Total methane combusted (metric tons) – as calculated in Equation 11; projects shall use the $CH_{4combusted}$ parameter when quantifying Equation 11 for use as the CH_{4total} parameter in Equation 9. Footnote 6 (now footnote 7) clarifies that Equation when applying equation 11, ICH4 combusted must be used for stand-alone ACS projects.	OK

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28	5.2.3	The proposed protocol requires three years of pre-project measurements of gas flow and methane percentage to establish baseline collection efficiency. Are these requirements in Section 5.2.3 intended to apply to pre-project measurement devices as well or only to measurement devices using after the start date of the project? If Section 5.2.3 requirements don't apply to pre-project measurement devices, then what calibration, maintenance, and other requirements apply to pre-project measurement devices?	These requirements only apply to devices used after the start date. Per Section 3.1, project proponents must submit a method for quantifying pre-project emission discounts to ACR for approval	OK
29	5.2.4	Section 5.2.4 references pipeline injection of landfill gas and requires evidence of the quantity injected. Some pipelines are privately owned and other beneficial use projects may not involve a utility company; therefore, I recommend additional requirements specifying evidence that either a utility-owned meter	Footnote added to section 5.2.4 per reviewer comments.	OK

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		is used or that these quantity measurements be provided from a gas flow meter subject to the same calibration, testing, and monitoring requirements as project gas flow meters.		
30	5.2.4	Section 5.2.4 does not specify the minimum frequency for recording destruction device operating measurements that would be considered "continuous" monitoring. Common minimum recording frequency for thermocouples is once per hour.	Footnote added to section 5.2.4 per reviewer comments.	OK
31	5.2.6	Section 5.2.6 parameter $LFG_{captured}$ should be units of "scf" rather than the stated "scfm".	Revised per reviewer comment	OK
32	5.2.6	Section 5.2.6 parameter $HLFG_{captured}$ specifies a minimum measurement frequency of once per day. What if the only pre-project measurements available are less frequent than once per day? Landfill gas flow varies	For parameter $HLFG_{captured}$, the reference to Source of Data shall be changed to: Parameter provided by the responsible party to the EPA GHG Reporting Program in accordance with the provisions of US EPA 40 CFR Part 98: Subpart HH.	OK

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		throughout the day, sometimes by 10% or more, and totalizing flow meters or other continuous flow meters are commonly used and comparatively inexpensive. Typically, a discount factor is applied when less-than-continuous measurements are taken, but in this case the historical gas flow parameter is used to determine baseline collection efficiency. So, the risk to additionality is that historical gas flow will be understated and consequently that baseline collection efficiency will be understated. A conservative approach for historical gas flow measurements taken less frequently than continuously would be to apply a penalty factor that increased historical gas flow by, say, 10% to ensure that unmeasured variation in gas flow did not understate historical collection efficiency and, as a result, overstate the increase in collection efficiency attributable	The reference to Measurement Frequency shall be changed to "In accordance with requirements of US EPA 40 CFR Part 98: Subpart HH."	

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		to the Automated Collection System.		
33	Definitions	I recommend the defined term “Automated collection system that increases landfill gas collection efficiency” be shortened to simply “Automated Collection System” for referential clarity. Definition text should reference “Gas Control and Collection System” instead of simply “gas collection system”. Is it necessary in the definition of an “Automated Collection System“ to include the stipulation that the system result in an “incremental increase in the aggregate methane volume” since a system that did not achieve this result would not have incremental emission reductions that qualified as additional?	Definition revised per reviewer comment	OK
34	Appendix C	The example Step 1, p. 51, describes a value for “k” as “0.038, which corresponds to a landfill existing in climate that receives 10 to 40 inches of precipitation	The reference shall be changed to “20 to 40 inches of precipitation” to be accurate and consistent.	OK

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		annually (for this example).” But the cited Table HH-1 (40 CFR Part 98 Subpart HH) stipulates k = 0.02 with less than 20 inches of precipitation, and k = 0.038 for between 20 and 40 inches. It appears that the EPA definitions of the value “k” are intended to be used, but this incongruity could become a source of confusion.		
35	Appendix C	The example ends at Step 7 (actually the second “Step 7”) which is the most convoluted part of the calculations since there is a precursor step involving Equation 11 that is not shown, and then a couple steps after Step 7 (one of which again requires Equation 11, but with a different input). Elaborating on the example in Appendix C to demonstrate these final steps necessary to calculate creditable emission reductions for a given reporting year would increase clarity for projects and verifiers given that, at present, there is a not-entirely-clear use of	Numbering for steps was corrected. The description includes the following explanatory text that clarifies the reviewer comments: *“Calculate the incremental efficiency improvement that is attributable to the automated collection system in 2017. To do this,* $CH_{4combusted}$ *is calculated in accordance with Equation 1 and* CH_{4total} *is calculated in accordance with Equation 11. In this example and for simplicity, assume that* $CH_{4combusted}$ *is calculated appropriately and is used to calculate* CH_{4total} *in Equation 11*	OK

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		Equation 11 multiple times with different inputs in this summarized step.	*with the resulting CH_{4total} set to 13,478 metric tons. Also, assume that G_{CH4} is calculated per Equation 2 for 2017 and is set equal to 18,395 metric tons."*	
36	Appendix C	The example would be greatly enhanced if it were more complete and showed the steps for each of the three pre-project years and concluded with Emission Reductions from Equation 16.	For brevity and lack of repetition, we have not replicated all calculations for each year (the calculations are performed the same way for each year). Throughout the explanatory text of the case study (in the introduction and in text describing each equation), we indicate the specific steps required as well as the example that is provided. Here is example language that we have included to ensure clarity in the case study: *"The calculation for modeled methane generation in T = 2014 is shown below. The same calculation is performed for each of the subsequent years (2015 and 2016) to establish the baseline for use of manual gas collection. The*	OK, but I still recommend carrying the example through to completion actual emission reductions **Author Response:** Worked equations through to emission reductions have been provided. Accepted. Thank you, I think this helps add clarity and will prevent any potential misinterpretations.

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			same calculation is used for 2017 and 2018 to establish the increment for use of the automated collection system."	
37	General	There is no consideration in the proposed protocol for a circumstance in which the incremental emission reductions are negative. While seemingly unlikely, such an event is not entirely outside the realm of possibility. Some pathways to such a result include but are not limited to: 1) management of the automated collection system to maximize methane percentage or otherwise optimize the composition of collected gas for a specific end use or gas treatment process for a specific beneficial use; 2) a change in the composition of landfilled waste that reduced the degradable organic carbon (DOC) content of landfilled waste (e.g., increased waste diversion for composting or biofuels production, etc.); or 3) changes in weather patterns, such	No application for carbon credits would be made if incremental emissions reductions are negative. In each of the prospective pathways listed, the ACS would still outperform a manual system. Adjustments to the calibrated collection efficiencies established during the three-year baseline would be required to compensate for these prospective pathways.	As previously mentioned, there is no provision allowing for adjustment of the baseline during the crediting period. The event of negative emissions reductions is made possible by this novel approach, although not probable. In some project types, such an occurrence ends the project, so it seems worth addressing. It could be submitted to ACR for review and determination, counted as a zero-credit year, be subject to a baseline revision method, or some other alternative treatment. **Author Response:** Footnote 5 has been modified as follows: In the event that these equations demonstrate zero or less than zero emissions reductions during a reporting

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		as drought or abnormally cool seasons, that reduce gas generation relative to the pre-project baseline years. Offsets are typically issued with a vintage year, but if incremental emission reductions for one year of a multi-year verification are negative, how are those negative emission reductions treated? How would negative emission reductions be handled in the event they occurred during a one-year verification?		period, the project shall apply zero credits to this time period. Accepted. Thank you.
38	General	The proposed protocol's use of a modeled baseline and calibrations/updates to baseline collection efficiency as the landfill area under different types of cover presents a neat picture that implicitly assumes the timing of landfill cover area changes lines up with annual modeled gas generation. This is unlikely to be the case in practice. Some guidance as to the proper	Installation of various covers over landfill areas typically occur over periods of months. These cover projects should be able to be captured quantitatively on a quarterly basis and the landfill area quantities updated on this basis.	Landfill surface area represented in quarter years is reasonable; a mention in the protocol would provide guidance and alleviate any potential competing interpretations between verifiers and project developers. **Author Response:** Per section 9.C of the ACR Standard,

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		handling of overlapping timeframes (e.g., 10,000 sq. meters transitioned from cover A3 to cover A4 halfway through the reporting year) would be useful. If percentages or fractions are to be used should they be based on number of days, months, quarters, half-years, etc.?		projects are able to verify at frequencies that are, at maximum, no more than 5 years in length. Projects are free to verify on any interval, including quarterly, per the ACR Standard. As a matter of practice, requirements from the ACR Standard are not repeated in individual methodologies. **Reviewer:** The previous comment was not referring to the frequency of verification, but rather an endorsement of the authors' suggestion that cover areas be quantified on a quarterly basis (or more frequently) to provide as accurate a determination of collection efficiency as possible. One approach, for example, for 1000 square meters that were classified under A2 cover at the start of the year but transitioned to A3 cover during the first quarter

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				would be divided such that 250/1000 square meters counted as A2 cover and 750 square meters counted as A3 for the year. An alternative more conservative approach would be to consider all landfill area to have been in the cover classification at which the landfill area ended the reporting year to ensure the higher of the collection efficiencies from Table HH-3 was applied for the full year. Either approach or something equivalently conservative is acceptable to me, so long as the timing aspect of cover area quantification is explicitly addressed in the protocol text. **Author Response.** Thank you for the clarification. The following language was added to the instructions in Equation 5 and 8:

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				"The cover system in place in each area at the end of the year shall apply to the entire year being quantified." Accepted