ATTACHMENT 5

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To: Virginia Association of Municipal Wastewater Agencies

From: Clyde Wilber, P.E.

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Re: Economic Impact on Virginia POTWs and other Sewage Treatment Facilities of Proposed Freshwater Aquatic Life Ammonia Standards

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Summary and Findings

At the request of VAMWA an estimate has been prepared of the statewide treatment facility costs of implementing proposed amendments to the Virginia Water Quality Standards, 9 VAC 25-260, for ammonia-nitrogen water quality criteria for the protection of freshwater aquatic life.

The federal Clean Water Act requires that the states reevaluate their water quality standards every three years. Virginia's Department of Environmental Quality (DEQ) has drafted proposed Triennial Review amendments, proposing a number of changes. The State Water Control Board (SWCB) has authorized public notice and comment, executive review is complete, and the public comment period runs until August 28, 2015.

Among the proposed changes is the adoption of EPA's new 2013 freshwater ammonia-nitrogen criteria for the protection of aquatic life. EPA's criteria are substantially more stringent than prior (1999) criteria (the current Virginia criteria), and are based in part on new data that reflect the sensitivity of freshwater mussel species to ammonia-nitrogen. It is clear that adoption and implementation of the now-proposed criteria will have substantial impacts on Publicly Owned Treatment Works (POTWs) and other sewage treatment facilities. More stringent VPDES permit limits for ammonia-nitrogen will require capital upgrades to and additional operations and maintenance (O&M) expense for many of these facilities.

Key findings include:

- The estimated costs for all affected facilities are substantial - estimated at more than one-half billion dollars ($512,000,000) in capital and $34 million in annual operations and maintenance with the capital and O&M costs for very small sewage facilities (those less than 0.1 MGD) being of specific concern.

- The analysis indicates that approximately 80 schools would require upgrades or new plants costing $200,000 to $300,000 each in capital plus substantial increases in operating costs.

- In addition, the DEQ data base shows 19 facilities with design ≤ 5000 GPD, and an additional 28 ≤ 10,000 GPD. These very small facilities typically serve VDOT rest areas and (in addition to small schools) other facilities not on a central sewer system that would face similar costs to those facing the 80 schools.

- Costs could be reduced if revised permit implementation provisions accompany the new standards, but such revisions have not yet been considered or proposed by the agency.

Virginia Department of Planning and Budget (VDPB) – Economic Impact Analysis

An economic impact analysis of DEQ's proposed Triennial Review changes was prepared by the VDPB on May 23, 2014. The VDPB analysis concludes the following:

- The benefits of the Triennial Review proposals would clearly exceed costs for some of the proposed water quality standards changes. Benefits are stated generally to be related to recreation, consumption of fish and shellfish, and protection of aquatic life and human health. There is no specific conclusion about whether the specific benefits will exceed costs for the proposed ammonia-nitrogen changes.

- The primary and most widespread cost increase from the Triennial Review proposals will be for implementation of the revised ammonia-nitrogen criteria.

- Many of the potentially affected facilities already have ammonia-nitrogen limits, and accordingly the facilities employ nitrification wastewater treatment processes to reduce ammonia-nitrogen. VDPB assumes that many of these facilities will generally be able to comply with more stringent permit limits brought about by the more stringent criteria.

The VDPB analysis does not present any total costs or quantified benefits. It does include the following basis for an estimated nitrification cost per gallon of wastewater treated.

Capital for a 0.1 mgd plant	$372,000
O&M for 0.1 mgd plant/year	$23,000
O&M for a .6 mgd plant/year	$195,000
Capital for a 0.7 mgd plant	$500,000
Overall Cost per gallon - new	0.71
Overall Cost per gallon - upgrade	0.26

The VDPB estimates that the cost of an upgrade to an existing nitrification system to meet the more stringent standards is about 1/3 the cost of a new system (0.26/0.71).

Will Upgrades Be Necessary to Plants that Currently Nitrify?

As noted above, VDPB assumes that many facilities that currently nitrify (treat for ammonia-nitrogen) will not require an upgrade. This result depends on individual permit calculations and on how stringent the permit implementation guidelines are for the new ammonia standards. It assumes that for those facilities that do need an upgrade, the cost for nitrification will be 1/3 of what the cost would be to add new nitrification. Our analysis uses VDPB's 1/3 of new nitrification cost as an estimate for facilities that currently nitrify. For plants that do not currently have a nitrification or other nitrogen removal requirement, a higher cost will be incurred, with the costs for these plants also dependent on the manner in which permits implement the revised standards.

How low a particular facility's permit limit will drop as a result of implementation of the proposed ammonia-nitrogen criteria is dependent on a number of factors, including the following:

- Whether freshwater mussels (which are particularly affected by ammonia) are present or absent
- Whether the new acute criteria or chronic criteria are controlling
- Receiving waters and facility effluent temperature
- Receiving waters and effluent pH
- Whether early life stages of aquatic life are present or absent
- Background stream ammonia-nitrogen concentration and dilution of the facility effluent
- The NPDES permit authority's implementation policy

Each of these factors is discussed below. As an introduction to the range of expected change, the following table presents the proposed and the existing criteria for ranges of pH and temperature.

Ammonia Receiving Water Objectives													
			CURRENT 1999 WQC mg/l				2013 WQC			Ratio New/Old Criteria		
			Acute		Monthly Chronic		Mussels Present					
							Acute		Chronic	Acute		Chronic
pH	Temp (F)	Temp (C)	CMC		CCC		CMC		CCC	CMC		CCC
			Salmonids Absent	Salmonids Present	ELS Absent	ELS Present	Rainbow Trout Absent	Rainbow Trout Present	ELS Present or Absent	Rainbow Trout Absent	Rainbow Trout Present	ELS Present or Absent
9.10	90.0	32.2	1.1	0.8	0.1	0.1	0.2	0.2	0.1	0.17	0.25	0.45
9.10	85.0	29.4	1.1	0.8	0.2	0.2	0.2	0.2	0.1	0.21	0.32	0.45
9.10	83.0	28.3	1.1	0.8	0.2	0.2	0.3	0.3	0.1	0.23	0.35	0.45
8.80	90.0	32.2	1.8	1.2	0.2	0.2	0.3	0.3	0.1	0.17	0.25	0.45
8.80	85.0	29.4	1.8	1.2	0.3	0.3	0.4	0.4	0.1	0.21	0.32	0.45
8.80	83.0	28.3	1.8	1.2	0.3	0.3	0.4	0.4	0.1	0.23	0.35	0.45
8.60	90.0	32.2	2.7	1.8	0.3	0.3	0.4	0.4	0.1	0.17	0.25	0.45
8.60	83.4	28.6	2.7	1.8	0.4	0.4	0.6	0.6	0.2	0.23	0.34	0.45
8.00	85.0	29.4	8.4	5.6	0.9	0.9	1.8	1.8	0.4	0.21	0.32	0.45
		Min	1.1	0.8	0.1	0.1	0.2	0.2	0.1	0.17	0.25	0.45
		Max	8.4	5.6	0.9	0.9	1.8	1.8	0.4	0.23	0.35	0.45
		Avg	2.5	1.7	0.3	0.3	0.5	0.5	0.1	0.20	0.31	0.45

Mussels present or absent – The table above does not include criteria values for sites where mussels are not present. This is based on the assumption that most if not all facilities discharging to freshwater will be determined to have mussels present or potentially present. DEQ, the Department of Game and Inland Fisheries and U.S. Fish and Wildlife Service have concluded that this is the case for Virginia waters.

Acute or chronic – In most cases chronic aquatic life criteria for other pollutant parameters are controlling because the values are more stringent (lower numerically) than the acute criteria. However, due to pH and temperature dependence, the ammonia-nitrogen criteria are more complex. As illustrated in the Table above, the proposed chronic criteria (CCC) are 45 of current criteria. However, the proposed acute criteria (CMC) are 17 - 35 of the current criteria. At facilities with high receiving water permitting temperature (90°F) the proposed acute criterion is 17 of the current criterion. Based on this and comparable analyses, it is expected that in many cases it will be the acute criteria that will determine the permit limit. The significance of this is that, compared with typical permitting that addresses other toxic parameters, such a disproportionate decrease in the acute criteria is more likely to trigger permit limits in facilities that currently do not have an ammonia limit. This will result in a larger number of facilities affected by the proposed criteria.

Temperature – The Table shows that high effluent/stream temperature has the greatest influence on how much lower the new criteria will be in comparison to the current Virginia criteria. A temperature range of 83 - 90 degrees is shown. DEQ currently has standard VPDES permit protocols for selecting the value of water quality variables needed for permit calculations. However, for selecting pH and temperature values to be used in permit determinations concerning the new ammonia-nitrogen criteria, a specific protocol is not yet established. By way of example, based on data from the Potomac River at Little Falls and the James River at Cartersville critical period instream temperatures could be as high as 90 degrees F, which would lead to relatively more stringent criteria.

pH – Criteria calculations are present in the Table above for pH from 8.0 to 9.1. By way of example the 90th percentile pH for the James River at Cartersville is about 8.6, the 95th about 8.8 and the 99th about 9.1. At these relatively high pH levels the criteria are shown to be considerably more stringent than the current criteria.

Background and dilution – Background concentrations could potentially be a much larger factor under the proposed new criteria than under the current criteria. The current acute ammonia-nitrogen (CMC) criteria (non-trout waters) are generally in the 1.1 - 2.7 mg/l range. A background of 0.1 - 0.2 mg/l would be at most 20 of the potential allocation. However, under the proposal with acute criteria (CMC) of 0.2 - 0.6 a background in the same range could consume all or most of the allocation and require a permit close to or at the CMC (or the CCC) regardless of available dilution in the receiving stream.

Implementation policy – Without updated implementation guidance specific to the proposed criteria, it is difficult to determine actual permit limits for individual facilities. However, based on the information available, it can be estimated that ammonia-nitrogen permit limits could decrease by at least a factor of two (50 of current limits) and potentially by a factor of 5 (20 of current limits). In typical permitting situations, receiving stream dilution moderates the permitting impact of criteria. However, if existing background stream concentrations approach the new lower numeric criteria, dilution may not be effective in providing the moderation of limits that is typically now found in permits. This result may be particularly important for very small plants which currently benefit from dilution, but which with implementation of the now-proposed criteria will be more likely to receive a stringent limit for ammonia-nitrogen.

Based on the above, there is a substantial potential that the proposed criteria will impose permit limits below 0.6 mg/l and possibly as low as 0.1 mg/l. Few POTW or sewage facility ammonia-nitrogen permit limits in Virginia are currently that stringent. Nitrification facilities, which were previously designed to meet much higher limits, should not be expected to meet the new criteria without a substantial investment in facility upgrades.

As VDPB noted, many major Chesapeake Bay watershed facilities currently nitrify. Total nitrogen (the total of ammonia-nitrogen plus other nitrogen species) permit limits for those facilities are between 3.0 and 8.0 mg/l. We expect that in a substantial number of cases current removal of ammonia-nitrogen will not be sufficient to comply with permit limits based on the proposed new criteria. Further affecting this is that Bay-related total nitrogen limits are applied and implemented on a calendar year basis. During the cold winter months biological nitrification processes are less effective. For the Bay-related limits higher effluent concentrations for a period of months is acceptable, because they are typically offset by lower concentrations during the warmer months. By contrast, ammonia-nitrogen and other toxicity limits are applied on weekly average and monthly average bases, reflecting relatively short term modes of impact on the aquatic life. Accordingly, design for ammonia-nitrogen limits must take into consideration reduced biological treatment during the colder months. This factor will increase the number of current nitrification facilities that will require an upgrade as a result of implementation of the proposed new criteria.

Costs to implement the proposed freshwater ammonia-nitrogen criteria are estimated below on the bases discussed above.

Statewide Cost Estimate Bases

To develop a statewide estimate of the costs of necessary new and upgraded wastewater treatment to allow POTWs and other sewage treatment facilities to achieve permit limits needed to implement the new ammonia-nitrogen criteria, we used the U.S. Environmental Protection Agency Innovative and Alternative Technology Assessment Manual (EPA I/A).[1] EPA I/A includes estimated costs for capital and O&M for a wide range of facilities. Costs updated to 2014 values[2] from the EPA I/A manual illustrate that the costs for a new nitrification process, designed to achieve a high level of ammonia removal, are as follows:

Design MGD	Capital $/Gal	O&M $/Yr/MGD	Capital $	O&M/year $
0.1	$6.79	1,054,203	678,643	105,420
0.5	$3.29	263,551	1,647,192	131,775
1	$2.37	177,897	2,371,956	177,897
5	$1.19	65,888	5,929,891	329,438
10	$0.77	46,121	7,708,858	461,214
100	$0.66	21,413	65,887,677	2,141,349

[1] U.S. Environmental Protection Agency Innovative and Alternative Technology Assessment Manual (Feb., 1980, 430/9-78-009).
[2] Engineering News Record construction cost escalators.

The EPA I/A data estimate capital costs ranging from 6.79 per gallon for very small plants down to 0.66/gallon for very large plants. The overall capital cost per gallon presented by VDPB is 0.71 /gallon for a new nitrification system. The EPA I/A-based data support the VDPB value for a plant in the 10 MGD range. However, based on the more robust EPA analysis, costs for smaller facilities can be expected to have substantially higher cost per gallon. The above table unit costs were used to estimate costs for plants above 0.1 mgd by using the mid-range of the /MGD costs for each range as follows:

Design Range MGD	Capital $/Gal	O&M $/Yr/MGD
0.1-0.499	$5.04	658,877
0.5-0.99	$2.83	220,724
1-4.99	$1.78	121,893
5-9.99	$0.98	56,005
10-100	$0.72	33,767
100+	$0.66	21,413

For very small plants the unit costs are even higher because of the absence of benefit of scale. For the purposes of this analysis we consider very small plants to be those less than 0.1 MGD. It is difficult to base the costs for very small facilities on actual example costs because plants of this size are not typically designed to remove ammonia to very low levels and the design/construction implementation costs are not readily obtainable. To address this, a total project cost for the regulatory and public procurement process for the smallest of plants (about 5,000 gpd) was estimated as follows:

Very Small Plant Implementation Costs

Permitting	$15,000
Design Procurement	$10,000
Design	$60,000
Certificate to Contruct	$10,000
Construction Procurment	$10,000
Construction	$80,000
Construction oversite	$15,000
Startup and Training	$40,000
Certificate to Operate	$10,000
	$250,000

Based on the above, the capital cost was estimated as 250,000 for a 5,000 GPD plant with a sliding scale up to EPA's 679,000 for a 0.1 MGD plant. For plants that currently have some form of nitrogen control, a minimum capital cost of 225,000 was used regardless of size.

The EPA analysis estimates O&M cost for a 0.1 MGD plant at 105,420/yr, with 89 of that cost (84,300) in labor. This analysis estimates the minimum annual O&M cost for very small plants at 80,000 per year. For plants that already have some nitrogen control we used 1/3 of the capital and O&M costs similar to the VDPD estimate discussed above.

Summary of Costs

The bases of cost estimating described above were applied to the list of permitted facilities provided by VDEQ. The list was parsed into plants with and without any ammonia, TKN or total nitrogen limit. In addition schools were separately analyzed. A total of 490 plants were included in the Statewide estimate. Costs are summarized as follows:

Plants w/o any N Limit	Count	Capital	Annual O&M
Schools	19	5,685,220	1,575,416
All Others	85	156,218,730	15,483,701
Subtotal	104	161,903,950	17,059,117

Plants w NH3, TKN or TN Limit	Count	Capital	Annual O&M
Schools	62	13,950,000	1,726,280
All Others	324	336,465,833	14,821,963
Subtotal	386	350,415,833	16,548,243

All Plants (Total)	Count	Capital	Annual O&M
Schools	81	19,635,220	3,301,696
All Others	409	492,684,563	30,305,664
Total	**490**	**$512,319,783**	**$33,607,360**

As discussed above, as the criteria are proposed and without implementation variances or other mitigating factors, we estimate necessary capital costs of over one-half billion dollars (512,000,000 in 2014 dollars) to implement the proposed ammonia-nitrogen criteria. It is expected that these costs would typically be incurred over an approximate ten (10) year time frame as VPDES permits are reissued with compliance schedules. Annual O&M costs would be approximately 34 million (2014 dollars) statewide. The relative costs for schools and other very small facilities will be much higher. The estimated capital costs for a school sewage treatment plant will be 250,000 - 300,000. Similar to the small facilities at schools, annual operating costs for other small facilities such as trailer parks, VDOT rest stops, etc. will be substantially higher than the current plants.

These costs only address facility additions and upgrades for POTWs and other sewage facilities. They do not address:

- upgrades and costs for commercial or industrial facilities with direct discharge VPDES permits
- upgrades and costs for pretreatment that POTWs may require of commercial and industrial facilities that discharge to POTW collection systems
- costs for preparing Total Maximum Daily Loads for additional waters that will be listed for aquatic life impairment as the result of the more stringent criteria
- non-point source TMDL implementation costs

Also of interest are nine State fish hatcheries and another nine commercial hatcheries identified in Virginia on the DGIF website. Only one of these appears to have a VPDES permit. A well-operated fish hatchery should have ammonia levels below 1 mg/l. However, given the proposed criteria it is not clear whether the hatcheries would require regulation and treatment facilities for ammonia.