To: Richard Tsai
From: Johnston and Courtney Hall (NRC)
Re: GHG modeling for the Organics Report

Thank you for sharing the WARM model input files. We were able to spend some time reviewing the EPA WARM documentation and playing with the model, which is surprisingly easy to run. In doing so, we found what we think are several places where the parameters chosen for the report are incorrect, or do not properly reflect local conditions. These have a substantial effect on GHG calculations.

In a separate Excel file (NRC_results_summary) are summaries of the model runs based on different parameter choices. The leftmost column contains scenario numbers used in this exercise. In each case the baseline (0 emissions) is raw waste at the curb, so to speak. According to the EPA documentation, some downstream processes produce CO_2 and are assigned positive values. Others like sequestration in landfills (and composting), or replacing fossil fuels (e.g. burning methane instead of natural gas) are assigned negative values. These individual factors are added up to produce the CO_2 emissions. That's how negative values are generated. It turns out that sequestration is a big part of our story.

Issue 1: Double-counting of the digestate composting

In the report, 75% of the digestate is assumed to be composted and 7000 tons is added to the composted weight. The GHG emissions are summed up from a two-step process (AD and composting, Scenario A in the Excel file, tab 1). When the anaerobic digestion (AD) option is chosen, however, the model assumes that the digestate is either aerobically composted and then spread onto soil (the "cured" option) or spread directly onto the spoil ("uncured). There is no option that we saw to grab the digestate and do something else with it. Consequently, running the model as a two-step process double-counts the composting of 7000 ton of material. In the Excel file, Scenario B does a two-step calculation with 14124 tons to AD and 11352 tons to composting. As can be seen, the GHG savings are smaller, reflecting the smaller tonnage sequestered in the soil by not double-counting the digestate. We don't believe the two-step process is correct and we've not used it below.

In Scenario C the model was set up as a one-step process using the same numbers, which gives the same result as Scenario B. Consequently we ran WARM in this mode. In these calculations the parameters used in the report were used.

Issue 2: Use of national rather than local parameters

In the report files, national averages were used for electricity-related emission pathways, emissions from landfilling, landfill gas recovery practices, and degradation factors. Options are available to use for California electricity-related emission factors, landfill gas recovery (which the Yolo Co website claims is being done), following California regulations concerning the efficiency of gas recovery, using the gas for power or flaring, and choosing a degradation factor based on local climate (rainfall). When these local factors are used, landfills look a lot better with regards to GHGs because methane emissions are controlled by LFG recovery. Compare Scenarios 1 vs. 2 and 3, 4 vs. 5 and 6, etc. in Column H, Tab 2. Flaring the captured gas is less attractive because fossil fuels are not displaced by power production. All of these parameters are available as buttons in WARM. It is not clear why Clements didn't use these settings. We don't see a reason not to use them.

Issue 3: Using"mixed organics" instead of "yard trimmings" as a feedstock.

The Davis feedstock is called "mixed organics" in the report, which is OK in that context. However, the EPA definition of this term in the model is quite different. In the EPA documentation, mixed organics are

53% food waste and 47% yard trimmings. Davis waste has <5% food waste; it is almost all yard waste. In the WARM documentation, EPA's yard trimmings is 50% grass, 25% leaves, and 25% tree and brush trimmings, which is a much better description of the Davis waste.

Moving from "mixed organics" to "yard trimmings" in WARM makes landfills look even better. Yard trimming are not assumed to degrade much in proper landfills so the calculated amount of carbon sequestered is large. Compare columns H vs. L. In fact, landfilling goes from a GHG emitter to a GHG sink when the waste input is changed. AD also becomes less appealing. Compare Scenarios 8 vs. 11 in column I. Our best interpretation of this is that in anaerobic digesters there is a greater breakdown of organics compared to composting, so the sequestration credit is smaller for digesters. The credit gained by burning digester gas (replacing fossil fuels) is not large enough to compensate for the smaller amount of sequestration, so the net result favors composting with regards to GHGs.

When using yard trimmings as the waste and getting a large sequestration credit in landfills, performing either composting or AD instead results in lesser carbon sequestration. Consequently compared to landfilling there is a net increase in emissions by doing something different. See Scenarios 2/3, 8/9, 11/12, column N; compare to column J values.

We did run a 5% food waste input series. For these we multiplied the gross tonnages by 5% and put that into the food waste row of the input file. See Columns P-R. Landfill sequestration decreases a bit (less negative values) because food waste degrades more readily than yard trimmings; AD emissions get more negative because of increased gas production. The net emissions decline (compare columns N and R).

Issue 4: Using the latest version of WARM

The report is based on version 14 of WARM which was the latest version available at the time Clements did its calculations (no complaint there). Version 15 is available now and is equally easy to use if it is desired to update the numbers. For our purposes, the main difference between the two versions is use of updated emission factors. Comparing versions 14 and 15 results for three scenarios (lines 28-30, tab 2) show minor changes in the calculated results.

Next Steps

We had limited time to investigate these issues so the results presented here should be reviewed by Clements. We'd like to present this, plus Clements' comments to the whole NRC at the next meeting.

The bottom line for the calculation sis that net emissions from AD are about 20% larger than those from composting (for instance, compare R19 with R24). The observation that doing anything other than landfilling has a negative effect on GHG emissions appears to run counter to the goals of SB 1383, which is worrisome. Nevertheless, there are secondary benefits of composting that may reduce GHG emissions that are not captured in WARM. Some offsets to GHG emissions are built into the model where the land-applied digestate reduces the demand for synthetic fertilizer. However, it is not clear that all GHG emissions associated with synthetic fertilizer production (including transportation of the raw materials) are captured in the model, and appear to be most likely omitted. Additionally, application of compost to soils results in healthier soils, including improved water-holding capacity. This results in a decreased demand for water, thus conserving a vital resource, as well as avoided energy costs for the associated pumping and treatment of water.