Tree Canopy Land Use Loading Rates – Summary of Questions, Comments & Responses

DRAFT v. 3/14/16

Note: As requested during the Urban Stormwater Workgroup meeting on 3/8/14, this draft Responses to Comments document has been prepared to summarize the questions and comments received during the partnership's review of Tree Canopy Land Use Loading Rates. The document is divided into 3 sections: 1) Responses to written comments received, 2) March Workgroup draft meeting minutes from Tree Canopy Loading Rate review, and 3) Q&A from 2/11/16 Webinar on Tree Canopy Loading Rates, draft recommendations. This document will be updated with final meeting minutes from 3/10 Modeling Workgroup and 3/14 WQGIT and included for reference in the Tree Canopy BMP Expert Panel Report, which is planned to be released for partnership review in April. If you have additional questions or suggested edits to help improve this Responses to Comments document, please send them to Julie Mawhorter, jmawhorter@fs.fed.us. (CB Tree Canopy Outcome Coordinator)

I. Responses to Written Comments Received following 2/11/16 Webinar

Comments From Randy Greer, DE DNREC

1. I was a little unclear about how the water balance methodology was linked to the NRCS runoff curve number method from reading the background paper. The runoff curve number method is an event-based method which has been acknowledged as underestimating runoff from small storm events, particularly for urban land covers. If the water balance methodology is relying on runoff calculations based on the range of precipitation shown in Figure 1 of the draft methodology paper, then it may be significantly underestimating that runoff.

   A: Hopefully the connection between water balance and NRCS curve number method is clearer in the updated background/technical paper. Runoff is one component of water balance, and we used the NRCS curve number method to estimate it. Based on information provided by Mr. Greer, we agree that our initial recommendations may be under estimating runoff for small precipitation events. In response to this new information we changed an underlying assumption in the curve number calculation, from Ia/S = 0.2 to Ia/S = 0.05, that better reflects the conditions that generate runoff at small spatial scales.

2. What was the rationale for using HSG D soils for the turfgrass areas in the analysis? These soils tend to be floodplain soils and/or soils with high water tables that are typically left undisturbed during development. I would recommend using HSG C soils instead as their hydrologic characteristics are more similar to typical compacted urban soils that have gone through the development process.

   A: Again, based on information provided by Mr. Greer, we agree that HSG C soils are likely more common in upland urban areas. In response to this new information, we changed CN values from CN = 84 to 79 for turfgrass, and CN = 80 to 74 for tree canopy over turfgrass. CN for impervious surfaces and tree canopy over impervious surfaces remained the same (CN = 98 for both).

3. Using HSG C soils rather than HSG D soils will decrease the runoff and may offset any increase in runoff using a more appropriate method for the water balance equations. However, even though there may be no net effect, I feel we need to make sure the results are based on sound methods. If you'd like to discuss this further, please let me know.

   A: Changing Ia/S from 0.2 to 0.05 and the CN numbers for pervious land uses from HSG D to HSG C caused the mean runoff reduction to decrease from approximately 39 % to 29 %, although this change could also be due to a longer rainfall record (from one to eleven years) for each of the eight weather stations.

<u>Comments From Jeff White, MDE:</u>

Summary of SSA's comments:

The primary driver of the estimated reductions in surface runoff appears to be the applied interception rates and differences in curve numbers between turf with D soils and turf with C soils (approximation of canopy conditions). The interception rate appears to be empirically derived, but its derivation is not well documented, and its temporal application is also of question. The direct relationship between reductions in surface runoff and pollutant loads is questionable, primarily for TN. Lastly, a more clear explanation needs to be provided for the various modeling protocols before MDE can make a judgement regarding the science supporting the proposed TN, TP, and TSS loading reductions.

Specific Comments:

1. TN, TP, and TSS reduction rates are set equal to the modeled reduction rates in surface runoff. This can be conceptually rationalized for TP and TSS. Less runoff volume potentially means less solids from EOF. For TN, this is not necessarily the case. The methodology document discusses how the major driver of nitrogen reductions are resultant from increased denitrification in the soil due to increased soil moisture and increased organic matter inputs. Soil moisture content is explicitly modeled, at least in the canopy scenarios. Assuming soil moisture content is also modeled for non-canopy scenarios, why is the TN reduction related to the reduction in surface runoff rather than the increase in soil moisture content?

A: Denitrification is one mechanism that trees enhance to prevent nitrogen from impacting water quality. The others are on-site storage in soils and biomass. While we would love to be able to quantify the flux of N removed via denitrification based on changes in soil moisture, we know of no method to do so. Also, we would like to point out that even though N, P, and sediment are reduced proportionally, the proportion is applied to unique loading rates for N, P, and sediment of the underlying land use. Therefore, a 25% reduction does not mean that trees reduce the same lbs. of N and P.

2. The model used to quantify reductions only captures the EOF effects for TSS and TP. It does not capture the EOS effects. This is noted by the modelers, and there is intent to capture these effects in the future. Per CBP P532 watershed model documentation, since a significant portion of the TSS and TP loading rate for impervious surfaces is attributed to downstream bank erosion from increased flows, it is recommended that a potential decrease in downstream TSS and TP loads due to canopy cover and

reduced flow volumes and velocities be quantified. If not, the reduction rates, especially for canopy over impervious surfaces, could be significantly under-estimated. The possibility exists that TSS and TP EOS loads, rather than solely EOF loads, are directly proportional to surface runoff. If this were the case, the current load reductions would reflect downstream impacts. The issue of downstream effects should be investigated further.

A: For tree canopy over turfgrass it is true that we have only considered the edge of field effects. We expect that the relative EOS effects from tree canopy over turfgrass will be small as turfgrass has moderate to high retentive properties compared to impervious surfaces. On the otherhand, reductions from tree canopy over impervious surfaces are primarily due to EOS effects as there is little to no opportunity for infiltration from impervious surfaces and they are highly connected to surface waters. Based on our methods and level of expertise in open-channel hydraulics, we are unable to estimate EOS effects of tree canopy over impervious surfaces beyond relative runoff reductions (~7%).

3. Generally speaking, the results and proposed reduction rates are based on modeling data, not empirical data. Modeling parameters do seem to be driven by empirically derived data, but the source of these empirical estimates is poorly documented in some instances, or it is not relevant to the Chesapeake Bay Watershed. For example, the 0.05 in/rain event interception rate applied in the model comes from the Minnesota Pollution Control Agency (MPCA). The MPCA uses this rate to credit loading reductions for urban trees. After looking into where MPCA came up with this rate, it is not clear how it was derived. The MPCA cites several studies that quantified the rate of interception for various types of trees. The documented rates for deciduous trees comes from a California study and provides a range of 0.09-0.14 in/rain event. It is also not clear in either MPCA documentation or CBP tree canopy documentation whether the interception rate is applied year round. Is the same interception rate applied in the summer during leaf-on conditions as applied in the winter during leaf-off conditions? Other modeling parameter values are not documented at all. For instance, the evapo-transpiration rates applied of 0.05, 0.08, and 0.05 in/day for turf, canopy over turf, and canopy over impervious are not cited.

A: All modeling parameters for plant function and soil properties were taken from peer-reviewed journal articles or textbooks on these subjects. The final report documents original data sources, the observed range of modeling parameters across different tree species and sizes when appropriate, and states each parameter value used in our calculations. Because mapping of tree canopy land uses only indicates the presence of a tree and contains no other information on species or health, we used parameter values slightly below the mean of the observed range in an effort to be conservative, but not so conservative that our calculations no longer reflect reality.

4. It is not clear how the total reductions per geographic area presented in Appendix 2 were derived. It is clear that the final proposed rates in Table 1 are an average of the total reduction values in Appendix 2; however, the derivation of these individual totals is not clear. For canopy over turf grass, a runoff reduction, leaching reduction, and total reduction are presented. Isn't the leaching reduction a subset of the runoff reduction? Further, why is the total reduction (reduction in runoff output in pre and post canopy scenarios) not equal to the runoff reduction?

A: For pollutants with soluble forms including N and P, runoff is only one component of water yield that may impact water quality. For each geographic location and year, runoff and leaching reductions were calculated individually using daily weather/rainfall data as well as an integrated total that

weights runoff and leaching separately based on the total flux of each component (see Eq. 1-3 below). For pervious areas, total reduction will fall closer to the reduction based on leaching because the water flux via leaching is greater than that of runoff.

It is true that runoff and leaching are related (less runoff = more potential leaching and vise versa), but it is not true that they are subsets of one another. Jeff White and Justin Hynicka discussed this question in person and realized that part of the confusion was due to how 'runoff' and 'leaching' are defined. Based on the CN method, 'runoff' from pervious surfaces can include overland flow (the most common definition of runoff) and shallow subsurface macro-pore flow (sometimes called throughflow or leaching). Both of these components help to explain the shape of a storm hydrograph but they cannot be differentiated from each other using this method. In our analysis, leaching refers to water that impacts baseflow AND NOT stormflow. This is the reason why leaching is not a subset of runoff based on our method.

$$f_r = \left(1 - \frac{\sum R_{gc}}{\sum R_g}\right) \times 100$$ **(Eq. 1; runoff reduction)**

$$f_l = \left(1 - \frac{\sum L_{gc}}{\sum L_g}\right) \times 100$$ **(Eq. 2, leaching reduction)**

$$f_t = \left(1 - \frac{\sum R_{gc} + \sum L_{gc}}{\sum R_g + \sum L_g}\right) \times 100$$ **(Eq. 3, total 'weighted' reduction)**

5. Related to #4, the throughflow modeling and reductions are poorly explained. Is a throughflow output estimated? Based on the descriptions of what happens to precipitation that infiltrates the shallow sub-surface in excess of the soil water holding capacity, it would appear as though a throughflow output is not estimated, even in a non-canopy scenario. All excess precipitation that infiltrates beyond the holding capacity of the shallow subsurface appears to infiltrate to deep ground water no matter whether canopy is present, based on the documentation. If this is the case, in the turf or impervious only scenarios, there is no throughflow output, so how can there be a calculated reduction?

A: To be clear, calculations based on throughflow apply only to impervious areas. We estimated throughflow inputs beneath impervious surfaces, which originate from adjacent lands, based on the leaching flux calculated from turfgrass land uses. Then we estimated throughflow outputs from tree canopy over impervious surfaces based on evapotranspiration rates of trees (input = output without trees). However, throughflow is a poorly constrained factor in our original calculations for tree canopy over impervious surfaces. This, combined with the fact that the vast majority of N and P taken up by trees from throughflow is returned to impervious surfaces as leaf litter, is the primary reason

that NO CREDIT was given based on the estimated change in throughflow. Very minimal credit is now given for the change in throughflow based on N and P storage in woody biomass (see final report for calculations). It is necessary to account for this component because otherwise no tree could exist, and these calculations may help to inform the ongoing discussion on whether leaf litter collection from impervious surfaces may be eligible for credit.

6. The final relative loading rate for tree canopy over turf should be less than turf but greater than forest. Since tree canopy over turf is an urban land-use to which it is assumed the suite of urban BMPs can be applied, the final loading rate after BMP application should also be greater than forest. This could be an issue when applying high efficiency urban BMPs, i.e., infiltration practices. See following example.

P532 No Action Scenario TN EOS Units Loads (MD) - Statewide Avg

Forest = 3.1 lbs/acre/yr

Urban Pervious = 10.8 lbs/acre/yr

Infiltration TN Efficiency = 85%

Proposed Tree Canopy Over Turf Efficiency = 26%

[(10.8 lbs/acre/yr) x (1 - 0.26)] x (1 - 0.85) = 1.2 lbs/acre/yr, which is < 3.1 lbs/acre/yr

Whether the approach is to limit the urban BMPs that can be applied to tree canopy over turf, or drop the canopy over turf reduction percentage, these situations need to be avoided.

A: We completely agree that the loading rate for tree canopy land uses should be higher than forest, and indeed they are several times higher than forest land uses. In the example provided above, an infiltration efficiently of 85% for TN by a retention basin will reduce TN loading from a parcel below the loading rate of forests regardless of whether tree canopy land uses are present or not.

<u>Comments from James Davis-Martin/VADEQ</u>

Q: Make a clear connection between the recommendations and the literature.

A: Additional literature citations (~50 references) have been added to the updated Tree Canopy Loading Rate Methodology document that has been posted for workgroups and WQGIT. In addition, the draft Expert Panel Literature Review completed by the Center for Watershed Protection has been posted with additional references.

Q: Where modeling is used, try to mirror the model assumptions in the watershed model. Hydrology, ET, etc.

A: Our team including Justin Hynicka and leadership from the TC Expert Panel and Forestry Workgroup worked closely with Gary Shenk and others from the modeling team to ensure that the TC loading rate modeling approach was compatible with the CB WSM processes and assumptions.

Q: Provide more justification for the overarching assumption that interception = runoff reduction. Particularly with different tree types, seasons and rainfall events.

A: While the preliminary Expert Panel recommendations from the fall used an interception=runoff reduction approach, the new methodology uses a water balance framework to better account for the full hydrological processes affected by tree canopy, connecting interception, evapotranspiration, leaching, and uptake to better estimate runoff and pollutant reduction. For defining Bay-wide land use target loading ratios, an average value is needed to account for variation across the landscape, in this case variation in tree types and sizes. Therefore, a .05 inch/storm interception rate was used, which reflects an interception rate just below the mean of literature values for deciduous trees. This effectively sets a science-based "saturation point" that eliminates over-crediting the effects of canopy during heavy rainfall events. The evapotranspiration rate was set based on average literature values. The modeling approach uses daily rainfall data averaged from 8 watershed locations over an 11 year period to provide a robust estimate of runoff reduction. Interception and evapotranspiration were set equal to zero (i.e. given no credit) during the 5 month winter season to account for leaf off conditions. These values represent conservative estimates, because only deciduous trees were used in the assumptions. Evergreen trees do exist in our region and provide benefits year-round, but we have not given any credit to their function.

Q: Should the recommended relative loading rates only apply in months when there is canopy and/or only under certain rainfall conditions?

A: Those effects are already built into the loading rate calculations, as summarized above and described more fully in the methodology document.

Q: Make sure the documentation adequately addresses the impact of leaf litter on loading rates. Hard for me to accept reductions in loading rates due to tree nitrogen uptake during the growing season without accounting for the nitrogen returned to the land as leaf litter in the fall.

A: The Street Sweeping Expert Panel gave in depth treatment to this issue and concluded that there is not sufficient science to quantify loadings from leaf litter in urban settings at this time. We took a conservative approach and for the Tree Canopy over Impervious land use, no credit is given for nutrient uptake into leaf biomass; only a small credit is given for uptake of N and P into woody biomass which provides longterm storage. In this context, the net effect of leaf litter is assumed to be zero because trees take up nutrients from subsurface flow (throughflow) in order to generate leaves each year, then these leaves are deposited on the pavement and re-enter the hydrologic system.

Q: If the current underlying loading rate included both areas with and without TC, shouldn't this be a net zero adjustment in the urban loads? This would also ease concerns about the need to adjust other BMP's efficiencies that likely included areas with and without TC.

A: Correct – as Olivia Devereux's presentation slides cover, the adjustments to the urban land use loading ratios have a net zero effect on urban loads. The total urban loads do not change, they are just reallocated slightly differently among the new land use classes. The loading rate of the underlying land uses (turf/impervious) goes up slightly, and the Tree Canopy land uses are set lower than those classes based on the recommended % reductions.

Q: As written, the practice seems to accept that any tree will do. Native. Invasive. Ornamental. Deciduous. Coniferous. Evergreen. Large. Small. Young. Old. All have the same effect. Our model, rightly or wrongly, differentiates between crops, 40+ varieties of agricultural crops I think, because it has been determined that they have different effects on water quality. If oats is different from wheat and corn for grain is different than corn for silage, how are we supposed to accept that a tree is a tree is a tree?

A: It is true that individual trees vary in performance – just as there is variation in performance across the landscape in other land uses, e.g. forest, turf, open space – but for land use loading rate targets the model needs one number that represents a reasonable average across this variation. Therefore the TC modeling approach uses an average size/performance of a deciduous tree to estimate the effect of the land use, as described above. Because mapping of tree canopy land uses only indicates the presence of a tree and contains no other information on species or health, we used parameter values slightly below the mean of the observed range in an effort to be conservative, but not so conservative that our calculations no longer reflect reality.

For the tree planting BMP efficiency (new plantings), the Expert Panel is building in consideration of these questions into their recommendations, and there will be an opportunity to give input on that when the BMP Panel Report makes its way through the partnership in April and beyond.

Q: If tree canopy is a land use, or two land uses, how are we going to hindcast and forecast the change in TC through time? The high-res land cover will provide one data point around 2013, a few localities may have a second data point. That one (or two where available) point would need to be extrapolated for 1985-2014 for the calibration and potentially out to 2025 for planning and progress scenarios.

A: This issue was raised and discussed with LUWG back in the fall, and the LUWG leadership issued a memo addressing the issue:

> **Another question concerned the accuracy of the process by which the Land Use Data team estimates the acreage and location of land uses throughout the entire Phase 6 calibration period, which extends from 1985 to 2013. The final baseline Phase 6 land use database will be derived from 2013 and 2014 imagery. Hindcasting, as the process of estimating land uses backward in time is known, from 2013 to 1985 presents a challenge due to data limitations affecting all Phase 6 land uses. The proposed tree canopy land uses would be hindcast using**

the same procedures that the Land Use Data team will employ for estimating the past extent of all major land uses. The accuracy of its estimation throughout the calibration period would be comparable to the accuracy for all other classes.

Peter Claggett can provide more detailed information on how they will approach the forecast/hindcasting for tree canopy and other land uses.

Comments from Douglas Smith, City of Lancaster Dept. of Public Works

The City of Lancaster recognizes the multiple benefits that its urban forest provides, including intercepting stormwater and mitigating pollution, among many other co-benefits. Accordingly, the City of Lancaster supports the Chesapeake Bay Program's efforts to include tree canopy land use loading rates in the Phase 6 Watershed Model. After reviewing the Tree Canopy Literature Synthesis DRAFT 1-2-16 and the Tree Canopy Loading Rate Methodology DRAFT 2-11-16, the City Stormwater Bureau would like to offer the following comments:

Q: - At present, the proposed methodology only considers rainfall data from 2015. Given the variation in rainfall from year to year, it may be helpful to consider historical data, at least within the last 10 years.

A: This suggestion has been incorporated into the final loading rate recommendations

Q: The current urban tree canopy assessment for the Chesapeake Bay watershed is 1m resolution, which will presumably be used for tree canopy land use loading rates; however, many trees in urban environments are smaller, not clustered, and partially obscured by buildings, and they might not be recognized with 1m resolution. It would be helpful if communities could be provided an opportunity to supply CBP with higher resolution urban tree canopy data so that more accurate loading rates can be calculated. This would also create an incentive for communities to invest in this higher quality data, while gaining the benefit of a more accurate BMP credit.

A: This is an important issue that pertains to how well the high resolution land cover assessment picks up all the urban tree canopy on the landscape. The science and modeling approach used to develop the Tree Canopy loading rates are based on whether canopy is present or absent, regardless of mapping considerations/accuracy. Because this question addresses mapping considerations, it should be raised for consideration with the Land Use Workgroup, as the partnership continues to develop and refine mapping methodologies going forward.

Q: The literature review does not consider how the resolution of urban tree canopy assessments might alter interception values. There should be some discussion of resolution included in the literature review, or at least a reporting of what the cited journal articles used.
A: The research studies used to set the interception rate in this methodology (.05 in/storm event) was based on site-scale studies of tree performance, not on landscape-level urban tree

canopy data as a modeling input. Therefore the loading rate calculations are not impacted by resolution of UTC data. However, the concerns you note above about data resolution will impact how much urban tree canopy is picked up/reflected in the CB model, therefore the issue can be taken up with the Land Use Workgroup which deals with mapping considerations.

Q: The City of Lancaster has a robust green infrastructure program that aims to eliminate its combined sewer overflows. This includes acres of porous parking that cannot be accurately calculated using a CN of 98 for impervious surface. The current tree canopy loading rate methodology does not consider how tree canopy interacts with other stormwater BMP's. The Forestry Workgroup and Tree Canopy Expert Panel should work towards incorporating this into the tree canopy model, especially because trees are increasingly an important part of green infrastructure projects.

The above recommendations have been offered for the following reasons: precipitation patterns are changing, hi-resolution aerial imagery (<1m) is increasingly accessible, and green infrastructure solutions increasingly common. Please take these considerations into account as you refine your methodology. The City of Lancaster is appreciative of the Chesapeake Bay Program's continued efforts to protect our regional environmental resources.

A: This is a good question that deals more with site-specific stormwater BMP implementation/credit than with land use loading rates, which must reflect a best estimate of Bay-wide average conditions pre-BMP application. We encourage that you look into the other Chesapeake Bay BMP credits for stormwater/green infrastructure practices, and engage with the Urban Stormwater Workgroup regarding additional questions and suggestions.

II. Draft Minutes from Workgroup Meetings March 2015 - Tree Canopy Loading Rate Presentations

Note: these minutes will be updated once workgroups have reviewed and finalized their meeting minutes

Forestry Workgroup 3/2/16

FWG approved TC loading rates, and had reviewed methodology at prior meetings; no comments received.

Land Use Workgroup 3/2/16

Briefing on Tree Canopy Land Use Loading Rates – Justin Hynicka

- Justin discussed the proposed tree canopy land use loading rates planned for incorporation into the Phase 6.0 model.
- Claggett: This is more of a process based approach to estimating the effects of canopy on underlying land uses, and it helps us conceptually in our discussions on turf grass versus open space.

- The LUWG expressed support for the proposed tree canopy land use loading rates.

Watershed Technical Workgroup 3/3/16

Discussion:

- Matt Johnston (WTWG): In the next month or two, the WTWG will receive the BMP panel report on tree canopy, which proposes a simple land use change crediting method, so we wanted to bring forward this update early. We aren't approving the loading rates, but this is a heads-up as far as what we expect to see from the panel report down the road.
- Bill Keeling (VA DEQ): Are we being asked to approve this?
    - Johnston: No. The Urban Stormwater Workgroup, Forestry Workgroup, Modeling Workgroup and Water Quality Goal Team will be asked to approve this.
- Marty Hurd (DOEE): Buildings and other impervious have a lower total phosphorus (TP) relative loading rate than tree canopy over impervious. Is that correct?
    - Hynicka: Yes, because most tree canopy occurs over roads, rather than buildings and other. This method applies tree canopy 90% over roads and 10% over buildings and other.
- Keeling: Did you turn off evapotranspiration effects in the winter months?
    - Hynicka: Yes.
- Keeling: Are you accounting for leaf litter as a nutrient input during the fall?
    - Hynicka: Not for tree canopy over pervious. For tree canopy over impervious, it would be net zero, because there is a benefit from interception of rainfall, offset by the increase in load from leaf litter
- Keeling: There is literature that says leaf litter is a source of nutrients in the fall.
    - Hynicka: Yes, but the increase is only in the fall. The trees are reducing nitrogen and phosphorus loads the rest of the year. Over the course of the whole year, the net effect is zero.
- Keeling: I see problems with how we will have to distribute BMPs across these new land uses using assumptions.
- Hurd: You did the original and adjusted tables. There wasn't one for sediment. Is there are reason, or is that available?
    - Olivia Devereux (DEC): We aren't doing targets for sediment the same way as nitrogen and phosphorus. Peter Claggett (USGS) is addressing sediment relative loading rates with a separate methodology using RUSLE. That is why they are not included.
- Hurd: Do we know the original turf grass loading rate for sediment? Can we expect a percent reduction from turfgrass to tree canopy over turfgrass for sediment?
    - Hynicka: That would be the correct way to interpret it. We could include that in the next few presentations.
- Johnston: What is the avenue for folks here to provide comments? Is it to brief their colleagues who sit on the other workgroups?
    - Sally Claggett (USFS): Yes, or we would be happy to take your comments directly as well.

ACTION: WTWG members should send questions or comments on the tree canopy land use relative loading rates to Julie Mawhorter (jmawhorter@fs.fed.us) and Justin Hynicka (justin.hynicka@maryland.gov).

- Robin Pellicano (MDE): It would be good to go into more detail on how you arrived at the relative loading rate reductions that are presented in the table.
    - Devereux: I have a presentation for the urban stormwater workgroup that provide further detail. It is based on a weighting process.
- Pellicano: So the tree canopy over turfgrass isn't just calculated from turfgrass?
    - Devereux: Tree canopy over turfgrass is calculated just from turfgrass. The tree canopy over impervious is calculated from roads as well as buildings and other, using a weighting approach.
- Pellicano: My concern is that when you have BMPs on a tree canopy land use, you have to be very careful that when you apply those BMPs that they don't lower the urban pervious loading rate to below a forest loading rate.
    - Johnston: That is a good point. That can happen the way the Phase 5.3.2 Model is currently set up, just as it can happen in Phase 6. I think that is something we should talk about as a partnership. It has more to do with the BMP efficiencies assigned than with the land use loading rates.
- Keeling: I know that BMPs are recorded as urban or impervious, and I'me not given information on where they are relative to tree canopy. Virginia's BMPs will be applied to those land uses based on assumptions that I am not sure I would support.
    - Johnston: If a state reports a BMP on urban pervious, it will get distributed proportionally to urban pervious and tree canopy over turfgrass in the geographic area. That's the same way we handle BMPs that are reported to just "row crops" for instance. They are proportioned across all of the row crops land uses.
- Claggett: My concern is that these two land uses are being treated differently than many other land uses.

<u>Urban Stormwater Workgroup 3/8/16</u>

Discussion:

- Jeremy Hanson (VT, CBPO): Please quickly explain why there isn't a table for relative sediment loading rates.
    - Olivia Devereux (DEC): Sediment loading rates are handled using a different methodology than nitrogen and phosphorus loading rates. Peter Claggett (USGS) uses factors from the RUSLE model run to determine sediment loads.
- Goulet: As far as worrying about speciation and some of the finer details, while those types of concerns do have some validity, they are probably not that big of an issue because we are looking for an average number. The one hang up I still have is with using loading rate information from the National Stormwater Quality Database (NSQD), where the data lump loads from urban lands with tree canopy and without tree canopy. I think the loads in that database are being affected by trees and because of that, we are trying to modify a rate that is already being modified. The numbers Olivia showed are small shifts, but they may be important at the local scale where they have to meet a certain number to achieve a local WIP in a permitted sector. The methodology presented today is a sound methodology and it has been well thought out. My only concern with the method is that we talk about storage of nitrogen and phosphorus in the wood, it seems a little precise when we are dealing with wide averages across a large watershed. I will not stand in the way of this moving forward. I do not think it has a fatal flaw.

- Tom Schueler (CSN, Coordinator): I would like to compliment the team for the amount of work done over a short period of time. I see no fatal flaws and would recommend moving it forward.
- Bauer: Can you briefly review how the seasonality of canopy is addressed?
    - Hynicka: The model we used is run at a daily time scale, so during winter months we didn't give any credit for canopy interception. So for 5 months out of the year, you don't get that interception credit.
- Bauer: For interception, was a saturation point factored in for heavy rainfall events?
    - Hynicka: Keeping in mind that this is a relative calculation we are doing, we used a canopy interception of 0.05 inches per storm, which sets the canopy saturation point. There is a point when the rainfall is no longer being stored in the canopy. There are some benefits of through-fall by reducing the flow rate, but we did set a saturation point for these calculations based on the literature.
- Goulet: The nitrogen and phosphorus values are the same, do the trees and turfgrass process nitrogen and phosphorus exactly the same?
    - Hynicka: No, nitrogen is more mobile than phosphorus, so the actual loading rates of N and P are different in turfgrass. But remember, we are talking about relative loading rates. To put it another way, the 20% value is 20% of two different numbers, so the loads are not the same.
- Ginny Snead (Louis Berger): I don't think there are any fatal flaws. The basis of using the NSQD creates larger margins of error than anything we are discussing in terms of the methods, and it would be great to have more data available to help make these decisions.
    - Goulet: I agree. I would recommend that we say there should be further research.
    - Hynicka: Is that comment specifically about these land uses, or urban lands in general?
        - Snead: Really any time we are using that database.
- Jesse Maines (City of Alexandria): Regarding the assumption about N and P contained in the woody part of trees, do you have greater uptake when leaves come back on in the spring?
    - Hynicka: When I use the value of N and P stored in wood, it is a number relative to what is also stored in leaves and being deposited from the atmosphere. From the total amount stored, 5% of N and P is taken up in the wood. The model does account for the large amount of N and P uptake that is used to build leaves, etc.
- Katherine Antos (EPA, CBPO): So the N and P that end up in the leaves isn't a credit because when the leaves come off they end up back in system anyways?
    - Hynicka: Correct.
- Maines: Then shouldn't there be a credit for a leaf program?
    - Schueler: That was explicitly dealt with by the street sweeping expert panel. While there was some interesting data, they came to consensus that a leaf program would not be eligible for credit because there just wasn't enough to support that credit. One of the panelists has started new research out of Minnesota to investigate this further. When that research is published, we will share it with the workgroup.
- Greg Busch (MDE): Is the final product going to be the memo that has been sent out? Will there be a formal comment and response document to go along with the memo?
    - Goulet: The memo, literature review summary, webinar, and responses to comments from the webinar and workgroups will all be part of the package. The BMP panel report is a separate process from this.

    - Rebecca Hanmer (FWG): Yes, we will supplement Justin's report with a Q&A document. We will respond to comments in writing.
    - Hanson: The panel has been involved throughout the process and the plan is for the BMP to be based on a land use change, so the panel is waiting for this outcome to develop the BMP report. This memo will likely be an appendix to that report as well.
- Goulet: Are there any objections to moving forward with the proposed tree canopy land use relative loading rates?
    - None were raised.

DECISION: The USWG approved the Phase 6 Relative Land Use Loading Rates for Tree Canopy.

Modeling Workgroup 3/10/16

To be added when minutes are available

III. Tree Canopy Loading Rates Webinar 2/11/16– Questions and Answers on Draft Loading Rates

Note: These notes summarize the questions and answers that occurred during the webinar on the draft loading rate recommendations. Following the webinar, these questions were used to help guide refinements to the loading rate methodology and technical documentation to respond more comprehensively to the questions raised.

Q: Is "impervious" defined in the context of the Phase 6 Model land uses as "roads" or "buildings and other"? Alternatively, is canopy over impervious intended to be a reduction from an area-weighted average of both of those land uses, as was discussed in September?
A: This analysis pertains mostly to roads. The percentage reduction would also be true for other impervious services, it just depends how those buildings are connected to the storm sewer, so that might change how we handle it. But it could probably be applied to all impervious surfaces. *[Additional follow-up confirmed that the vast majority (~90%) of TC over impervious occurs on roads]*

Q: Slide 44 - is the 'Result' statement that reduction of nutrient loads from trees over turfgrass are likely directly proportional to reduction in water yield...is this based on data (i.e. computer program analysis showing direct relationship)?
A: No, there is no computing using nutrient concentration data. We are pulling from the literature information on tree function at an ecosystem level. We did look at some of soil leachate work, for the most part there is not a huge difference in leachates beneath turf grass versus beneath trees. The big question is whether it is fertilized. When dealing with fertilizer, there is a question about spatial variability. In this model, because we are doing relative loading rate, we are covering both ends of the spectrum. The relative difference would be similar whether fertilized or not.

Q: The Bay Model assumes that all turf is fertilized, including turf under trees. Were these loading rates estimated assuming that the turf was fertilized? And if not, how could the loading rates be changed to reflect that?
A: We assumed that all inputs of nitrogen, phosphorus and sediment were the same between the underlying land uses and the Tree Canopy land uses. The only thing we did was see how water yield changes across land uses, and applied the same amount of N, P, and sediment to that. The assumption of fertilizer being used may not be true across all land uses but we are making assumption that all inputs are the same.

Q: Can you repeat where the interception rate of 0.05 in/storm and ET rate of 0.08 in/day for TC over turf come from?
A: This is pulled from several literature documents, to save time please reference the technical documentation.

Q: The reduction rates proposed here are a direct result of the modeling. I would like to hear some more discussion of the assumptions in that model...CN, hydrology, etc
A: For the most part the assumptions of CN we basically used the recommendations from the USDA technical report. Hydrology is a different question, might need more clarification on that, so maybe another point to follow up on.

Q: Why did you look at just one year of data?
A: Because the Chesapeake Bay Watershed Model also looks at it year by year. We could expand it to look at previous rainfall in previous years. *[note: following the webinar, rainfall inputs were expanded to include 11-years worth of data from eight different locations]*

Q: Slide 47 - why would the assumption be that trees intercept precipitation on leaves and branches and reduce intensity, volume, and velocity only over impervious and not over turfgrass?
A: Great question. We are not assuming that when you have tree over turf grass the tree isn't doing the same thing. It is just that there are factors in the underlying land use that determine runoff. The amount generated from turf is a lot less than on impervious. So the energy of water running off will be reduced overall.

Q: Will the reduction rates here be applied to the Tree Planting BMP to ensure there is consistency between lands currently classified as tree canopy and those created in the future?
A: These proposed loading rates would only apply in Phase 6. The current Tree Planting BMP used for Phase 5.3.2 will remain unchanged. For phase 6, the recommendations from the BMP Expert Panel are coming in April or this Spring. The Panel is waiting for the results from this analysis, and will be making a recommendation afterwards.

Q: I might have missed this in the beginning of the presentation, but could you clarify what pollution sources you are assuming in this model?
A: For turf grass, inputs are fertilizer, nitrogen, phosphorus, and particulates from both wet and dry deposition. This applies when are talking about direct benefits. For indirect benefits, we looked at nitrogen, phosphorus and sediment which become mobilized when you have erosion.

Q: Based on your last slides, it looks like the indirect effects of decreased flow and bank erosion from TC over impervious are not reflected in the proposed loading reduction (7%), is that correct?

A: That is correct. That 7% is just the reduced water volume. We will be working the next two weeks on the temporal effects of interception. So that is why we described the 7% as kind of being the floor, and the number might be raised. If we have data to adjust it upward, it would be described in March updates at all of the workgroup meetings in addition to other comments received. So likely it is 7% plus.

Q: Do the proposed reductions apply to N, P and S? Please describe the evidence supporting this.
A: Yes, we are using these proposed reductions across all three pollutants. I think there could be an opportunity for the indirect benefits to have slightly different rates, and that evidence is supported in the technical document we uploaded. For those indirect benefits, when we look at erosion, soil has three components: sediment mass, nitrogen inorganic matter and phosphorus so we can use those proportions to adjust the relative loading rate.

Q: Do you have any other data available to you for soil leachate other than an annual amount so that seasonal variation could be applied instead of dividing by 365 to come up with the throughflow rate?
A: That throughflow assumption is really critical for the water balance model, but when applying water balance to nutrient fluxes we are dropping that out.

Q: It seems a stretch that all three pollutants would be directly proportional to runoff reduction, under all precipitation intensities, all tree types, and any time of the year.
A: Noted for future reference. What you could do is that if those pollutants have different rates for tree canopy, you apply the percent reduction to that.

Q: I agree if the annual percent reduction in water yield by tree canopy is going to be used, historical rainfall data should be analyzed...not one year.
A: All sites have data that go back 10 years, the model is easy to run for every one of those years just a little bit of processing on backend. If people want to see this I am happy to accommodate that.

Q: What % of the total rainfall is the 0.05 in interception capacity?
A: Percent of total rainfall will depend on the storm. We are presenting daily rainfall data, the sum of precipitation over the year is what we are using to get the percentage reduction value.

Q: How do the analyses or lit review incorporate USFS i-Tree considerations, as these are commonly accepted?
A: The Expert Panel literature review on our summary of runoff reduction looked at studies that used the i-Tree model program, so the literature review incorporated those where available. The Expert Panel has looked closely at these tools to see how they can be incorporated to characterize this BMP. Many of the models reviewed used loading rates, none of them characterized modeling environment that would be suitable to the land use in question.
The i-Tree hydro model combined tree canopy over pervious and impervious and forest, so we have had to look elsewhere to tease that out, but we are comparing our results to the output of the i-Tree model.

Q: Why one number for the whole watershed?

A: It is true that individual trees vary in performance – just as there is variation in performance across the landscape in other land uses, e.g. forest, turf, open space – but the model needs one number that

represents a reasonable average across this variation; therefore the TC modeling approach uses an average size/performance deciduous tree to estimate the effect of the land use.

Q: What soil groups used?

A: This is explained in the documentation. *[hydrological soil group C was used in final calculations]*

Q: How do different species factor in?

A: For the purposes of the land use and relative loading rate, an average deciduous tree is used. The expert panel is developing methods for crediting the related BMP that will account for a range of commonly planted species.

Q: Why not more geographically based than one size fits all? There have been efforts to move away from a one-size-fits all approach.

A: See previous responses. For land use purposes it is appropriate to use a reasonable average.