

**COMMENTS SUBMITTED RE: MANURE TREATMENT TECHNOLOGIES
EXPERT PANEL REPORT (MARCH 31, 2016 VERSION), DURING INITIAL 30-
DAY COMMENT PERIOD**

Source	Text of comment	Label(s)
	Note: Comments are verbatim but may be split into separate rows. Verbal comments from participants during April 14 th webinar or April 21 st Agriculture Workgroup are not summarized here when those same individuals or organizations provided written comments that include their verbal comments.	
	Note: Complete responses and specific revisions are still under discussion. A written summary of these responses and proposed revisions will be provided to the AgWG in advance of their June call. Comments are not listed in any particular order in this document.	
Angstadt	Manure Treatment Technology – Requests 1. Is the manure application process (with bmps) more clearly diagramed in 6.0 beta SB documentation - Figure 3. Manure Application Processes (4.1 ESTIMATING MANURE AVAILABLE IN A COUNTY) than in MTT webinar - Figure B.2 – Conceptual diagram of manure nutrients in the Phase 5.3.2 Watershed Model (slide 10)?	Edit
Angstadt	2. SB 6.0 beta documentation – Table 10 – Dairy manure ammonia = 17.5% of TN. Should MTT efficiency be calculated against total N or only ammonia percentage of TN?	Modeling
Angstadt	3. Could the EOF load reduction from MTT bmp versus manure application be delineation? · MTT webinar (slide 71) - Example • MTT6: 1 ton Dairy = 84 lbs TN @ 95% = 4 lbs TN · SB with bmps (SB documentation) without MTT – o Table 14: Barnyard ammonia volatilization = 0.65 o Table 17: In-field ammonia volatilization = 0.65 o Table 11: Mineralization fraction = 35% · Could MTT increase available application N?	Modeling
Angstadt	4. There is no disputing that volatilizing ammonia N reduces N for manure applications, but ammonia deposition is greatly increased. USDA ARS, Peter Kleinman, has research (MD) that the majority of the ammonia volatilization from poultry production areas returns nearby as dry deposition. Is promoting increased ammonia emissions good environmental policy?	Air
Angstadt	5. How will the 6.0 Airshed Model be adjusted for each MTT bmp reported? Thanks, Bill Angstadt Angstadt Consulting, Inc. P.O. Box 377 Reading, PA 19607 610-334-3390 angstadtconsult@aol.com	Air
USDA ARS	Jeremy - my question (or request) to the MTT is to have the Panel see if they could break down the NVE into what would be likely proportion as N ₂ (a virtually inert gas), N ₂ O (a potent greenhouse gas) .. and NH ₃ (a nutrient). This large difference in environmental impacts would be of importance to the Bay Program. Even if such a subdivision of the NVE would be done just qualitatively for the different MTTs (e.g., only estimate what proportion is N ₂ (the least environmental impact loss)) such information would be much more useful in the Bay Model than the current combined NVE.	Air

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	(Jack Meisinger at April AgWVG; included here since full written comments were not provided separately via email)	
CBC	<p>Dear Jason and David:</p> <p>Thank you for the opportunity to comment on the Expert Panel's report addressing Manure Treatment Technologies. With full respect to timeline and by way of this e-mail, we are also sharing our comments (attached) with the Source Sector Workgroup and strategic members of the Modeling Workgroup who interface with the Source Sector Workgroup. If there are others who should be receiving these comments, we trust that you will help us to share the attachment to them.</p> <p>Thank you for your hard work, Ann</p>	Air
CBC	<p>Thank you for you work to determine how best to credit manure treatment technology in the model. We appreciate this opportunity to offer input on the Expert Panel's draft report.</p> <p>The Chesapeake Bay Program Expert Panel has done an incredibly thorough job analyzing the most common manure treatments used in the watershed and has recommended three credit types: a default credit when only the manure type and technology type are known; a defined credit when manure type and pertinent operating conditions of the treatment technology are known; and a data driven credit for when actual monitoring data for a technology is available. This approach makes sense.</p> <p>We take issue with only one part of the analysis which is the default crediting of thermochemical and composting systems with nitrogen reductions for volatilization of nitrogen.</p>	
CBC	<p>The CBC has long experience with manure to energy systems, having organized a Manure-to-Energy Summit in 2011, and having served on the Farm Manure to Energy Initiative that field tested and monitored emissions of several farm scale thermochemical technologies. In our experience some thermochemical systems volatilize nitrogen into N₂ (nitrogen) gas, which we understand is not environmentally harmful and does not deposit itself back onto the earth. These types of systems should receive a credit for nitrogen reductions.</p> <p>Other thermochemical systems and all composting methods volatilize manure nitrogen into NH₃ (ammonia) or NO_x (nitrogen oxide) emissions which are deposited back to the earth as pollutants that run into the Bay, or are deposited directly to water bodies. These types of systems should not be credited for producing nitrogen reductions.</p> <p>Awarding nitrogen reduction credits for simply changing the form of pollution from land based pollution into to air pollution should not be approved because it does not reflect a real overall nitrogen reduction. The report acknowledges this issue where it explains nutrient transformations of thermochemical systems on page 31 and notes that "the deposition fate of ammonia and NO_x may be of interest to other technical groups and/or future iterations of the model."</p> <p>We strongly suggest that this issue be addressed in this iteration of the model, or the Bay Program crediting methodology may unintentionally incentivize technologies that create environmentally harmful nitrogen</p>	Air

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	emissions. We suggest that before the crediting methodology proposed by this expert panel is approved, either this issue be sent to the modeling workgroup to develop a more refined methodology for only crediting manure treatment systems for the N ₂ that is produced, and not for their NH ₃ or NO _x emissions. As an alternative, The Bay Program could decline to grant a default efficiency for nitrogen volatilization, but instead could offer the data driven transfer efficiency for those systems that are monitored or can otherwise demonstrate which portion of manure nitrogen is being converted to N ₂ .	
CBC	<p>In addition, although this issue is outside the scope of the work of this expert panel, we ask that the Modeling Workgroup address a related question: If manure treatment technology is used to treat a farm's manure, would the model assume that replacement fertilizer is always applied according to a Nutrient Management Plan? How will this be handled where Nutrient Management Plans are not required?</p> <p>Please do not hesitate to contact us if you need further information. Our subject matter expert on staff, Bevin Buchheister can be reached at bevinb@chesbay.us or 410-263-3420.</p>	Misc-Field application
VA DCR	<p>A few comments and questions on the report. I did a word document with track changes. I notated page numbers for each comment to assist in finding the excerpts. Document as a whole shows a lot of hard work and energy was devoted to it by those involved. Thanks to you and the group.</p> <p>Bobby Long Nutrient Management Coordinator, Animal Waste P.O. Box 130 Phenix, VA 23959 434-547-8172 bobby.long@dcr.virginia.gov</p>	Edits
CBF	<p>Hey Jeremy – Attached please find CBF's comments on the manure treatment expert panel draft report. If you have any questions, please let me know. Thanks! Hope you are well. Beth</p> <p>*****</p> <p>Beth L. McGee, Ph.D. Senior Regional Water Quality Scientist Chesapeake Bay Foundation 6 Herndon Avenue Annapolis, MD 21403 ph: 410-268-8816</p>	
CBF	<p>First, our sincere thanks to the Expert Panel for their work on the draft document. The scientific foundation of the Chesapeake Bay Program rests largely on the willingness of technical experts to engage in the process and help inform our decision-making tools. We very much appreciate their time and expertise. The draft document was comprehensive in its inclusion and discussion of various manure treatment technologies. We do, however, have some questions about how the various recommended efficiencies would actually be incorporated into the Chesapeake Bay Watershed</p>	BMP Verification

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	<p>Model/Scenario Builder and also, specifically, with how nitrogen emissions to the atmosphere will be handled. We request that these details be addressed and included in the final version of the report.</p> <p>Show how the efficiencies will be incorporated into Scenario Builder. On page 14, it is stated there are three ways that manure treatment technologies could be incorporated into Chesapeake Bay Program modeling tools. For clarity, we recommend that Figure TT.3 be modified to explicitly include these various options. Furthermore, we also recommend that the default and defined efficiencies recommended for the various technologies also refer back to this figure and that the text indicate where in the process these efficiencies will be applied. As it stands, we believe the transfer efficiencies make sense (except as noted below for air emissions), but their application as best management practice (BMP) efficiencies is unclear.</p> <p>Include recommendations for how the technologies will be tracked, reported, and verified. As stated in the July 2014 version of the “Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model,” the panel should also provide a description of how the practice will tracked, reported, and verified by the jurisdictions. This is particularly important given that some of the treatment technology efficiencies rely on the assumption that nutrients will be moved to a “flow path more likely to be used off-farm.” For example, as noted on page 72, “Nutrients in both the effluent and sludge streams are utilized in land application; however the smaller volume and mass of the sludge stream allows it to be transported more economically...making sludge more likely to be utilized off-farm.” The separation efficiencies should not be applied unless it can be demonstrated that the sludge is indeed being transported. Another example is the efficiencies for liquid-solid separators that are also dependent on the assumption of off-farm transport. Overall, the panel needs to describe the tracking and verification for all the treatment technologies to ensure the benefits are appropriately credited.</p>	
CBF	<p>Nitrogen losses to the atmosphere need to be characterized and addressed. We echo the comments made by the Chesapeake Bay Commission (CBC), who questioned the default crediting of thermochemical and composting systems with nitrogen reductions for volatilization of nitrogen. In this context, benefits should only accrue to technologies where the emissions are demonstrated to be nitrogen (N₂) gas. Other forms of nitrogen released by these technologies, e.g., ammonia and NO_x, can have impacts on water quality and should not be ignored. The CBC presents a couple of options for addressing this concern and we request that this question be resolved before crediting alternate treatment technologies. In addition, if the form of nitrogen that is volatilized is not nitrogen gas, there needs to be a discussion of how this form of nitrogen will be captured in the Chesapeake Bay Watershed Model.</p>	Air
CBF	<p>Specific comments: Table C1. Is there a typo on the third line of the table? The NVE and NSE don't add up to 100. Table AD.3. We do not see support for the efficiencies attributed to the covered lagoon. Please provide more information on the justification for this</p>	Edits

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	estimate. In addition, as noted above, for this practice to be credited the ultimate fate of the sludge needs to be tracked and reported.	
VA DEQ	<p>Page 3 and 4 indicate a list of MTT BMPs 1 to 19 with varying degrees of TN reductions and no TP reduction. And indicates these are currently available for reporting. However, the NEIEN Appendix A (NEIEN NPS BMP CBP Data Flow_P6AppendixA 15_4_031416.xlsx) does not list any of the MTT BMPs. Instead it lists 20 other BMPs applied to the same simulated loadings source including the 8 BMPs mapped to the AWMS scenario builder BMP. This list of MTT BMPs 1 to 19 are based on thermochemical and composting technologies and is silent on the anaerobic digestion and other technologies which do have TN and TP reductions listed within the report. This is confusing as the report indicates other technologies and efficiencies that are not included in the list of reportable MTTs. It looks as if the list of available MTT BMPs should be expanded to include all where a NVE, NSE, or a PSE has been determined and beyond just thermochemical and composting methods. Also on page 4 the paragraph at the bottom of the table seems to contradict the table in that the paragraph says MTTs do not remove nutrients from manure but the table list TN removal numbers? Either they do remove TN as the table indicates or they do not as the paragraph would seem to indicate.</p>	Reporting & Modeling
VA DEQ	<p>It is also not abundantly clear as to if the proposed MTT BMPs are to replace the existing 20 BMPs actually listed in the NEIEN documentation and eligible to report or in addition to the following NEIEN Appendix A listed BMPs:</p> <ul style="list-style-type: none"> • SB short name BarnRunoffCont: <ul style="list-style-type: none"> ○ Barnyard Runoff Control RI, ○ Barnyard Runoff Control; • SB short name LoafLot: Loafing Lot Management System; • SB short name DairyPrecFeed: Feed Management; • SB short name LitAmend: Amendments for the Treatment of Agricultural Wastes; • SB short name Manure Transport: Manure Transport; • SB short name: MortlityComp: <ul style="list-style-type: none"> ○ Animal Compost Structure RI, ○ Animal Mortality Facility, ○ Composter Facilities, ○ Composting Facilities, Dead Bird Composting Facility; • SB short name AWMS: <ul style="list-style-type: none"> ○ Animal Waste Management Systems, ○ Dry Waste Storage Structure RI, ○ Waste Control Facilities, ○ Waste Storage Facility, Waste Storage Pond, ○ Waste Storage Facility, Waste Treatment – by animal type i.e. Waste Treatment – Beef, and Waste Treatment Lagoon. 	Reporting & modeling
VA DEQ	<p>It seems as if some of the proposed technologies cross over into the existing list of BMPs and previously established reduction potentials. Please be clear as whether the proposed technologies are a replacement of the 20 listed BMPs or not. And if they are replacing one or more clearly describe those being replaced. For example Wet Chemical Treatments of manures seems very close to Amendments for the Treatment of Agricultural Wastes BMP.</p>	Reporting & modeling

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VA DEQ	The report reads like the historical BMPs (20 listed above) would be reported as level 1 MTT BMPs and default to MTT 1 or MTT 7 when insufficient information is available for reporting as in we only know some kind of AWMS was implemented but we do not know the animal type or amounts of manure treated/managed. Or is it that these BMPs are reported as they have always been and MTT BMPs are reported in addition? If so the NEIEN appendix needs to have the complete listing of MTT BMPs (including anaerobic digestion and other technologies) and required reporting elements included. This would include the currently listed BMPs as well. And the report should make this very clear.	Reporting & modeling
VA DEQ	Page 117 bullet 2 indicating the reporting of sampling information annually with the progress run BMP data via NEIEN needs re-thinking as there currently in Virginia does not exist the mechanism to collect the data and report it in a way it could be provided to CBP. Additionally, the NEIEN schema is not currently configured to accept this kind of data. There should be a simpler and less cumbersome method of reporting such data if it is actually or becomes available than via NEIEN.	Tracking and reporting
VA DEQ	Page 118 has 6 bulleted items. Currently VA might be able to do the first 3 but do not see a way to get the latter 3 items. End user when manure brokers are involved creates a significant impediment to following this item. Brokers collect and comingle wastes from multiple farm operations and then carry that mixture to land application sites. True cradle to grave is not possible in such a scenario. Analysis of manures is not currently included in CBP reporting metrics within VA. Considerable effort will be needed to facilitate such and VA does not see this data if collected as being NEIEN reportable. Prefer a more straight-forward or less complicated way to report manure analysis than NEIEN if the data is even available to report.	Tracking and reporting
VA DEQ	It seems there is a mixing of the manure transport BMP with manure transported after treatment by one or more of these technologies. There should be a way to report manure transported when there is no idea as to additional treatments verses those that are transported after treatment via the technologies listed in the document.	Tracking and reporting
VA DEQ	Did not see an appendix showing how this panel's recommendations comport with the BMP Protocol.	Misc
VA DEQ	It would seem that the currently acceptable BMPs tied to existing Scenario Builder short names need to be explained in relation to the new proposed BMPs and if there is any interaction or if these are all separate BMP or if any are mutually exclusive of and or replacing each other.	Tracking and reporting
VA DEQ	Section 4 Thermochemical Conversion Processes has a table listing NVE, NSE, and PSE values (100% for TP) but the table on page 4 indicates zero TP efficiency, same for section 5 composting technologies. Additional explanation that NVE, NSE, or PSE of 100 equates to zero reduction and seemingly one of 95 would equate to a 5% reduction if this reviewer understands how the math works. Section 6 lists on page 63 NSE and PSE values for a BMP but the table on page 4 does not include it as a one of the reportable BMPs. Similar to section 7 dealing with settling technologies as listed on pages 74 and 78 and for section 8 pages 95 and 96. The report is not clear on why these apparent BMPs were not included in the MTT list provided on page 4 and in one of the provided appendixes.	NVE/NSE/PSE
VA DEQ	Overall have confusion on the NVE and NSE values and the calculation of total N reduced. It seems as if these are both possible mechanisms for the attenuation or loss of nitrogen. That a value of 100 means zero reduction and a value of 0.0 means a 100% reduction. But that is not how it seems to	NVE/NSE/PSE

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	be implemented in the table on page 4. It seems for the Thermochemical MTT's seem to have a TN reduction based on $1 - \text{NSE}$ value and for the Composting MTTs it is just the NVE value listed as the TN reduction even if there is a NSE value less than 100 for the same practice. If there is a NVE value less than 100 and a NSE value less than 100 would the TN reduction be some combination of NVE and NSE values and not based on only one of these values? Some of the equations specify dry manure and others do not. Manure analysis are typically expressed on a dry weight basis so why would not all the equations be based on dry manure nutrient values?	
Aqua Terra	Attached are comments on the report from Ron and me. We limited the scope of our comments to questions regarding volatilization efficiencies for N components and a question on NSE and PSE for compost and anaerobic digestion.	
Aqua Terra	<p>We will not attempt to provide comment on the full report and all the technologies. Our focus will be on the approach to representing efficiencies with a particular focus on volatilization as a BMP earning a reduction efficiency. We do have some expertise on MTTs, particularly composting which will be used in the discussion.</p> <p>It is obvious the panel has put much work into assessing technologies for manure treatment at all levels of sophistication. The use of "Nitrogen Volatilization Efficiency" (NVE) and "N or P Separation Efficiency" (NSE or PSE) is unique and we think the separation efficiency concept makes it clear that separation does not constitute use so reduction credit is not given until a post separation use is implemented. Nuances of this approach for composting and anaerobic digestion will be discussed later.</p> <p>We do not understand how volatilization efficiency results in N reductions across the different technologies used and the different forms of N emitted by different technologies. If N_2 gas is volatilized it remains inert in the atmosphere and could be counted as a conversion reducing N available for loss without atmospheric impacts. Both nitrous oxide (NOX) and ammonia (NH_3) can cause air pollution impacts and also be redeposited. Nitrous oxide tends to be carried in the global atmosphere whereas ammonia can be deposited both locally and become of global atmospheric emissions. Research indicates that 25-50% of emitted ammonia may be deposited within a few kilometers of the point of emission and is, of course, immediately biologically active whereas more globally deposited nitrous oxide would be converted to nitrate before becoming biologically active.</p> <p>While we are certain the expert panel understands the discussion above, it is unclear why "NVE" is not related to emitted N species and for technologies emitting nitrous oxide or ammonia, how it can be considered an "efficiency" given effects on both water and air quality. It is suggested that species of N emissions be estimated for all technologies and that NOX and ammonia not be considered as part of NVE.</p>	Air
Aqua Terra	This is particularly true for ammonia from composting. NVE for manures and bulking agents range from about one quarter to one third of the total nitrogen, except for closed vessel systems, and essentially all of this is ammonia with local redeposition.	Air (composting)

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	The panel needs to provide the rationale for considering such emissions and efficiencies. Open compost facilities can become a “point source for atmospheric emissions and land/water deposition of ammonia if emission scrubbing (e.g. through finished compost) is not possible or not done.	
Aqua Terra	<p>Settling/storage devices or basins and solid separators (excluding centrifuges) may emit ammonia as well though likely at much lower levels than compost facilities (unless agitated). The panel needs to explain why these all have NVEs of 0 or provide estimated NVEs and explain what part of the emission/volatilization is ammonia, if possible.</p> <p>For all other systems, form of N in the NVE needs to be estimated, as suggested above, and N compounds potentially harmful to air and water should be removed from the “NVE”. It would also seem appropriate to add a paragraph or section about N emissions and redeposition (particularly for ammonia) from MTTs and that activities like in-house “composting” of poultry litter are sources of nitrogen to water, not MTTs or BMPs.</p>	Air (STTL and MSLS)
Aqua Terra	<p>The only comment beyond NVE and emissions from MTTs that we want to make regards N and P separation efficiencies for anaerobic digestors and composting. It is unclear why composting is given NSEs of 100% -NVE and PSEs of 100% while anaerobic digestors have NSEs and PSEs of 0%. In both cases, organic carbon is digested either anaerobically or aerobically and in composting a bulking agent is added to actually increase initial volume. The end products from both processes are a more stable, “user friendly” material that may lend itself to a wider range of both agricultural and other uses (anaerobic digestion residues may need more drying and both need to stabilize). As the panel developed the NVE, NSE, PSE approach, we think they possess the expertise and understanding to best address this apparent discrepancy. We suggest they either provide a technical explanation for the differences in NSE and PSE between composting and anaerobic digestion or modify NSE and PSE for anaerobic digestors to better reflect the improved potential for use following digestion consistent with compost.</p> <p>The concerns about using volatilization as an efficiency without regard to N species needs review throughout the report. The consistency of NVEs, NSEs and PSEs between and within technology groups needs further review by the panel for consistency. As stated above, we will not discuss technology specifics and operational functionality as we think the panel and others have more expertise to do that.</p>	AD & composting
PA DEP	<p>We have done a detailed analysis of the attached Expert Panel report. We see that there was an extensive study done and it does:</p> <ul style="list-style-type: none"> · Provide efficiencies for 18 manure treatment technologies for what occurs inside the “black box”, in the event there is minimal monitoring of the system. · Provide some good suggestions for what to ask the operators of manure technologies to report who use “Level 3 transfer efficiencies.” <p>The “black box”, I am referencing is what occurs when the manure enters</p>	Various. Trading, Modeling, Air

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	<p>one of these treatment technology facilities, how it is transformed within the facility, and how it exits the facility. This is a mass balance equation. We already have a high level of confidence in our current sampling and reporting protocol for this.</p> <p>Unfortunately, the report only focuses on half of the equation for nutrient reductions. The report falls short in providing what we need to move forward in a number of areas such as accounting for:</p> <ul style="list-style-type: none"> · Replacement nutrients · Crop uptake · Air deposition of NH₄ · Ground water infiltration of nitrates · Other possible losses · Sediment and phosphorous runoff <p>In other words, there is no methodology for accounting for what happens on the farm where the manure treated is removed. For example, is commercial fertilizer used instead? In addition, there is no methodology offered for consistently accounting for what happens to the byproducts from the treatment process. Some are re-sold as feed, some as fertilizer, some transported out of the watershed. The residual nutrients from these byproducts need to be considered. We need both what is inside the “black box” and what is outside to determine the amount of nutrient reductions generated. As part of the credit calculation application used to calculate credits for one such technology in Pennsylvania, we did create a very conservative model to attempt to accomplish this, but we were hoping to refine this model with the results from this panel report. Perhaps another look at this methodology would facilitate resolution of this issue.</p>	
PA DEP	<p>Finally, there are a number of policy issues that should not be addressed in this document. For example:</p> <ul style="list-style-type: none"> · It is unclear what the purpose for Table DD1 is. · References as to how this panel report relates or can be applied to states Nutrient Trading Program on page 118 are problematic. We were hoping this report would provide a consistent methodology that could be used by all the states to calculate reductions from these technologies that could be transferred to nutrient credit calculation and facilitate Interstate Trading. This language is not helpful in achieving that goal. · Requiring monitoring protocols to be part of a state’s QAPP is a policy decision that needs further discussion. <p>Therefore, we would strongly recommend that any discussion after page 114 be deleted from the panel report to facilitate finalization. The policy issues and discussion on these last pages should be dealt with using the process now under development by the WQGIT, the Management Board and EPA in another forum.</p>	Various. Trading, modeling, verif.

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	<p>Thank you for the opportunity to comment on this important panel report. Should you wish to discuss this further, please do not hesitate to contact our PA members of the Agriculture Workgroup or myself. We look forward to working with you to finalize this report as quickly as possible. These technologies are a key component to Pennsylvania's continued progress towards achieving our reduction goals under the TMDL.</p> <p>Veronica Kasi Program Manager Chesapeake Bay Program Office P. O. Box 8555 Department of Environmental Protection Rachel Carson State Office Building Harrisburg PA 17105-8555 Phone: 717.772.4053 Fax: 717.787-9549 www.dep.pa.gov</p>	
MD	<p>Hi Jeremy!</p> <p>Attached is the compilation of comments from MDE, MDA, and DNR.</p> <p>Best, Susan</p> <p>Susan Frick Payne Program Coordinator Ecosystem Markets Maryland Department of Agriculture 50 Harry S. Truman Parkway Annapolis, MD 21401 410-841-5897 susan.payne@maryland.gov</p>	
MDE	<p>1. The panel did not create pathways for the different forms of material that will potentially be transported vs. others that may remain on a farm (e.g. solids vs. liquids). As an example the "Compost Tea" could be used to fertilize fields on a farm while the remaining solids could be transported elsewhere. CBPO is aware of this concern.</p>	Reporting & modeling
MDE	<p>2. The mass balance is important to understand in terms of potential air contribution: are there significant impacts or loading of nitrogen (in various forms) that the panel has noted or about which the panel has concerns following the use of any of the technologies reviewed?</p>	Air
MDE	<p>3. Reductions from this practice come through volatilization of nitrogen in various species, some bound N₂ and others hazardous NO_x. We have issues with giving credit when the nitrogen is most likely still impacting local water quality to some degree through deposition. It is also difficult to determine the percentage of each particular N species that was volatilized.</p>	Air
MDE	<p>4. In terms of market solutions, once the processed material has been reduced in mass but remains in a more concentrated form with respect to phosphorus, is it a concern that a market solution must be readily available in order for the P to be considered removed from the system? In other words, if one of the combustion processes concentrates the P</p>	Misc

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	into a char, does the panel have any concern that there must be a business readily capable of selling and removing the product for the process to be effective?	
MDE	5. In general, this BMP will be difficult and time consuming to track. Currently the State does not have an obvious means to report this BMP. In addition, the modeling mechanics of tracking and reporting two separate waste streams, with different nutrient levels determined by technology, has not been defined.	reporting
MDA	1. According to page 118 of the report, <i>"The estimated nitrogen reductions associated with a given manure treatment system reported under Level 3 and calculated in the Chesapeake Bay Program Partnership environmental modeling tools will not necessarily be equal to credits generated (in pounds of TN) for water quality trading purposes. Water quality trading programs, whether intrastate or interstate, may have different calculation steps, retirement ratios, additionality requirements, or other factors that are not considered for this panel's purposes. This may be a source of confusion if attempts are made to compare the reductions credited for a treatment system in the CBP partnership modeling tools with any water quality trading credits associated with that same manure treatment system under a state's water quality trading program."</i> Maryland and other Bay states are looking to the BMP panel to provide clear guidance for determining water quality benefits/reductions and associated credits for nutrient trading activities. The factors cited above by the Panel - retirement ratios and additionality requirements - are not related to the initial generation of a credit, but rather are programmatic elements. We need further clarity on what occurs outside the "black box" since it is only a part of total nutrient reductions. It would be useful to have a formula for dealing with factors such as replacement nutrients, air disposition of ammonium and methane, ground water infiltration of nitrates, and sediment and phosphorus runoff.	Trading
MDA	2. Page 114 of the report addresses some of the above but then basically tells the states they are on their own. Maryland, Pennsylvania, and Virginia are trying to present a united front and this is not helpful. Given the potential controversy this page will cause with the purveyors of MTT technologies, it would be better to delete it from the report.	?
MDA	3. The Panel does not include consideration of the necessary mineral fertilizer that would likely be required to meet a crop's agronomic need, should a MTT be utilized and create an organic product that could be transported off-farm.	Misc. Field and other pathways
MDA	4. MDA echoes the comments and concerns of MDE's comment #5 concerning the difficulty of tracking multiple waste streams, especially Settling MTTs and Solid-Liquid Separation MTTs. Much of this is operationally specific and would occur outside the Manure Transport cost-share program (e.g. ineligibility for short distances) providing no records for reporting purposes. MDA recognizes that the Watershed Model considers a county-level mass balance such that short distance transporting would not effect a county's overall input load; however, the use of MTTs can alter the nutrient concentration of the multiple waste	Reporting & modeling

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	streams and we believe the Watershed Model should have a mechanism to reflect for those input changes.	
MD DNR	I. Default values still require manure type to be known. For technologies not taking advantage of NRCS or state funded cost-share or grant programs, how can MD track and report manure type? Some of the technologies require permits (air emissions, etc.) that could be used to track manure type, but not all do (i.e. compost).	Reporting & modeling
EnergyWorks	<p>Jeremy,</p> <p>I'd like to add my congratulations to the MTT Expert Panel for its clear and thoughtful recommendations. I found the mass transfer framework very helpful in describing the combination of technologies used in our Gettysburg facility. We are proceeding with a credit generator certification renewal based on the panel's framework and terminology.</p> <p>Pat</p> <p>Patrick Thompson President & CEO EnergyWorks Group www.energyworks.com T 410-349-2001 x105 C 443-831-2360</p>	Misc
Sustainable Chesapeake	<p>Greetings Jeremy:</p> <p>Please accept the attached comments for the Manure Treatment Expert Panel's March 2016 draft report.</p> <p>I am really impressed by the work this panel was able to accomplish.</p> <p>Please let me know if you have any questions,</p> <p>Kristen</p>	
Sustainable Chesapeake	<p>I am writing first to thank the Manure Treatment Technology Expert Panel for their outstanding work on the March 2016 Manure Treatment Technology report.</p> <p>Secondly, I am writing to provide comments regarding nitrogen reduction crediting for thermal manure-to-energy technologies. In the Chesapeake Bay Commissions' (CBC) May 2, 2016 memorandum to Dr. Doug Hamilton, staff express a concern that the default and defined transfer efficiencies award credits for volatilization of reactive nitrogen emissions (oxides of nitrogen and ammonia-nitrogen).</p> <p>We concur with CBC staff in this regard and recommend that that nitrogen reduction credits should not be issued for nitrogen volatilized in the reactive form. If the panel has already taken this into consideration, we suggest that the report provide clarification in this regard. Given that Table TCC.I. and TCC. 5 have nitrogen values less than 100 percent for combustion technologies, this may be the case.</p>	Air

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	<p>We would also like to direct the panel's attention to the final Farm Manure-to-Energy Initiative report, which includes a data on air emissions (Appendix E) and nutrient balance (Appendix G) for three thermal manure-to-energy technologies installed on farms in the Chesapeake Bay region (two combustion systems and a gasifier). Results from emissions testing indicate that the technologies vary in terms of reactive nitrogen reduction:</p> <p>http://articles.extension.org/pages/73602/farm-manure-to-energy-initiative-in-the-chesapeake-region-report-january-2016</p> <p>Thank you for the opportunity to provide comments. Please do not hesitate to contact me via email at Kristen@susches.org; or by phone at 415-730-7503 with questions regarding the Farm Manure-to-Energy Initiative report.</p>	
EnviroKure	<p>Hi Jeremy,</p> <p>So they decided not to review any novel approaches such as the EnviroKure aqueous composting process?</p> <p>Since we presented in December 2014 we have moved forward with building a plant in Harrington, DE that will utilize about 20% of the excess manure produced in DE annually when operating at full capacity, removing all but 0.3% of the P from that manure and shipping approximately 65% of all the nutrients out of the CBWS.</p> <p>Hope all is well, Sonia</p>	Misc-Composting
Coaltec	I am surprised that not once does the report mention that some of the technologies (such as MTT4 - high temperature gasification) are NRCS Conservation Practices.	
Coaltec	<p>Jeremy,</p> <p>Thank you again for all of your hard work on behalf of the Manure Treatment Technology BMP Panel over the past 18 months.</p> <p>The primary request we have is to add one sentence on page 3 to "Defined Transfer Efficiency (Level 2)." The sentence would read:</p> <p>"The Defined Transfer Efficiency (Level 2) should be used for large-scale technologies that process manure or waste from multiple farms within the same watershed, or that process the manure or waste from a single farm where the manure or waste is usually land applied on large acreage in the same or adjacent watersheds."</p> <p>As you know, each large-scale gasification system can process ~20,000 tons of poultry litter per year, or it dries and processes ~40,000 tons of 57%-moisture spent mushroom substrate (SMS) per year. Currently, 20,000 tons of litter comes to us from dozens of poultry growers within a 15 to 20-mile radius, or 40,000 tons of spent mushroom substrate is owned by a single large mushroom farm (e.g. West Coast Mushrooms in Cecil County, MD). In either case, these large tonnages of litter and SMS are currently being land applied on thousands of acres in the Bay watershed. It would help enormously if the above sentence were added to page 3 of the Report, so nutrient trading officials in each Bay state understood that large-scale gasification systems have a well-known (i.e. Defined), on-site mass transfer</p>	TCC

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	<p>efficiency and should not be subjected to the field-by-field, farm-by-farm calculations of the Nutrient Tracking Tool or the nutrient reduction (run-off) uncertainties of Model 6. We realize that the nitrogen that we drive off, and the phosphorus that we capture in the biochar will be subject to the tidal waters attenuation percentages in the Bay Model, but it is not reasonable or practical to require field-by-field and farm-by-farm calculations over thousands of acres in order to calculate gross (pre-attenuation) nutrient trading credits.</p> <p>As I indicated the other day, I think it would be very helpful if those who review and utilize the Panel's report understood that MTT4 ("Gasification – High Temperature") is NRCS Conservation Practice Code 735, entitled "Waste Gasification Facilities". I don't know where it is most appropriate to insert this, so I will leave this to your discretion.</p> <p>Please let me know your thoughts.</p> <p>Regards,</p> <p>Peter Thomas Coaltec Energy USA, Inc. 434-989-1417 (Cell) www.coaltecenergy.com</p>	
Coaltec	<p>Jeremy,</p> <p>Thanks for a good presentation this morning. I would like to suggest that the wording in the Data Driven Transfer Efficiency category be slightly revised to read: "... for a given farm or centralized manure treatment system is available." This wording helps by acknowledging that there are multi-farm technology systems like ours that fit into the Data Driven category.</p> <p>As an aside, we agree with the person who voiced a concern this morning about manure or litter incineration systems that simply convert nitrogen compounds in the manure to other forms that will harm the air or the Bay. She was also correct when pointing out that more costly systems convert the nitrogen compounds to N₂ – the air we breathe. That is exactly why the EPA issued the attached letter ruling in December 2013, differentiating between biosolids incineration and oxygen-starved gasification systems that utilize an efficient thermal oxidizer.</p>	TCC
Coaltec	<p>Jeremy,</p> <p>In the discussion of Data Collection and Reporting Protocols for Data Driven systems in Section 10 on page 114, a preface to the 3rd sentence in paragraph 1 could read: "Regardless of whether the data is generated by a single farm or by a multi-farm, centralized manure treatment facility, treatment systems reported under this category will have unique transfer efficiencies...."</p> <p>Peter</p>	Edit
Coaltec	<p>Jeremy,</p> <p>The Manure Expert Panel has created two gasification BMP categories, based solely on high temperature (> 1,500o F) versus low temperature (< 1,500o</p>	TCC- gasification

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	<p>F). Highly automated, sensor-enabled, refractory-lined gasification / thermal oxidizer systems can and are operated at a wide range of temperatures, with infinite levels of oxygen, and with a wide variety of biomass residence times. Since manure gasification systems are covered by both interim NRCS Conservation Practice Code 735 ("Waste Gasification Facilities") and by permanent NRCS Conservation Practice Code 629 ("Waste Treatment"), and since the vast majority (>85%) of all of the nitrogen compounds in the manure or litter is converted to N₂ over a wide range of temperatures and residence times, we ask that gasification be approved as a single Bay BMP, not two.</p> <p>Regards,</p> <p>Peter Thomas Coaltec Energy USA, Inc. 434-989-1417 (Cell) www.coaltecenergy.com</p>	
Coaltec	<p>Jeremy and Doug,</p> <p>Based on the input during the initial reviews of the MTT report, it is clear that the issue of N emissions is going come up repeatedly during the reviews by the TOWG, the Agricultural Workgroup, Watershed Technical Workgroup and the Water Quality GIT. I hope you will insert language in the report to distinguish between the N emissions of gasification and composting, and not simply say that it was not in the scope of this Panel's responsibility. This language would be very helpful, so everyone will understand that gasification systems that include a thermal oxidizer drive off the N compounds in the manure or litter as N₂ – the air we breathe – not as NO_x. Manure composting has an unenviable N, methane and CO₂ emissions profile, but it is what it is, and to my knowledge, there is not a technology can't solve this problem for composters. I can't speak to the other manure technologies that are discussed in the MTT report, but it is very important to note that gasifier / thermal oxidizer systems convert the N compounds in the manure or litter to N₂. The very low emissions profile of gasification / thermal oxidizer systems (and its clear distinction from waste incinerators) is precisely why the EPA in Washington issued the attached letter ruling in December 2013.</p> <p>Regards,</p> <p>Peter Thomas Coaltec Energy USA, Inc. 434-989-1417 (Cell) www.coaltecenergy.com</p>	Air
CleanBay	<p>Hi Jeremy,</p> <p>Thank you for your work coordinating the BMP Assessment for the Chesapeake Bay Program. My name is Shawn Freitas and I am the CTO of CleanBay Renewables. We have recently reviewed the Report Recommendations from the BMP expert panel for Manure Treatment Technologies and have attached our initial comments. There are a number of concerns we hope to discuss with you and the panel and we will attend the webinar on Thurs 4/14 to learn more.</p>	

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	<p>CleanBay Renewables is a Maryland-based project development company founded to recycle agricultural and municipal wastes that are environmental “problems” and turn them into valuable renewable products. Maryland’s Eastern Shore has significant quantities of excess poultry waste and an oversupply of phosphorus polluting the Chesapeake Bay, creating an opportunity to re-purpose this material. CleanBay aims to utilize poultry litter as the primary feedstock for a new class of anaerobic digestion biorefineries that will generate both electricity from biogas and inorganic chemicals such as struvite (a stable, time-release fertilizer), as well as a sustainable compost. Additional feedstocks and manures will also be incorporated in future designs to maximize the utilization of locally available resources and to improve the level of integration with the poultry industry.</p> <p>We are very interested in contributing to and supporting constructive nutrient management policies and regulations that will decrease eutrophication and improve the water quality of the Chesapeake Bay. As such, we have set up a series of meetings and discussions over the next few weeks with a wide range of manure technology and policy experts to discuss this report and to solicit additional feedback. We hope to incorporate this feedback into our final comments and if possible to work with the panel moving forward. Please feel free to contact me if you would like to discuss any of our initial comments, thanks.</p> <p>Best Regards, Shawn</p> <p>Shawn Freitas Ph.D., MPM Chief Technology Officer Cleanbay Renewables 315-317-6056</p>	
CleanBay	<p>Hi Jeremy,</p> <p>I have attached the final version of the CleanBay comments on the report. We were concerned by a number of issues that we felt were not addressed in the public webinar on April 14th. As a result, we recently chose to directly reach out to additional members of the Chesapeake Bay Program to identify others with similar concerns and to establish a path forward. Our objective is to start constructive dialogue with members of the Agriculture Workgroup (AgWG), Watershed Technical Workgroup (WTWG), and the Water Quality Goal Implementation Team (WQGIT) regarding the issues we have outlined. We are still very interested in your feedback regarding these concerns and your guidance/direction as to how we can best make them part of the conversation moving forward. Thank you for your time, we look forward to hearing from you.</p> <p>Best Regards, Shawn</p> <p>Shawn Freitas Ph.D., MPM Chief Technology Officer</p>	

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	Cleanbay Renewables 315-317-6056	
CleanBay	<p>Executive Summary</p> <p>CleanBay Renewables is impressed and supportive of the development of the Chesapeake Bay Watershed Model (CBWM) and the use of Scenario Builder as powerful tools in the comprehensive management of nutrients loads in the region. As a project development company committed to improving the condition of the Chesapeake Bay Watershed, CleanBay is focused entirely on implementing technologies with proven commercial track records of controlling nitrogen and phosphorous from poultry litter. As such, considerable diligence review has been completed on all of the technologies outlined in the Draft Manure Treatment Technologies report over the last few years.</p> <p>The objective of this report and in fact this environmental effort is to improve the water quality of the Chesapeake Bay. The fundamental issue with nitrogen and phosphorous in the watershed is not its phase (gas, liquid, or solid), but whether or not its release can be controlled such that eutrophication does not occur.</p> <p>Unfortunately, the report is based upon some incorrect assumptions. First, the report surmises that nitrogen loss through volatilization is a positive thing and the only way to control nitrogen. This is incorrect.</p> <p>In addition, this assumption is carried through the mass balance calculations causing further degradation of the report's conclusions. The finding that nitrogen volatilization is the preferred method for comparing functional to non-functional technologies will end up doing more harm than good if the base assumptions are not corrected.</p> <p>In the interest of supporting our common goals and completing a scientifically foundational report, we sincerely hope that the areas below will be systematically addressed. The Chesapeake Bay Program serves as a guiding body for a number of important issues and CleanBay would like the final report to better support local, federal, nonprofit, and industry leaders who have an interest or impact on the Chesapeake Bay watershed.</p>	Overall
CleanBay	<p>Summarized concerns are as follows;</p> <ul style="list-style-type: none"> • Nitrogen air pollution should be avoided at all costs and should not be considered a reasonable trade-off in order to address manure challenges. Sources of nitrogen air pollution need to be better characterized for all technologies studied by this report. • Manure drying, emissions scrubbing, and commercially practiced absorption/adsorption technologies are all fundamentally important processes for the reviewed manure conversions, but they have not been assessed or considered in the report. • Manure conversion technology mass balances in the report are frequently subjective and incomplete. Further work needs to be done for nutrient balances to adequately reflect actual working facilities. • Anaerobic digestion and composting are some of the most common and successful manure technologies in the world, but are negatively 	Overall

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	<p>characterized by this report compared to thermal conversion technologies. Troubling scientific and engineering inaccuracies are used to justify these comparisons.</p> <ul style="list-style-type: none"> An improved assessment of nitrogen and phosphorous chemical speciation and phase (gas, liquid, solid) in manure inputs and manure conversion outputs is fundamentally necessary to support the nutrient management recommendations by this report <p>General CleanBay recommendations are as follows;</p> <ul style="list-style-type: none"> Conventional mass balances centered on nitrogen and phosphorous should be used instead of mass transfer efficiency. Mass transfer efficiencies are used to check mass balance closures, but they are rarely used in chemical or environmental engineering as a method for comparison because theoretically all mass balances can come to closure. Nutrient management assessments for a given technology should encompass all of the primary and supporting processes that would be found at the facility site to support the manure conversion, avoiding potentially subjective definitions regarding importance. The results and conclusions of the report will be far more defensible and manageable if the technology scope is initially narrowed to include only commercially practiced technologies. CleanBay recommends that the basis for technology comparison be twofold with the primary objectives being; 1 - Production of more stable and controllable forms of nitrogen and phosphorous from manure that will not contribute to increased nutrient loads in surface waters. 2 - Significant volume reduction of the manure into liquids or solids that can be easily and economically transported out of the watershed 	
CleanBay	<p>Detailed Comments</p> <p>I. Nitrogen lost through volatilization primarily returns to the environment as precipitation. Decades of data and analysis by the National Atmospheric Deposition Program make this very clear and in fact, a Chesapeake Bay Program report from 1999, "The State of the Chesapeake Bay, CBP/TRS 222/108" clearly describes the significant effects of atmospheric deposition on the Bay. Nitrogen volatilizes primarily in two forms, either as nitrogen oxides (NOx) species or as ammonia. NOx is a potent greenhouse gas and its emissions are regulated by the EPA. NOx also contributes to acid rain and widespread ecologic damage in the Northeast and Mid-Atlantic regions. Ammonia is a hazardous, flammable gas and is less regulated by the EPA, but associated with a variety of air quality issues. In most commercial and industrial practices, both of these nitrogen species are considered pollutants and are scrubbed from emissions using a variety of treatment processes. One of the commonalities in many of these treatment processes is that they are water-based. This is because both NOx and ammonia have high water solubility and this characteristic is also why</p>	Air

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	these are the primary species associated with unwanted atmospheric nitrogen deposition through rain, snow, and fog.	
CleanBay	2. Mass of Nitrogen Transferred to the Atmosphere expressed as Nitrogen Volatilization Efficiency (NVE) is a negative characteristic of a manure conversion process from an environmental perspective and should not be used as a constructive basis of comparison the way it is in this report. From an environmental perspective nitrogen emissions need to be addressed like they are in all other commercial/industrial processes where they are scrubbed using emissions treatment technologies. Furthermore, scrubbing represents an additional unit operation, increasing the cost and process intensity of any proposed project, and it does not actually get rid of the nitrogen species or even stabilize them. <u>Scrubbing the nitrogen from these emissions simply puts it in a wastewater form where it will require yet another process so that it can either be bio-accumulated or precipitated as a mineral (similar to what happens in current municipal wastewater treatment).</u> This report makes volatile nitrogen species a cornerstone of its proposed nitrogen management plan and does not ever address the multitude of scrubbing technologies and downstream processes that would be necessary to mitigate the effects of NOx and ammonia emissions. It is important that this is addressed for this report to have a meaningful and constructive impact on the CBWM and management of nutrients in the Chesapeake Bay watershed.	Air
CleanBay	3. In the report, Nitrogen Separation Efficiency (NSE) and Phosphorus Separation Efficiency (PSE) are logical values for achieving nutrient management objectives, but unfortunately they are calculated inappropriately in most of the mass balance assessments. In all techno-economic or lifecycle assessment, the location of the boundaries drawn on the process has major effects on the results of the model. This makes deciding where to draw the boundaries incredibly important as they can either make the model functional or undermine its predictive abilities. In the case of NSE and PSE, many of the boundaries have been drawn too closely to a single unit operation in a highly integrated process containing many unit operations, such that they suggest inaccurate and unreal NSE and PSE values.	NVE/NSE/PSE
CleanBay	4. The fate of nitrogen and phosphorous in combustion, gasification, and pyrolysis processes is very complicated and is not adequately assessed in this report. In efficient and commercially viable combustion and gasification processes where greater than 90% conversion of solids to gas occurs, over 95% of the nitrogen in the fuel will be volatilized as ammonia. In a gasifier, this ammonia will remain in the syngas unless it is removed and when the syngas is combusted the ammonia will be primarily converted to NOx. In a combustion process, most of this ammonia is rapidly converted to NOx. Depending on conditions a very small amount of ammonia may pyrolyze to N2, but the vast majority will remain either as ammonia or be converted to NOx when the ammonia is oxidized. The nitrogen emission challenges associated biomass gasification and combustion have been known for decades and unfortunately remain a weakness for this type of biomass conversion (Sethuraman, S. et al, Energy & Fuels, 2011; Jeremiáš, M., et al, Fuel, 2014; Van Huynh, C., Fuel, 2013). A slight exception is when gasification	TCC

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	<p>occurs with an excess of steam in which case most of the nitrogen will be converted to ammonia (NH₃), but some will also be converted to hydrogen cyanide (HCN). In the case of combustion the NO_x will be present in the CO₂ emissions and must be scrubbed out. In the case of gasification the NO_x, NH₃, and HCN that is present in the syngas will either have to be scrubbed out upstream or downstream of the syngas combustion or synthesis processes. Nearly all of the nitrogen retained in the solid form in these processes is retained in the char, it is almost never found in the ash. The tables in the report suggest that low temperature gasification can retain a high level of nitrogen in the char. This is misleading because in reality inefficient gasification that does not effectively convert the solids to gases generates more char and less syngas. Because the nitrogen can be trapped in the char, inefficient gasification process will retain more nitrogen in the solid char form. This is a problem because commercially relevant gasifiers are designed to be efficient and even low temperature gasifiers running in the 1500-1400F temperature regime are optimized to generate as much gas as possible and therefore most of the nitrogen is converted to a gas form – where it presents a scrubbing challenge. The fast and slow pyrolysis values have the same weaknesses. Fast pyrolysis generates less char and more gas, slow pyrolysis generates more char and less gas, so the dynamic ends up being the same as gasification, processes that generate more char will leave more nitrogen trapped in a solid phase and vice versa for nitrogen in the gas phase. However, unlike gasification and combustion which are commercially proven processes for manure conversion, pyrolysis is not a commercially proven process yet and all of the data provided in this report is based on primary literature. This is a significant issue as this makes it more a literature review than a legitimate design basis for contributing to nutrient regulation for the state of Maryland. At this time there is no accurate way to assess the overall nitrogen mass balance for a realistic manure pyrolysis facility.</p>	
CleanBay	<p>5. The statement that;</p> <p>“Gaseous emissions are considered true losses of nitrogen from the solid phase as ammonia emissions are generally less than 2% of total losses (Caron-Lassiter, 2014). Additionally, based on reported air permits (Energy Works Biopower, 2014) and available EPA air emission data NO_x-N emissions can be estimated as 10% of feed N. The deposition fate of ammonia and NO_x may be of interest to other technical groups and/or future iterations of the model.”</p> <p>Represents a significant misinterpretation of those reports and their conclusions. This author must incorrectly assume that during combustion and gasification the nitrogen in the feedstock primarily converts back to dinitrogen gas (N₂) as is found in the air, which is simply untrue. Combustion and gasification are thermal oxidation processes and they either pyrolyze organic nitrogen into ammonia or they oxidize the organic and inorganic nitrogen species into NO_x. In lab settings, depending on the level of control of the combustion process, NO_x emissions can be reduced and the level of ammonia pyrolysis back to N₂ can be improved, but in commercial settings these results are rarely if ever achieved (Sethuraman, S. et al, Energy & Fuels, 2011; Jeremiáš, M., et al, Fuel, 2014; Van Huynh, C., Fuel, 2013).</p>	Air-TCC

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CleanBay	6. Ignoring pyrolysis and focusing on commercially relevant combustion and gasification, the fate of phosphorous is also not nearly as simple as suggested. One of the primary issues is lightly described and that is the phosphorous present in the ash is highly soluble and capable of moving easily into a soil-water system. This means that even though the phosphorous can be up-concentrated through combustion and then shipped elsewhere, it is in an unstable form and likely to just cause eutrophication issues in a new place. CleanBay does not believe this is actually a solution to the problem, it is just outsourcing the problem. Alternatively, there have been some processes piloted in Europe (Outotec, Metawater, etc) where phosphorous can be extracted from ash and stabilized into a more functional form. These are technologies worth reviewing and belong in this report if phosphorous management is considered important. When animals eat food they up-concentrate the phosphorous from the food in their manure and this has created a eutrophication problem. It defies logic that up-concentrating the phosphorous from manure into an even more phosphorous rich and unstable solid could be a solution to the eutrophication. The logical solution is to focus on putting the phosphorous into a stable and controllable form so that eutrophication is reduced.	TCC
CleanBay	7. The comparative heating values provided for manure, grass, wood, and coal are inaccurate because the author either did not properly correct for moisture content before creating the comparison table or unfairly selected papers that studied highly irregular forms of the stated feedstocks. The heating value for the manure and the grass appear to have been calculated on a dry basis. The heating value for the wood and the coal are based on either wet feedstock or forms that are never commercially utilized. Dry wood has a heating value of ~8,500 BTU/lb and dry coal has a heating value of ~15,000 BTU/lb and this is well known (https://www.ecn.nl/phyllis2/). Based on ash content and carbon density alone, on a dry basis, it is thermodynamically impossible for manure to have a higher heating value than wood or coal. Furthermore, poultry litter tends to be the driest manure at around 20-30% moisture, but dairy, beef, and swine manure are incredibly wet at 60-70% moisture and make terrible combustion feedstocks without considerable drying. This is part of why farms tend to anaerobically digest this manure instead of combust it – if it was easy to burn they would be burning it because combustion is a common method of waste disposal on a farm. The energy value remaining in manure is largely related to the level of undigested carbohydrate, not the amount of dry and easily combustible carbon.	TCC
CleanBay	8. With regards to the earlier comment that the boundaries for assessing the NSE and PSE are unfair, thermochemical conversion offers two clear examples. The first is in regards to the scrubbing necessary to prevent the NH3 and NOx from being emitted to the atmosphere. The necessary scrubbing technologies would capture the NH3 and the NOx in an aqueous phase and this would then have to be treated, meaning technically thermochemical conversion should have a very low NVE. The other major technical omission is that of the dryers that would be necessary. In order to combust or gasify a feedstock with 60-70%	TCC

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	<p>moisture, it must be either dried or fired as a minority feedstock into a process being driven by a better fuel (natural gas, coal, wood, etc). If drying is not done and wet fuel is fired into the process, the oxidation and conversion will be inefficient and the emissions will be even worse. However, drying manure itself carries challenges because it is an energy intensive process and it is likely to cause significant NH₃ emissions. Technically these NH₃ emissions could increase the NVE, but it is more likely that they would represent such a significant air quality threat that these emissions would need to be scrubbed the same way the combustion/gasification emissions would need to be scrubbed. Not addressing the necessary drying and air emissions scrubbing technologies needed for thermochemical conversion invalidates any functional mass & energy balance calculations for these processes and demands a reassessment of the NSE and PSE.</p>	
CleanBay	<p>9. The composting section is well written and properly assumes that nitrogen will be primarily transformed to solid microbial biomass and nitrates or emitted as gaseous NH₃ or NO_x. The remaining mobile nitrogen will be found solubilized in the liquid leachate, primarily in inorganic forms. However, there is very little discussion about the fact that level of nitrate/nitrite and NH₃/NH₄ can be higher in compost than it is in manure and that these nitrogen species are very water soluble. Addressing the nitrogen solubility and runoff considerations around compost is very important for nutrient management. The same needs to be done for compost tea and leachates. Additionally, these mobile nitrogen species can be concentrated and stabilized through the addition of different minerals and also carbon char products like activated carbon, charcoal, and biochar. From a nutrient management perspective, reviewing methods for stabilizing the nitrogen forms expected from compost is as important as considering composting itself.</p>	Composting
CleanBay	<p>10. Unfortunately, the composting section makes some of the same improper assumptions about phosphorous as the thermochemical section. Phosphorous from compost ends up being fairly mobile and while it does not leave in a gaseous form, it can absolutely be extracted by water. Compost tea and leachate tends to contain fairly high levels of phosphates and unfortunately, when used in excessive amounts, compost has increasingly been shown to contribute to eutrophication. From a mass balance perspective, composting results in a minor loss of carbon, and additional time for bacteria to heat and breakdown organic matter. This has a positive effect on reducing pathogens and bringing the compost closer to a soil-state, but it actually concentrates the phosphorous a little and liberates more free phosphate from the phytic acids that it is bound in. This makes the phosphorous in compost more mobile than the phosphorous in manure and while this increases plant uptake, it also means that high levels of rainfall can cause compost to be a contributor to eutrophication. Like the nitrogen species, these mobile phosphorous species can be concentrated and stabilized through the addition of different minerals and also carbon char products like activated carbon, charcoal, and biochar. From a nutrient management perspective, reviewing methods for stabilizing the phosphorous forms expected from compost is as important as considering composting itself.</p>	Composting

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CleanBay	11. An important differentiator of composting compared to thermochemical and anaerobic digestion conversion processes is that composting is an open reactor system and the other two are closed. This presents an emissions challenge that the report does not address. Unlike the NVE values from thermochemical and anaerobic digestion processes, which in practice would nearly always be zero due to scrubbing, the NVE values from composting are real because composting emissions cannot be easily controlled. The NH ₃ and NO _x that is released from the compost during the composting process will drift into the air and then be returned to the watershed as precipitation. While the NVE values from composting are not very high, it is important to address them as an uncontrolled emission with negative effects on the environment.	Composting
CleanBay	12. The weakest and most unfair assessment in this report is the Anaerobic Digestion section. The “Transfer Efficiencies of Anaerobic Digestion” and “Default Transfer Efficiencies for Anaerobic Digestion” paragraphs are incorrect and misleading. Anaerobic digestion is a significant manure conversion process similar in many respects to thermochemical conversion. Manure is broken down at a molecular level in a heated aqueous environment from a combination of bacterial, thermal, and hydrolytic mechanisms. This conversion results in 60-80% of the solid carbon being converted into gas composed primarily of methane (CH ₄) and carbon dioxide (CO ₂). This gas is known as biogas and the process of converting the carbon into a gas at this scale also logically has effects on the nitrogen and phosphorous. The nitrogen is heavily converted into NH ₃ /NH ₄ species and also some nitrate/nitrite similar to compost. When NH ₄ is the dominant species the nitrogen tends to concentrate in the solid sludge material as various precipitates. When NH ₃ is the dominant species the nitrogen tends to concentrate in the biogas as gaseous ammonia. A similar conversion happens with the phosphates. The phosphates present in manure are frequently organophosphates with a minority or inorganic phosphate minerals. During the anaerobic conversion process, particularly thermophilic conversions, the organophosphates (phytic acid, other phytates, etc) are broken down and the orthophosphate levels are increased. Depending on feedstock chemistry and anaerobic digester conditions, this orthophosphate is usually bound and mineralized by an ionic alkali and alkaline metal species that are also solubilized in the solution. This is a precipitation process that converts the phosphorous to a stable inorganic form, similar to the forms in which geologic rock phosphates are typically found. The phosphorous is never found in the biogas and is always up-concentrated in the sludge, similar to the concentrating that occurs in the ash and char with thermochemical conversions.	AD
CleanBay	13. From a mass balance perspective, the report suggests an impossible thermodynamic scenario regarding nitrogen and phosphorous and furthermore, the notion that 10 years is a necessary or legitimate retention time is unreasonable. Most commercial anaerobic digesters have retention times on the order of 20-30 days and in this time 60-80% of the solid feedstock mass is converted to the gaseous biogas form. This leaves 20-40% of the mass in the sludge form that must be removed, otherwise it would build up indefinitely and the conversion would have to stop. Therefore, sludge that has no more digestible	AD

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	carbon to contribute to the bacterial ecosystem in the reactor is removed regularly. It is also illogical to assume that manure and sludge are mixed in such a way that fresh manure is removed from the system when sludge is removed. This would be counterproductive to the objective of converting the digestible carbon remaining in the manure and to making biogas. All anaerobic digesters are operated so that the sludge removed is material that has experienced the longest possible retention time and therefore has experienced the greatest up-concentrating of inorganic components. This means the incoming manure and outgoing sludge are absolutely not the same material.	
CleanBay	14. If the nitrogen and phosphorous were not removed regularly in the sludge and to a certain extent in the biogas, then they would just build up forever until the system no longer operated. This is clearly not a logical approach to mass flow for a reactor type that has enjoyed substantial success and commercial implementations globally. The mass and concentration of nitrogen and phosphorus in the sludge is always significantly higher than it is in the manure, usually by 3-5x depending on the efficiency of the anaerobic digester and the concentration of nitrogen and phosphorous in the feedstock. More importantly though are the forms of nitrogen and phosphorous found in the sludge. The phosphorous in the sludge is primarily found in an inorganic mineral form compared to the manure where it is predominately in an organic form. The nitrogen is primarily found as NH ₃ /NH ₄ and nitrate/nitrite compared to the manure where it often found as urea and various types of organic nitrogen species. This conversion of the phosphorus and nitrogen species into these new forms is a major benefit from the stability and control perspective, offering important advantages for processes that aim to capture these elements in a functional form and prevent eutrophication. As a result, the NVE, NSE, and PSE values for anaerobic digestion are incorrect.	AD
CleanBay	15. A final significant aspect of anaerobic digesters that is not addressed in the report nitrogen mass balance is the ultimate fate of biogas which is always combusted either to generate heat or energy. Exactly like thermochemical conversion, any NH ₃ or NO _x that is present in the biogas will either have to be scrubbed out upstream or downstream of the biogas combustion process. However, in the case of biogas because the NH ₃ and NO _x concentrations are lower than those found in manure combustion processes, biogas can be scrubbed with much smaller and less intensive scrubbers that often trap the nitrogen species in stable solid phases through biofiltration and mineralization.	AD
CleanBay	16. The remaining sections on settling, mechanical solid-liquid separation, and wet chemical treatment are good, but organized improperly and suggest that these processes are used for manure conversion, which is untrue. The three currently practiced manure conversion technologies are only thermochemical, composting, and anaerobic digestion. These processes fundamentally alter the molecular and chemical makeup of the manure and generate outputs that are significantly different than the manure inputs. Settling, mechanical solid-liquid separation, and wet chemical treatment do not perform the same function and in fact are only used in practice to support thermochemical, composting, and anaerobic digestion conversion processes. Addressing these methods as	STTL, MSLS, WCT

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	<p>separate processes from a mass balance perspective is confusing and creates an untenable situation from a nutrient management perspective, particularly given that all conversion processes in commercial practice are highly integrated and utilize many different supporting unit operations. This report should be organized to focus on the 3 primary conversion processes and then it should address all the supporting unit operations within those sections. This is the only way to develop a comprehensive and functional mass balance for comparing the conversion processes.</p>	
CleanBay	<p>17. Not covering adsorption and absorption as supporting processes in the wet chemical treatment section is inappropriate given the importance of these mechanisms for the solid outputs of the anaerobic digestion and composting conversion processes. On a mass basis the primary outputs of these two manure conversion technologies are solids and one of the principal ways to stabilize and improve solids is to blend in adsorptive and absorptive materials. These materials contribute to mineralization or ion exchange and they result in dramatically improved retention and controlled release of nutrients. The use of these materials is highly common in the management of storm-water and municipal wastewater treatment for these exact reasons. The fact that the wet chemical treatment section focuses almost entirely on treatment of liquid streams means that it assesses mass balance considerations that have minimal importance and impact on traditional manure conversion technologies. This is not to suggest that these precipitation methods could not be utilized on liquids to a greater extent for improving manure conversion nutrient management in the future, just that it is currently not practiced often.</p>	WCT
CleanBay	<p>Recommendations</p> <p>The calculating and use of Level 3 Transfer Efficiencies as described in this report need to be re-thought and improved for this plan to have positive effects on nutrient management in the Chesapeake Bay watershed. CleanBay believes that the report generally offers helpful background and introduction material for the various technologies involved in manure conversion, but would like to recommend alternative methods for assessing the nitrogen and phosphorus pathways in support of improved nutrient management.</p> <p>Mass is neither created nor destroyed in any of these processes, so mass balances have a role, but mass transfer efficiency does not. Ultimately the nitrogen and phosphorus in the manure will enter the Box in the solid phase and will leave in some combination of solid, liquid, or gas phases. This means that there can never be any true difference between the mass of nutrient leaving the box and the mass of nutrients entering the box. Mass transfer efficiencies are used to check mass balance closures, but they are never used in chemical, process, or environmental engineering as a method for comparison because theoretically all mass balances come to closure because all mass can be accounted for. To suggest otherwise would be to suggest that mass is being destroyed or discounted and with the exception of fusion, fission, and transmutation processes this is impossible. Therefore, mass transfer efficiency as a standard of measure for this assessment needs to be replaced with something more logical.</p>	Overall

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	<ul style="list-style-type: none"> • CleanBay recommends that instead of mass transfer efficiency the Chesapeake Bay Watershed Model (CBWM) and Scenario Builder utilize conventional mass balances centered on nitrogen and phosphorous. These mass balances would be completed for each of the 3 major manure conversion processes using a minimum of 3 different combinations of the necessary supporting processes which include settling, mechanical solid-liquid separation, emissions scrubbing, drying, and wet chemical treatment. It would be understood and stated that more than 3 different combinations are possible, but these examples would provide a pragmatic platform for assessing commercially relevant, fully integrated, manure conversion processes. Conventional mass balances would track the nitrogen and phosphorus leaving the Box in all 3 phases (solid, liquid, gas). • CleanBay recommends that the boundaries on primary and supporting processes be drawn to encompass all of the processes that would be found at the facility site to support the manure conversion. Ultimately manure will arrive to the facility as an input and various outputs will leave. These outputs will include products and wastes and all outputs need to be accounted for to support responsible nutrient management. • CleanBay recommends that these mass balances only be completed for commercially practiced technologies. The reason being that mass balances based on lab, bench, and pilot scale processes that are then scaled up to commercial scales using a multiplier, are frequently wrong. The results and conclusions of the report will be far more legitimate and realistic if the scope is initially narrowed to include only commercially practiced technologies. This will make data collection easier and more straightforward and will avoid the subjectivity that comes with interpretation and extrapolation from primary literature. The option to include new technologies in the future should be left open, but the fundamental platform for this initial report should be defined by functioning processes of the appropriate scale to provide a solid basis for comparison. • CleanBay recommends that the basis for comparison be twofold with the objectives being: <ul style="list-style-type: none"> 1 - Production of more stable and controllable forms of nitrogen and phosphorous from manure that will not contribute to increased nutrient loads in surface waters 2 - Significant volume reduction of the manure into liquids or solids that can be easily and economically transported out of the watershed <p>Both of these objectives have the potential to truly have an effect on the nitrogen and phosphorus cycles in the Chesapeake Bay watershed. Simply putting the nitrogen and phosphorous into a different phase or changing its concentration will not actually address the problem. However, improving its chemical stability and significantly reducing volume both contribute to better</p>	
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	<p>control over the fate of the nutrients and ultimately improving control is the core philosophy of any sound nutrient management plan.</p> <ul style="list-style-type: none"> • CleanBay recommends that the production of stable and controllable forms of nitrogen and phosphorous be tested using a standardized method defined (or at least proposed) in the report. The most practical method would be a leach test to see what the effects of rainwater and soaking are on the nitrogen and phosphorous products. A grading scale can be used to determine the level of improvement over manure or vice versa if the product is less stable than manure. The scale should also contain values for commonly used agricultural fertilizers so that improvements over these products can be assessed as well. The level of improvement will be correlated with the CBWM and Scenario Builder to assess the effects on the watershed. • CleanBay recommends that volume reduction benefits only apply to outputs that will be removed from the watershed. Volume reduction is easily calculated for any commercially proven technology, but only solids or liquids that will be transported out of the watershed should be considered. Liquid and solids remaining in the watershed should not be counted towards any sort of benefit unless efforts have been made to stabilize as described above and the leach test has been performed. The benefits of volume reduction for transport need to be carefully considered alongside the sources of nitrogen fertilizers that will continue to be used by regional agricultural producers. While volume reduction provides a sort of control related to transportation, the benefits of this objective may be more related to improved ability to convert the outputs to a more stable form as described above. <p>Conclusions</p> <p>A functional methodology for assessing manure conversion technologies is important to CleanBay and we would like to offer our support in improving the process. CleanBay is quite willing to provide process expertise on anaerobic digestion and thermochemical conversions and to act as a sounding board for new ideas. As a company committed to improving the condition of the Chesapeake Bay Watershed and focused entirely on implementing technologies with proven commercial track records of controlling nitrogen and phosphorous from manure, CleanBay would like to participate in the development of improved nutrient management policies as much as possible. We look forward to attending the webinar and will be happy to set up additional meetings and calls to discuss further with any interested parties.</p>	
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