Three-State Air Quality Study
Response to Comments by 3SAQS Cooperators
Document: Draft Technical Memorandum: 3SAQS Methane Emission Inventory Recommendations - 3SAQS_CH4_Emissions_Memo_v3.docx
Response-to-Comments Dated February 18, 2014

#	From	Date	Draft CH4 Inventory Memo Comment	Response for Final Memo
1	CDPHE – Daniel Bon	1/22/14	How is ethane currently handled? As proposed, our current reg. 7 title will change to include "hydrocarbon" instead of just "VOC". This means that in the future, we'll likely be regulating both ethane and methane in Colorado. We know that O&G is a significant source (similar mixing ratios to propane in Erie, CO for example). However ethane is excluded from the definition of "VOC". There will be several measurements of ethane during the Discover AQ/FRAPPE field study this summer, but honestly, it is often overlooked both in measurement and in inventories. Are you already including ethane in the inventory, or is that a future project?	Ethane (ETHA) is already included as en explicit species in the versions of the Carbon Bond mechanisms that we're using for the 3SAQS photochemical modeling (CB05 in Base 2008 and CB6r2 in Base 2011). Methane and ethane are both added into the VOC inventory through a ROG-to-TOG conversion in the chemical speciation step of emissions processing sequence. ROG-to-TOG converts inventory VOC (aka ROG) to total organic gases (TOG) through a multiplier that basically adds the methane and ethane mass back into the inventory VOC. The ROG-to-TOG multipliers are coupled to speciation profiles; both are generated from the same speciation profile database.
2	CDPHE – Dale Wells	1/23/14	It seems to me that the same activity factors that are required for Livestock Waste and Enteric Fermentation are in the ammonia inventories (2009 and 2011 NEI and any improvements by WESTJUMP or us). The task for these two items reduces to the fairly trivial one of using emission factors for methane instead of ammonia.	The livestock activity used for the 2008 and 2011 NEI (i.e. animal population), are embedded in the Carnegie Mellon University (CMU) NH3 emissions model. The version of the CMU model used for these inventories includes county-total animal population numbers from the 2007 Census of Agriculture. If the animal population inventory used the CMU model can be mapped easily to the animal type/regional emissions factors for methane listed in the AP-42 GHG guidance (Table 14.4-1 in http://www.epa.gov/ttn/chief/ap42/ch14/final/c14s0

				4.pdf), then this could be a fairly easy process. Developing the methane inventory will not be straightforward, however, because the 2007 county-level animal population inventory is by animal (e.g. dairy cattle, beef cattle) and manure management process (e.g. confinement, storage, land application, etc.) and does not contain information on the animal type (e.g. beef cattle-mature cows, dairy cattle-replacements 0-12 months). While we can easily obtain a total number of animal head per county by summing across the management processes, the 2007 inventory does not provide information on the distribution of the types of animals in the inventory. As seen in Table 14.4-1 above, the methane emissions factors are quite variable by animal type. Additional research is needed to determine the county animal type distribution in the 2007 livestock inventory before we can use these data for developing an enteric formation methane inventory.
3	CDPHE – Kevin Briggs	1/29/14	Colorado is presently proposing a GHG EI which of course includes estimated statewide methane emissions (see http://www.colorado.gov/cs/Satellite/CDPHE-AP/CBON/1251594825385). Colorado's methane inventory for GHG is based on the EPA State Inventory Tool (SIT) (see http://www.epa.gov/statelocalclimate/resources/tool.html). For Colorado, the SIT emission inventory was mostly developed using defaults in the SIT framework. The SIT framework is used to develop statewide GHG/methane emissions. I would consider the SIT methane inventory as a first cut approximation for Colorado.	The county-level NEI/APEN inventories are definitely more appeal from the regional modeling standpoint than the state-level SIT inventory. While we can develop state → grid cell surrogates to adapt the SIT inventory for use in regional modeling, if, as you suggest, the CO SIT inventory is based on defaults, my recommendation is to first pursue the approach in the previous comment to develop an enteric fermentation methane inventory from the bottom up. You're correct that we can always fall back on the SIT inventory to gapfill sources that missing in the county-based inventories.

			As suggested in Zac's memo, most of the methane emissions used thus far for modeling are from source categories that contain VOCs, which are then speciated to TOGs, and methane emissions directly reported to the emission inventory reporting systems for the respective states. In Colorado's case, agricultural methane is not directly reported to our APEN system. So, as a suggestion, you could use the TOG inventory produced by SMOKE as the basis for the methane inventory for those VOC sources that report to the NEI/APEN system. I would then use the SIT inventory to fill in the missing and incomplete methane source categories that NEI/APEN do not have. For example, you could use the enteric fermentation emission inventory estimate from SIT to gapfill what the NEI/APEN systems do not have. On the flip side, I'm not sure the SIT inventories encompass all the developments in the O&G EI that various groups like the WRAP/ENVIRON/APCD have done which would affect the O&G methane estimates.	
4	CDPHE – Kevin Briggs	1/29/14	The reason for using the SMOKE produced methane inventory as the base starting point is that the VOC/methane emissions in the NEI/APEN system would be much more source specific and up to date then the default SIT inventory. In addition, for modeling purposes, the largest sources would be spatially and temporally allocated.	We agree, county-based inventories are a more appealing starting point than the state-level SIT inventory.

5	CDPHE – Kevin Briggs	1/29/14	One of the bigger challenges for modeling would be developing spatial and temporal surrogates to allocate emissions in SMOKE from the SIT inventory. For agricultural methane, the same surrogate used to distribute ammonia emissions could be used to distribute methane emissions.	You are correct, although we can create state→ grid cell surrogates using the same underlying shapefile data that we used for the county-level surrogates.
6	CDPHE – Kevin Briggs	1/29/14	Hopefully, by blending the SMOKE/SIT methane inventories, Colorado/Utah/Wyoming would have complete methane inventories for modeling as well as more developed GHG/methane emission inventories.	This approach is reasonable and while not standard, is something that could be accomplished with SMOKE. We will need to pay close attention to avoid double counting any sources.
7	CDPHE – Kevin Briggs	1/29/14	A couple other comments: Does ENVIRON have or propose to incorporate the methane module into CAMx?	CAMx version 6 includes a version of the Carbon Bond mechanism (CB6r2) with a methane emissions species (ECH4) that is "active" in the photochemistry.
8	CDPHE – Kevin Briggs	1/29/14	Recognizing that methane in the modeling is being used more as a tracer rather than an ozone producer, what is the computational hit does the methane module have in CMAQ and can it be employed for a year-long simulation?	While methane is slow to react and can be considered a tracer, it is an ozone precursor in this version of CAMx. We will use CAMx version 6 for the 2011-based 3SAQS modeling. There is only one methane oxidation reaction and with the addition of only one new species (ECH4), the computational burden of adding this species should be small. We don't have an exact number at this time.
9	CDPHE – Daniel Bon	2/3/14	Just wanted to make sure this was in the hopper. We (Colorado) just issued the draft of our first greenhouse gas inventory. It's based on the EPA State Inventory Tool and includes model output (with some appropriate adjustments) for methane by sector. Might be useful as a starting point for comparison with the 3SAQS.	Noted. Thank you for letting us know