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The Honorable Peter F. Murphy, Jr.
Chairman, Fairfax County Planning Commission
12000 Government Center Parkway, Suite 552
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Re: ZMOD –Difficult Run nitrate issues related to septic discharge

Dear Chairman Murphy,

As a follow-up to my testimony on January 28, 2020, I have become aware of additional information that is relevant to the topic of septic tank discharge in Fairfax County. Last Friday I attended a virtual meeting of the Potomac Watershed Roundtable where the key speaker from the Virginia Institute of Marine Sciences discussed failing septic systems in Virginia's Coastal Zone. She briefly referred to a 2016 study done by USGS, EPA, and USDA that included the Difficult Run watershed as one of the four study areas. I have just obtained a copy of that paper from a colleague at USGS.

In order to facilitate your rapid review at this late hour, I excerpted brief portions of the lengthy USGS abstract conclusions – the link and abstract portion related to Difficult Run is attached, (but it's not necessary to read that right now). The key USGS conclusion is that <u>elevated nitrate levels present in Difficult Run are correlated to the density of septic tanks</u>. My additional interpretation is that if a contaminant transport pathway is proven to exist for nitrates, than it also exists for toxic chemicals and pathogens.

- Due to continued development and urbanization of the Difficult Run watershed, the percent of stream flow due to base flow, or <u>groundwater discharge</u>, has <u>decreased from 58% to 50%</u> in the last 20 years. (This means the corresponding <u>stormwater runoff component</u> has increased from <u>42% to 50%</u> over the same time). This base-flow index was less than those of the other watersheds evaluated in this study, likely because the Difficult Run watershed largely is underlain by crystalline piedmont metamorphic rocks and has a greater proportion of impervious urban land cover.
- The total <u>phosphorus load</u> was 14,000 pounds per year, with the majority of the load contributed <u>during stormflow periods</u>.
- The total <u>nitrogen load</u> is estimated to be 140,000 pounds per year, with total nitrogen accumulation <u>less dominated by stormwater runoff than that of phosphorus</u> and <u>strongly affected by base flow (groundwater discharge)</u> export of nitrogen from the basin.
- **<u>Elevated nitrate concentrations were</u>** observed in a <u>subset of monitoring sites</u> that are inversely correlated with population density and **<u>positively correlated to the septic system density</u>** within each subwatershed. The majority of the elevated nitrate concentrations for these sites are hypothesized to be caused by nitrate leaching from septic systems, <u>more so than homeowner fertilizer usage</u> among these subwatersheds that have lower population densities than other parts of the watershed.

- Nitrate isotope data, temporal patterns in the water-quality data, mass-balance computations, and a separate land-use analysis all generally indicate that **leachate from septic systems was the likely source of the elevated nitrate.**
- Another group of water-quality sites have relatively low nitrogen concentrations, are located in areas that are served by city sewer lines.

In my opinion, these study conclusions are very significant for Fairfax County. If leachate from septic tanks is proven to cause elevated nitrate levels in surface water (as this study does), **then a complex series of contaminant transport pathways from individual septic tanks to surface waters must exist.** Nitrates are relatively easy to measure. The migration of toxic chemicals or untreated pathogens (due to discharge of oxidizers or other chemicals down the drain that reduce the effectiveness of or kill the anaerobic bacteria) are not as easy to track.

This study clearly illustrates the incredible complexity and seriousness of the relationship between the:

- increased frequency of high-intensity storm events due to climate change;
- effect of incremental increases in impervious surfaces, which have increased the percentage of stormwater runoff by 8%, in the last 20 years. This has overwhelmed our under-designed and inadequate infrastructure and threatens significant economic damage and loss of life; and
- aging and decreased effectiveness of existing septic systems and the potential for leaching of harmful and toxic chemicals and pathogens to the surface water.

No one Department in the County seems to be responsible for coordinating these issues. In fact many groups have objectives that are at cross purposes to solving this goal, either by responding to homeowner/developer pressures to permit structures and increase density, making statements to minimize the effect of these issues, reducing overall enforcement, or not upgrading adequate outfall and stormwater conveyance requirements. As a result, DPW has an extremely challenging task. They try to respond to the torrential rainstorms (July8 and August 14 2019) and resulting catastrophic stormwater flows even while overall conditions are exacerbated by the increase in impervious surfaces due to development density.

This complexity shows that by-right ALU and HBB are not good ideas. Each property is unique, and the specific circumstances must be considered. Public hearings to give neighbors a chance to provide input must be included. Please vote at least to separate these two issues from the rest of the ZMOD streamlining. Significantly more thought is required to keep us all safe.

Thank you again for the opportunity to provide input.

Sincerely

CEK

Chris Koerner

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Hyer, K.E., Denver, J.M., Langland, M.J., Webber, J.S., Böhlke, J.K., Hively, W.D., and Clune, J.W., 2016, Spatial and temporal variation of stream chemistry associated with contrasting geology and land-use patterns in the Chesapeake Bay watershed—Summary of results from Smith Creek, Virginia; Upper Chester River, Maryland; Conewago Creek, Pennsylvania; and Difficult Run, Virginia, 2010–2013: U.S. Geological Survey Scientific Investigations Report 2016–5093, 211 p., http://dx.doi.org/10.3133/sir20165093.

Copied from the USGS Abstract

"In 2010, the U.S. Geological Survey partnered with the U.S. Environmental Protection Agency and the U.S. Department of Agriculture to initiate water-quality monitoring in four selected small watersheds that were targeted for increased implementation of conservation practices."… "The fourth watershed, Difficult Run, is a suburban watershed in northern Virginia that is dominated by medium density residential development. The objective of this study was to investigate spatial and temporal variations in water chemistry and suspended sediment in these four relatively small watersheds that represent a range of land-use patterns and underlying geology to (1) characterize current water-quality conditions in these watersheds, and (2) identify the dominant sources, sinks, and transport processes in each watershed."

The general study design involved two components. The first included intensive routine water-quality monitoring at an existing streamgage within each study area (including continuous water-quality monitoring as well as discrete water-quality sampling) to develop a detailed understanding of the temporal and hydrologic variability in stream chemistry and sediment transport in each watershed. The second component involved extensive water-quality monitoring at various sites throughout each watershed to develop a detailed understanding of spatial patterns. Both components were used to improve understanding of sources and transport processes affecting stream chemistry, including nutrients and suspended sediments, and their implications for detecting long-term trends related to best management practices. This report summarizes the results of monitoring that was performed from April 2010 through September 2013."….

Difficult Run

The Difficult Run watershed is a 57.82-mi^2 watershed that drains to the Potomac River. The long-term Difficult Run base-flow index (from 1936 to 2010) was 57.9, indicating that approximately 58 percent of streamflow exited the watershed as base flow (*CEKoerner insert– due to groundwater discharge*) and 42 percent as stormflow; (*CEKoerner insert- stormwater runoff*) however, with continued development and urbanization of the watershed, the base-flow index has decreased to 50 percent during the last 20 years. This base-flow index was less than those of the other watersheds evaluated in this study, likely because the Difficult Run watershed largely is underlain by crystalline piedmont metamorphic rocks and has a greater proportion of impervious urban land cover. A series of cluster and principal components analyses indicated that most of the variability in Difficult Run water quality could be attributed to hydrologic variability and seasonality. Statistically significant positive correlations with flow were observed for turbidity, dissolved oxygen, suspended sediments, ammonium, orthophosphate, iron, and total phosphorus. Statistically significant inverse correlations with flow were observed for water temperature, pH, specific conductance, bicarbonate, calcium, magnesium, nitrate, $\delta^{15}N$ of nitrate, and silica. Statistically significant seasonal patterns were observed for numerous water-quality constituents: water temperature, ammonium, orthophosphate, and $\delta^{15}N$ of nitrate were higher during the warm season, and dissolved oxygen, nitrate, and manganese were higher during the cool season. Surrogate regression models were developed to compute sediment and nutrient loading rates. The Difficult Run sediment load was approximately 8,000 tons per year, with greater than 95 percent of the sediment load in the 2013 water year contributed by the seven largest storm events. The total phosphorus load in Difficult Run was approximately 14,000 pounds of phosphorus per year, with the majority of the load contributed during stormflow periods. The total nitrogen load in Difficult Run is estimated to have been approximately 140,000 pounds per year, with total nitrogen accumulation less dominated by stormflow contributions than that of phosphorus and strongly affected by base-flow export of nitrogen from the basin.

Extensive water-quality monitoring throughout the Difficult Run watershed revealed relatively uniform generation of flow per unit of watershed area, as well as spatial variation in water quality that is strongly related to land-use activities. Elevated nitrate concentrations were observed in a subset of monitoring sites that are inversely correlated with population density and positively correlated to the septic system density within each subwatershed. The majority of the elevated nitrate concentrations for these sites are hypothesized to be caused by nitrate leaching from septic systems, more so than homeowner fertilizer usage among these subwatersheds that have lower population densities than other parts of the watershed. Nitrate isotope data, temporal patterns in the water-quality data, mass-balance computations, and a separate land-use analysis all generally indicate that leachate from septic systems was the likely source of the elevated nitrate. Another group of water-quality sites have relatively low nitrogen concentrations, are located in areas that are served by city sewer lines, and have experienced stream restoration activities. A final group of sites drained the areas with the highest imperviousness and had strongly elevated specific conductance, chloride, and sodium, which were likely caused by a combination of road salting and other anthropogenic sources draining these urbanized areas in the watershed. A fourth group of sites represents a mixture of water sources and had water quality similar to that at the Difficult Run streamgage. Analysis of the nitrate isotope data generally indicates a broad range of composition indicative of mixed natural and anthropogenic nitrogen sources. Implementation of conservation practices increased in the Difficult Run watershed during the study period, and while a broad range of practice types was implemented, the most common practices included stream restoration. While the implementation of these conservation practices is encouraging, the cumulative effect of these practices probably will not be detected in Difficult Run water quality for several years.