A Further Analysis of EOS Factors Used by DEP

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In a previous report prepared for Bion Technologies (Evans, 2010), work was completed to support the claim that the EOS factor for conservation tillage within watershed segment 710 should be between 0.70 and 0.80 rather than the value of 0.21 currently being used by DEP for nutrient trading purposes. Since that report was submitted, additional data have been compiled and analyzed to strengthen this claim. Specifically, digital map (GIS) data that depicts the delivery factors derived by U.S. Geological Survey researchers associated with earlier SPARROW modeling completed in the Chesapeake Bay region (Preston and Brakebill, 1999) have been obtained and analyzed.

In the previous report by Evans (2010), a figure was included (see Figure 1 below) that depicts the relative delivery rates for nitrogen throughout the Chesapeake Bay watershed. This map itself was created by first calculating nitrogen delivery rates for almost 3400 sub-basins within the larger Chesapeake Bay watershed. Figure 2 is a sub-set of this work in which the delivery rates for segment 710 and the surrounding areas are shown. (For illustration purposes, the approximate location of the Kreider Farm site where Bion is currently operating is indicated in the upper right portion of segment 710). In this figure, delivery rates are color-coded with darker shades of brown depicting higher rates and lighter shades depicting lower rates. The values shown in green depict the SPARROW-estimated nitrogen delivery rates for four different sub-areas of segment 710. These values, which range from 73.08 to 98.46, represent the amount (percent) of nitrogen estimated to be delivered to the Bay after initial "removals" such as plant uptake, harvesting, volatilization, etc. have been accounted for. In other words, these rates account for attenuation of nitrogen loads that would result from transport processes that would occur after the load is "released" from a point on the landscape and moves via overland flow, sub-surface flow, and in-stream flow to the Bay.

For nutrient trading purposes, DEP uses both an "edge of segment" (EOS) factor and a "delivery factor" to characterize the amount (percent) of a given load delivered from a specific landscape location to the Bay. For example, in segment 710, DEP has established an EOS factor of 0.21 (21%) for areas of conservation tillage and a delivery factor of 0.97 (97%) for large streams. This means that it is assumed that only 21% of the nitrogen load emanating from conservation tillage areas (after plant uptake and harvesting) will reach a nearby large stream after it is transported from a point on the landscape, and that 97% of this initial delivered load will ultimately be transported to the Bay (i.e., only an additional 3% will be removed via in-stream processes). So, by extension, if segment 710 were only comprised of conservation tillage-type land, the total nitrogen load delivered to the Bay could be calculated as 0.97 x 0.21 = 0.20.

The value of 0.20 (20%) calculated above is obviously less than the value of 73.08% shown in Figure 2. To be clear, the values derived by USGS (and shown in Figure 2) are "weighted" values in the sense that they represent the "combined" delivery rates for all potential sources within a given area. For example, the lower sub-area in segment 710 has a value of 98.46%, which is likely due to the presence of more

urban land and point source discharges in comparison to the sub-area in which Kreider is located. Since these sources would have "EOS factors" of 1 (or close to 1), it is expected that the SPARROW-derived factor (which is source-weighted) would be higher. Similarly, it would be expected that in areas that are predominantly agricultural (such as the sub-basin in which Kreider is located), the product of DEP's delivery factor (0.97 in this case) times the area-weighted individual EOS factors for the four agricultural categories used by DEP (conventional till, conservation till, hay and pasture) would be fairly close to the value calculated by SPARROW (in this case, 0.7308). In fact, the highest EOS factor of all four agricultural land types (0.28 for conventional till) would only suggest a "SPARROW" delivery factor of about 0.27 (i.e., 0.97 x 0.28 = 0.27), which is clearly much less than the "combined" SPARROW value of 73.08 shown in Figure 2.

To do a more direct 1-to-1 comparison between the SPARROW-derived delivery rates and the EOS and delivery factors used by DEP, it would be more accurate to calculate a new "combined" factor using EOS factors from all land types and sources within segment 710. At this time, this is not possible since these other factors have not been provided by DEP. However, in watersheds where there are no point sources and the landscape is dominated by only a few land/cover types, the delivery rate estimated by SPARROW and a "combined" delivery rate based on the product of area-weighted EOS factors and the "large stream" delivery factor used by DEP should be very close in value. However, in the sub-area of segment 710 where the Kreider farm is located, there appears to be quite a difference between nitrogen delivery rates estimated by the SPARROW model and those calculated using rates established by DEP. Based on the evidence presented, it would appear that the EOS factors for any of the agricultural categories established by DEP should be higher than they currently are, and that they should certainly be closer to a value of 0.70 given that the northern portion of segment 710 is predominantly agriculture.

References

Evans, B.M., 2010. Appropriate EOS Loading Rates and Factors as Used Within the Chesapeake Bay Watershed Model and by PaDEP for Nutrient Trading as Applied To Kreider Farms Current Operations, 19 pp.

Preston, S.D. and J.W. Brakebill, 1999. Application of Spatially Referenced Regression Modeling for the Evaluation of Total Nitrogen Loading in the Chesapeake Bay Watershed. USGS Water-Resources Onvestigations Report 99-4054, 12 pp.

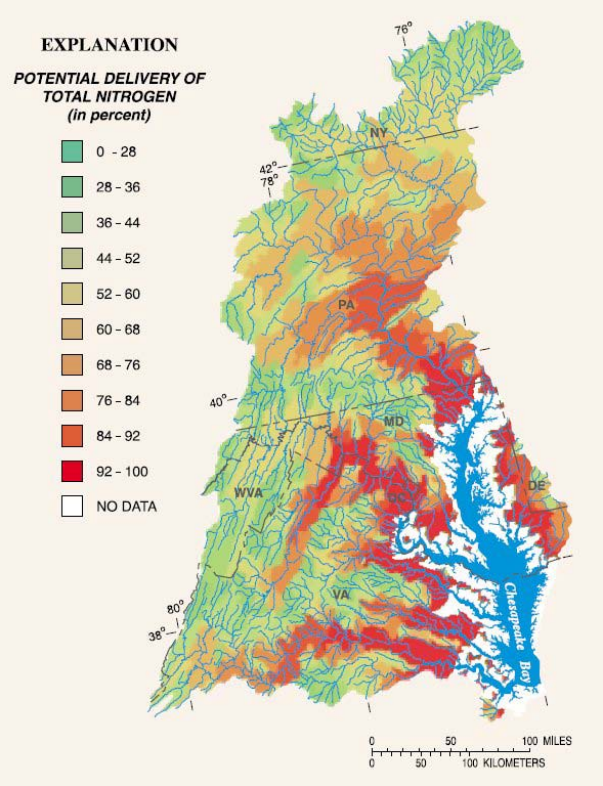

Figure 1. Estimated nitrogen delivery rates (from Preston and Brakebill, 1999).

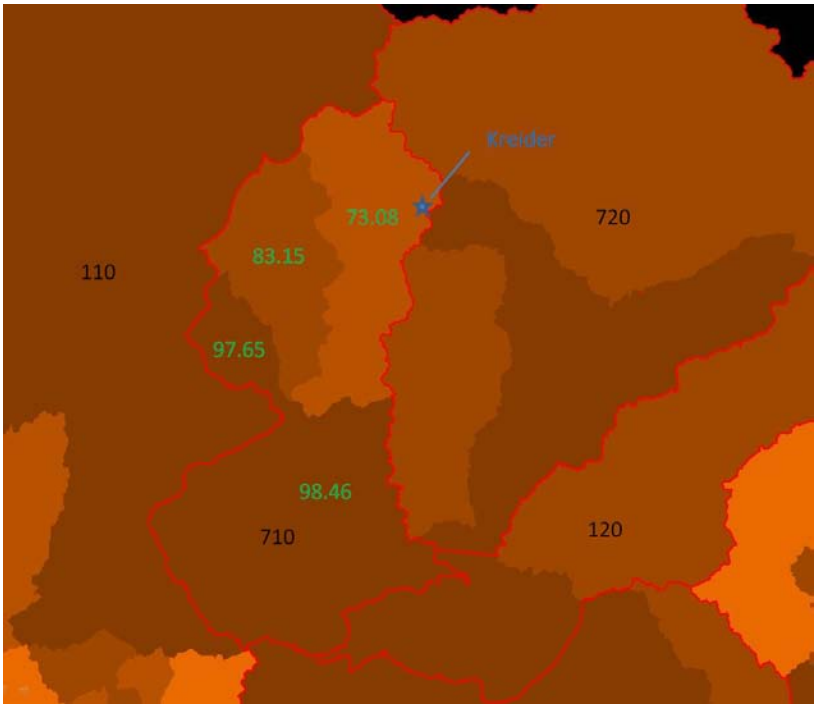

Figure 2. SPARROW-derived rates for watershed segment 710.