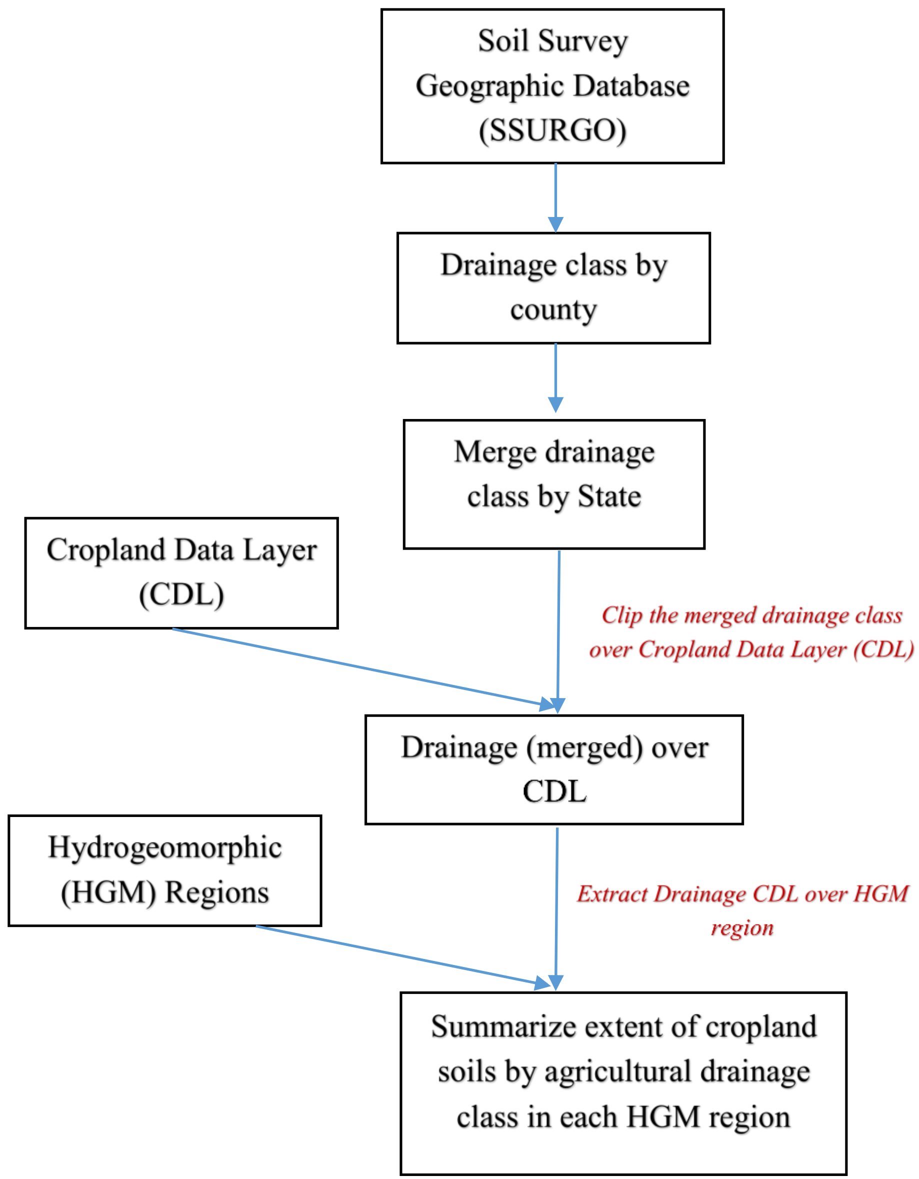
Conservation Tillage Phase 6 Panel

Tillage categories and info.

Category	**Residue cover and soil disturbance**	**Corollary Phase 5.3.2 practice**	**Other relevant standard**
1. Conventional/high till	< 15% cover OR 15 – 29% cover with full width tillage.	high till/conventional tillage	
2. Low residue, strip till/no-till	15 – 29% cover, strip till or no-till, and less than 40% soil disturbance	N/A - This is a new category for the conservation tillage practice.	NRCS Conservation Practice Standard Code 329
3. Conservation tillage	30 – 59% cover	conservation tillage	NRCS Conservation Practice Standard Code 345
4. High residue, minimum soil disturbance tillage	≥60% cover, minimum disturbance	High residue, minimum soil disturbance tillage (HRTill)	

Sediment and N

Low residue, strip till/no-till 16-29% residue		Conservation tillage 30-59% residue		HRMSD ≥60% residue	
Sediment Losses (relative to conventional/high tillage)					
	-18%		-41%		-79%
Surface N Losses (relative to conventional/high tillage)					
Uplands:	-5%	Uplands:	-10%	Uplands:	-14%
Coastal Plain:	-2%	Coastal Plain:	-4%	Coastal Plain:	-12%


Soil Survey Geographic Database (SSURGO)
Drainage class by county
Merge drainage class by State
Cropland Data Layer (CDL)
Clip the merged drainage class over Cropland Data Layer (CDL)
Drainage (merged) over CDL
Hydrogeomorphic (HGM) Regions
Extract Drainage CDL over HGM region
Summarize extent of cropland soils by agricultural drainage class in each HGM region

CBW cropland drainage area by HGM region

Proportion of Cropland	%Well drained	% Poorly drained
Appalachian Plateau, Siliciclastic	76%	24%
Appalachian Plateau, Carbonate	81%	19%
Blue Ridge	93%	7%
Coastal Plain Disected Upland	85%	15%
Coastal Plain Lowland	68%	32%
Coastal Plain Upland	75%	25%
Mesozoil Lowland	78%	22%
Piedmont Carbonate	98%	2%
Piecmont Chrystalline	97%	3%
Valley and Ridge Carbonate	97%	3%
Valley and Ridge Siliciclastic	92%	8%

Literature values for Surface P loss reductions (well-drained average)

		Surface P Loss Reduction
Low residue, strip till/no-till	16-29% residue	-9%
Conservation Tillage	30-59% residue	-64%
High Residue, Min Soil Disturbance	≥60% residue	-72%

Literature values for Surface P loss increases (poorly-drained average)

125%

HGM Region	Surface P Losses		
	Low residue, strip till/no-till	Conservation Tillage	High Residue, Min Soil Disturbance
	16-29% residue	30-59% residue	≥60% residue
	Load Reduction Rel to High-Till	Load Reduction Rel to High-Till	Load Reduction Rel to High-Till
Appalachian Plateau, Siliciclastic	-7%	-17%	-27%
Appalachian Plateau, Carbonate	-7%	-27%	-38%
Blue Ridge	-8%	-50%	-63%
Coastal Plain Disected Upland	-8%	-35%	-47%
Coastal Plain Lowland	-6%	-2%	-11%
Coastal Plain Upland	-7%	-16%	-26%
Mesozoil Lowland	-7%	-21%	-32%
Piedmont Carbonate	-9%	-60%	-74%
Piecmont Chrystalline	-9%	-58%	-71%
Valley and Ridge Carbonate	-9%	-57%	-71%
Valley and Ridge Siliciclastic	-8%	-49%	-62%

Questions and comments

- **PA SCC & DEP:** Please include the statements made in the Manure Injection and Incorporation report regarding the consistency of the type of NRCS standard tillage practice with the type of manure incorporation. This will link the two reports together, as both types of practices are connected.

This requested language has now been copied into the tillage panel report on 9, in addition to being included in table 2 and in Appendix A.

Questions and comments

- **PA SCC & DEP:** Page 9 – If the practice cannot be verified using the thresholds for SCI and STIR, how should it be verified?

As indicated in Table 2, the panel recommends that surface residue cover, either living or dead, but used as the criteria for verification. This measure has the advantage of being simple to use and to verify in the field. It also aligns with previously available data from CTIC for the watershed.

- **PA SCC & DEP:** Page 10 – Table 3. The table is incomplete, as the soil type, slope length, and percent slope are variable factors when determining soil loss/acre (T). Also, is this a one year or multi-year rotation – if multi-year, how many years? Please include these factors when showing the relative soil loss, SCI and STIR values.

Information for the location, soil series, T value, slope length, and slope have been added to the table. Discussion has been added to the text describing when RUSLE2 runs represent single year or two-year cropping scenarios.

Questions and comments

- **PA SCC & DEP:** Page 11 – Table 4. How are sediment reduction efficiencies the same throughout the watershed, regardless of location in either upland or coastal plains? Sediment loss, when using RUSLEII, is determined using a number of different parameters, including soil type, percent slope, slope length. It would seem that the upland areas would have a greater reduction in sediment loss than the coastal plains area.

The absolute losses of sediment (erosion) is definitely greater with steeper slopes. However our review of the literature and various models for corroboration found that the RELATIVE erosion reduction due to reduced or no-tillage were similar across the landscape.

Questions and comments

- **Jenn Volk UD:** Regarding Table 5 for the Coastal Plain Lowland surface P losses, it appears that for every other HGM region, the surface P losses increase from low residue/strip till/no till to conservation tillage to HRMSD. Except, in the coastal plain lowland it drops for conservation tillage (-7%, -2%, -11%). I looked through the justification section that followed, but I didn't see any specific discussion of why this one HGM had a different pattern.

The description of how the reduction were calculated and presented just after Figure 2, on page 14.

Literature values for P losses for the HRMSD and conservation tillage practices were then applied to the appropriate proportion of cropland by drainage as follows:

(% well drained cropland)*(literature reduction value) + (% poorly drained cropland)*(literature increase value) = P loss value for HGM region

Because of the absence of data on the effect of the low residue, strip-till/no-till practice on poorly drained soils estimates of P losses are presented as the literature value for the study conducted on well-drained soils but do vary based on the proportion of cropland drainage by category. The calculation used for the low residue, strip-till/no-till practice was:

(% well drained cropland)*(literature reduction value) = P loss value for HGM region

The lowland coastal plain HGM region has the greatest proportion of poorly-drained soils so the increase in P load attributed to these sites has a significant effect on the final calculation.

Questions and comments

- **Beth McGee, CBF (comment submitted after deadline):** As noted in the draft report, there is a perception that conservation tillage increases N leaching. The panel dismisses those concerns by looking at 5 studies that looked at subsurface N loss and concluding there is no difference among tillage intensity and leaching. This conclusion needs to be reconciled with that of the 2009 BMP Assessment report by Simpson and Weammert that cites more than a dozen studies documenting increased infiltration rates and presumably increased leaching of soluble nitrogen with reduced tillage. This is a pretty big disconnect and I think worthy of further explanation in the final report.

The panel reviewed the following resources which are believed to be the most relevant to the region as they were conducted either within the watershed or in areas with similar soils, management and cropping systems.

- Angle, J.S., Gross, C.M. and McIntosh, M.S., 1989. Nitrate concentrations in percolate and groundwater under conventional and no-till Zea mays (L.) watersheds. Agric. Ecosystems Environ., 25: 279-286.
- Angle, J. S., Gross, C. M., Hill, R. L., & McIntosh, M. S. (1993). Soil nitrate concentrations under corn as affected by tillage, manure, and fertilizer applications. Journal of Environmental Quality, 22(1), 141-147.
- Owens, L. B. (1987). Nitrate leaching losses from monolith lysimeters as influenced by nitrapyrin. Journal of environmental quality, 16(1), 34-38.
- Menelik, G., R. Reneau, D. Martens, T. Simpson, G. Hawkins. 1990. Effects of tillage and nitrogen fertilization on nitrogen losses from soil used for corn. VPT-VWRRC- Bul 167. Virginia Tech, Blacksburg, VA.
- Zhu, Y., & Fox, R. H. (2003). Corn–soybean rotation effects on nitrate leaching. Agronomy Journal, 95(4), 1028-1033.
- M. M. Alley, J. T. Spargo, C. H. Sequeira, and T. R. Woodward (2011). Nitrate and Orthophosphate Leaching Losses in Agronomic Crop Production in the Virginia Coastal Plain. Final report to The Virginia Environmental Endowment.

- Angle et al, 1989, concluded that there was no effect of tillage on nitrate leaching.
- Angle et al, 1993, reported that soil nitrate levels were consistently lower for no-till than conventional.
- Owens, 1987, reported a 3% increase in leachate for no-till.
- Menelik et al, 1990, reported no difference in soil profile N (0-100 cm) between no-till and tilled treatments.
- Zhu and Fox, 2003, concluded that tillage treatment had no effect on leachate nitrate losses.
- Alley et al, 2011, reported no difference in nitrate level in leachate between tilled and no-tilled systems

Questions and comments

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In addition, the panel reviewed the 2009 BMP assessment report in response to this query. The report appears to rely heavily on the work of Dinnes, 2004 which was a very thorough review conducted at that time, though it was focused on Iowa.

While the table (included in both documents) that shows greater relative N leaching due to NT is based on a plausible theory, none of the studies that the panel found most relevant to the Bay watershed provided evidence for higher leaching losses for NT. In our own review of the sources in the Dinnes paper, we found three citations that report no difference in nitrate leaching due to tillage system, two with higher nitrate leaching with no-till systems, two with lower nitrate leaching due to the use of no-tillage systems, and three with lower nitrate in the soil profile (which could indicate more leaching or could indicate N moving into a number of other potential pathways). Dinnes appears to rely on studies that link higher leaching with greater infiltration conducted under urban conditions. That relationship is extrapolated in the 2009 BMP report which provides sources reporting greater infiltration in no-tillage systems. However we found no consistent effect of tillage on N leaching, either increased or decreased, in the available literature.

Questions and comments

- **PA SCC & DEP:** Page 19 – Are there any agricultural land uses that are not eligible for Conservation Tillage Practices?

Yes. Those crops (trees, vineyards, etc) where tillage is not typically practiced. A listing of eligible land uses is included in Appendix A.

- **PA SCC & DEP:** Page 22—How do P application rates relate to Conservation Tillage?

Perhaps the real question revolves around how application rate (or soil test P level) affects the relative losses or loss reductions due to conservation tillage/greater residue cover. The most plausible answer is that greater P rates and STP likely result in greater loss. Marginal increase are likely to occur until soil is P-saturated, then much greater losses are likely. Models, like APLE and others show this. Unfortunately the data that would allow us to validate or test this question do not exist in the literature most applicable to the Bay Watershed. There simply aren't enough studies over enough rates or STP levels to use to develop a relationship or conclusion. And in the end, if what is desired is a site-specific loss value, then models should be used. However the panel has significant scientific concerns about using model outputs as the base inputs in another model or routine.