Flexibilities for Virginia's Permitted Dischargers Implementing EPA's 2013 Nationally-Recommended Ammonia Criteria

2019 Update on Permitting Practices and Procedures

Virginia Department of Environmental Quality
COMMONWEALTH OF VIRGINIA

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Executive Summary

In 2013 the U.S. Environmental Protection Agency (EPA) updated its freshwater ammonia criteria. In 2018 the General Assembly approved HB 1475 and SB 344, which were signed by the Governor on March 29, 2018, with an effective date of July 1, 2018 (2018 Va. Acts Chs. 510 and 511). This legislation dealt with the State Water Control Board's (Board) adoption of EPA's recommended changes to the freshwater ammonia criteria, requiring that the Board include in such adoption a phased implementation program (PIP) consistent with the federal Clean Water Act. Including the PIP in the adoption of the new ammonia criteria was intended to address potential impacts on permitted dischargers across the state that will need extended compliance schedules and may be affected by fiscal stress.

HB 1475 and SB 344 also directed the Department of Environmental Quality (DEQ) to provide certain additional information to the General Assembly, no later than November 1, 2018. Specifically, HB 1475 and SB 344 asked DEQ to:

- Identify any other states that have adopted EPA's 2013 Aquatic Life Ambient Water Quality Criteria for Ammonia as of July 1, 2018.
- Identify the specific procedures and practices for the implementation of the freshwater ammonia criteria that will both minimize the impact of the criteria on Virginia sewerage systems or other treatment works and be permissible under the federal Clean Water Act (33 U.S.C. § 1251 *et seq.*), including an opportunity to request consideration of alternative effluent limitations based on a demonstration by the permittee, acceptable to the Board, of the lack of appreciable harm from the discharge of ammonia to aquatic life that is present in the vicinity of the discharge or which should be present but for the discharge.

DEQ's 2018 report, Flexibilities for Virginia's Permitted Dischargers Implementing EPA's 2013 Nationally Recommended Ammonia Criteria, addressed these requirements. The budget adopted during the 2019 General Assembly session included a requirement to update this report (HB 1700, 2019 Va. Acts Ch. 854, Item 366(J.)). Specifically, this budget language directed DEQ to "expand…[on the]…specific procedures and practices for ammonia criteria implementation to minimize their impact on Virginia sewerage systems or other treatment works, specifically by including all existing or potential permitting procedures and practices that are not prohibited by the Clean Water Act but which would provide relief to permitted dischargers." This report details those procedures and evaluates opportunities to minimize the impact on Virginia's sewerage systems, while also protecting water quality.

There are numerous considerations taken into account by DEQ permit writers in establishing appropriate effluent limitations for ammonia. These considerations include discharge flow, stream flow, in-stream mixing conditions, and the pH and temperature of both the discharge and the receiving stream. DEQ formed an internal implementation workgroup to evaluate these and other factors related specifically to the proposed nationally recommended freshwater ammonia criteria. Both the federal Clean Water Act and federal regulations must be considered in evaluating and determining the appropriate procedures. The internal workgroup is developing draft guidance for ammonia, which will supersede existing effluent limitation development guidance specific to ammonia and is expected to provide some relief to permitted dischargers as will be discussed more fully in this report. This internal workgroup is tasked with establishing ammonia criteria implementation procedures that prevent instream toxicity as well as minimize the impact to the regulated community to the extent possible under the federal Clean Water Act. Because of the complexities involved in evaluating reasonable potential and establishing effluent limits, this is an inherently technically complex process. DEQ expects to release new guidance for public comment by the end of 2019.

Ammonia Toxicity

Ammonia is a toxic pollutant for which standards were originally promulgated in the early- to mid-1980s. Since that time, the criteria have been updated on several occasions to account for new scientific data on toxicity to sensitive species. The most recent proposed revision is required to protect sensitive mussel and snail species. Virginia is home to the world's most diverse population of freshwater mussels, with a number of those species being threatened or endangered. These organisms play a vital role in the delicate balance of ecosystems and are some of the few organisms that improve water quality. The loss of freshwater mussels can lead to cascading adverse effects on the chemical and biological water quality of Virginia's waters.

Virginia Pollutant Discharge Elimination System (VPDES) Permit Program

The federal Clean Water Act, Section 402, makes it unlawful to directly discharge pollutants to water of the Unites States except in compliance with a National Pollutant Discharge Elimination System (NPDES) permit issued by either EPA or an authorized state. EPA authorized the Board to administer the NPDES Permit Program in Virginia in 1975. Virginia subsequently renamed the delegated program the Virginia Pollutant Discharge Elimination System (VPDES) to indicate Virginia as the permitting agency. DEQ develops each VPDES permit

on a site-specific basis, considering a variety of factors including effluent characteristics, treatment technology, biological and chemical characteristics of the receiving stream and a mixing analysis. The resulting permit is subject to review and comment by local governments, natural resource agencies, EPA, non-governmental organizations, and the general public. Issuing a permit is a case decision under the Virginia Administrative Process Act (Va. Code § 2.2-4000 *et seq.*). In accordance with Va. Code § 2.2-4026 any "party aggrieved by and claiming unlawfulness of a case decision" has a right to direct review by an appropriate court. Therefore, it is critical that DEQ develop scientifically and legally defensible permits that are protective of water quality, and that each decision be thoroughly supported by the individual permit development record.

Legislative & Regulatory Basis for Effluent Limitations

The federal Clean Water Act establishes requirements for the adoption of water quality standards (Section 303) and for establishing effluent limitations in NPDES permits as necessary to protect those instream standards (Section 402). The federal NPDES regulation and Virginia's VPDES Permit Regulation (see 9VAC25-31-220.D) require that limitations control all pollutants that the agency determines may be discharged at a level which cause, have the "reasonable potential" to cause, or contribute to an excursion above any Virginia water quality standard. It is important to note that neither the federal Clean Water Act itself, nor the associated federal regulations, include specific technical procedures for the calculation of water quality-based effluent limitations (WQBELs). EPA relies upon guidance documents such as its March 1991 document *Technical Support Document for Water Quality-based Toxics Control*. DEQ and other NPDES permitting agencies rely on such guidance in developing procedures to determine whether a discharge has the "reasonable potential" to cause or contribute to an excursion above the water quality criteria. If reasonable potential exists, then a WQBEL is developed.

Effluent Limitation Development

The acute water quality criterion for ammonia is expressed as a 1-hour average concentration that cannot be exceeded more than once every 3 years on average. In other words, for any given 1-hour period, the chance of exceeding the criterion should be less than 0.004%. Likewise, the 30-day average ammonia concentration cannot exceed the chronic water quality criterion more than once in every 3 years on average. This equates to an exceedance rate of less than 3% for any given calendar month. Virginia's Water Quality Standards require that steady state wasteload allocations be calculated at 1Q10 streamflow[1] (acute) and 30Q10

[1] 1Q10 streamflow is the lowest 1-day average flow which occurs once every 10 years on average.

streamflow[2] (chronic ammonia) "unless statistically valid methods are employed which demonstrate compliance with the duration and return frequency of the water quality criteria" (9VAC25-260-155). DEQ does not have the resources to generate the complex dynamic models necessary to generate statistically valid methods for hundreds of dischargers and relies, as other states do, on the calculation of steady state wasteload allocations under the critical low flow conditions identified in the Water Quality Standards. The premise of this approach is that if limits are established to protect the stream during critical low flow conditions, then the stream will also be protected during more normal conditions. This concept is further explained in EPA's *Technical Support Document for Water Quality-based Toxics Control*:

> *Traditional single-value or two-value steady-state WLA models calculate WLAs at critical conditions, which are usually combinations of worst-case assumptions of flow, effluent, and environmental effects. For example, a steady-state model for ammonia considers the maximum effluent discharge to occur on the day of lowest river flow, highest upstream concentration, highest pH, and highest temperature. Each condition by itself has a low probability of occurrence; the combination of conditions may rarely or never occur. Permit limits derived from a steady-state WLA model will be protective of water quality standards at the critical conditions and for all environmental conditions less than critical. However, such permit limits may be more stringent than necessary to meet the return frequency requirements of the water quality criterion for the pollutant of concern.*
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> *On the other hand, a steady-state model approach may involve simplifying assumptions for other factors, such as ambient background concentrations of a toxicant, multiple source discharges of a toxicant, number of pollutants causing toxicity, incorrect effluent variability assumptions, and infrequent compliance monitoring. The effect of these types of factors, especially if unaccounted for in the WLA determination, can reduce the level of protectiveness provided by the critical condition assumptions of the steady-state model approach. Therefore, when using a steady-state WLA model, the permitting authority should be aware of the different assumptions and factors involved and should consider these assumptions and factors adequately consideration [sic] when developing permit limits.*
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> *In general, steady-state analyses tend to be more conservative than dynamic models because they rely on worst-case assumptions. Thus, permit limits derived from these outputs will generally be lower than limits derived from dynamic models.*

[2] 30Q10 streamflow is the lowest 30-day average flow which occurs once every 10 years on average.

In evaluating the reasonable potential for a discharge to cause or contribute to an excursion above the water quality criteria, DEQ must take into consideration multiple variables. These include discharge flow, stream flow, instream mixing conditions, and the pH and temperature of both the discharge and the receiving stream. It is important to select a combination of variables for each discharge scenario that is both "reasonable" (*i.e.*, realistic) and protective of the water quality criteria. The selection of these variables has a significant impact on the reasonable potential determination.

It should be noted that the treatment of an individual variable (*e.g.*, pH or stream flow) may be different for different discharge scenarios. What matters is the reasonableness of the combination of variables for any given situation. For example, the requirement to use 30Q10 and 7Q10 flow stream flows ensures a level of conservatism for a large free flowing river. Using drought stream flow conditions on a large river ensures that the critical mixing condition occurs very infrequently. On the other hand, on small streams that run dry or close to dry for portions of most years the critical mixing condition may occur regularly. Likewise, for a discharge to tidal waters, critical low tide conditions occur twice a day.

The following is a discussion of the impact of each of these variables on the reasonable potential analysis, other permitting procedures specific to the evaluation of ammonia toxicity and DEQ's evaluation of specific comments provided by the regulated community.

Stream Flows

As noted above, Virginia's Water Quality Standards require that steady state wasteload allocations be calculated at 1Q10 streamflow (acute) and 30Q10 streamflow (chronic ammonia) "unless statistically valid methods are employed which demonstrate compliance with the duration and return frequency of the water quality criteria" (9VAC25-260-155). Lacking the resources to develop the complex models necessary to generate statistically valid methods for hundreds of dischargers, Virginia relies on the calculation of steady state wasteload allocations under the low flow conditions identified in the Water Quality Standards. DEQ does allow applicants to develop statistically valid methods on a case-by-basis and to submit those demonstrations to DEQ for review and approval.

Discharge Flow

As noted above, DEQ has historically used steady-state modeling for the development of WQBELs, with a combination of worst-case assumptions to protect water quality during critical conditions. EPA's *Technical Support Document for Water Quality-based Toxics Control* recommends using the maximum effluent discharge, which DEQ has traditionally determined to

be the design flow for municipal facilities. Both the NPDES regulation (§122.45(b)(1)) and the VPDES Permit Regulation (9VAC25-31-230) specify that production-based limitations for publicly owned treatment works (POTWs) shall be calculated based on design flow. This requirement predated the water quality standards and WQBELs. Therefore, the regulation does not explicitly dictate the flow that should be used for the development of WQBELs. Clarification of this issue was proposed in 2016 with the federal NPDES Application and Program Updates Rule. However, in response to stakeholder concerns, EPA deferred action on this and several other issues addressed in the proposed rule. Because the regulation is not explicit, there may be flexibility to use a flow other than design flow for POTWs; however, there are implementation challenges that would need to be addressed in revised DEQ permitting guidance.

Further consideration would also be necessary for the implications of using an alternate flow in evaluating the reasonable potential to exceed acute versus chronic criteria. As noted above, the acute criteria are based on a 1-hour exposure time whereas the chronic criteria are based on a 30-day exposure. Wastewater treatment facilities are designed with peaking factors (typically 2.5 times design flow) in order to handle diurnal flow variations and may routinely exceed design flow for periods greater than one hour. For this reason some states use flows considerably higher than design flow to evaluate reasonable potential for acute toxicity. The monthly average flows are typically more stable and frequently well under design flow. Therefore, it may not be appropriate to use the same operational flow value in both the acute and chronic reasonable potential analyses. The use of statistically derived flows that more closely match the underlying standard (*i.e.*, 30-day chronic vs. 1-hour acute exposure times) may be reasonable. Such a change would likely provide some relief on the evaluation of chronic toxicity while making the evaluation of acute toxicity more stringent.

pH

The toxicity of total ammonia is more dependent upon pH than any other variable. At lower pH values, more of the total ammonia exists in the less toxic form of ionized ammonia or ammonium (NH4+). At higher pH values, a larger portion of the total ammonia exists in the form of the more toxic un-ionized ammonia (NH3).

The reasonable potential analysis, including selection of critical stream and effluent pH must be conservative enough to maintain water quality under a wide variety of permitting conditions. DEQ has historically used the 90th percentile pH value for establishing steady-state wasteload allocations for ammonia. This value is considered to be representative of critical late summer/early fall conditions, when low streamflow, high temperatures and high pH often all occur simultaneously. High pH values often result from photosynthesis during periods of high

algal growth in late summer/early fall. This approach is consistent with the EPA's guidance on the application of steady state wasteload allocation models.

DEQ can consider the use of alternative pH values in lieu of the 90th percentile pH value currently used in evaluating reasonable potential to exceed the chronic criteria. However, a percentile of daily values does not align well with a 30-day average chronic criterion. While it is difficult to conclusively demonstrate that a lower pH percentile would be protective of the chronic water quality criterion, changing the statistic to more closely match the underlying standard may be appropriate and provide some relief to the permittee. Since the chronic criteria is based on a 30-day average exposure, it may be possible to use the average pH over a critical 30-day period to evaluate chronic toxicity. This approach would be reliant on the permittee providing daily effluent pH data as well as the availability of representative daily stream pH data. The critical 30-day period may be defined differently based upon the mixing conditions in the receiving stream.

Similarly to the discharge flow discussion above, the evaluation of reasonable potential to exceed the 1-hour acute criteria must be considered separately from the 30-day chronic evaluation. If DEQ pursued a statistically derived pH to more accurately match the underlying standard for the chronic evaluation, it may also be appropriate to consider a statistically derived pH to more accurately match the 1-hour acute criterion.

Temperature

DEQ has historically used 90th percentile temperature values for the evaluation of both chronic and acute toxicity. Stream temperatures remain relatively stable during critical dry weather flow conditions and the 90th percentile temperature is considered representative for the evaluation of both acute and chronic toxicity. Critical low flow conditions often occur during the late summer/early fall, so the 90th percentile temperature is considered representative of the conditions when water quality criteria violations are most likely to occur. As with pH, DEQ could choose to use a temperature condition that more closely matches the underlying duration of the chronic and acute criterion. A maximum 30-day average effluent temperature over the course of at least three years would match the duration of the chronic criteria and be scientifically defensible. This approach may also provide some relief to the permittee. This again would require that the permittee submit daily effluent temperature data for evaluation. DEQ could also investigate the availability of daily temperature records on streams similar to the actual receiving stream and use a temperature more representative of a critical 30-day average. As with pH, the use of a temperature less than the 90th percentile value currently used would not likely be protective of the 1-hour acute criteria.

Evaluation of actual discharge data vs. a default value

In evaluating whether or not a discharge has the reasonable potential to exceed the water quality criteria for ammonia, it is important to consider the source of the wastestream. Influent flows into municipal wastewater treatment facilities all contain high levels of ammonia. According to EPA's September 2010 NPDES Permit Writer's Manual, Page 6-30, "State implementation procedures might allow, or even require, a permit writer to determine reasonable potential through a qualitative assessment process without using available facility-specific effluent monitoring data or when such data are not readily available. . . a permitting authority might also determine that WQBEL's are required for specific pollutants for all facilities that exhibit certain operational or discharge characteristics (e.g., WQBEL's for pathogens in all permits for POTWs discharging to recreational waters)." Furthermore, EPA's Technical Support Document states: "POTW's should … be characterized for the possibility of chlorine and ammonia problems".

Typical moderate strength municipal wastewater contains approximately 30 mg/l of ammonia. Wastewater treatment facilities remove ammonia from the wastestream through a biological process known as nitrification in which bacteria convert ammonia to nitrite and nitrate. The degree of nitrification provided by a wastewater treatment facility is dependent upon the treatment technology installed and the proper operation of the facility. Without adequate operational controls, any municipal wastewater treatment facility can lose the biological nitrification process and begin discharging high levels of ammonia. In essence, all municipal wastewater treatment facilities have the reasonable potential to discharge high levels of ammonia. For this reason most states that responded to a DEQ survey either (1) do not rely on the evaluation of actual effluent data but instead use a higher default concentration more representative of the expected influent concentration or (2) automatically assume reasonable potential exists for any municipal discharge and establish WQBELs without the evaluation of any actual or assumed effluent data.

DEQ has historically used an assumed ammonia concentration of 9 mg/l for municipal facilities. The use of this historical default concentration has provided dischargers with a considerable amount of relief in the reasonable potential determination. The states that responded to DEQ's survey that used a default ammonia concentration used values that ranged from 25 mg/l to 65 mg/l. Again, most states assumed that municipal facilities had the reasonable potential to discharge high levels of ammonia and assigned WQBELs without any further evaluation. DEQ proposes to continue the practice of using a default concentration of 9 mg/l unless actual discharge data indicates that a higher concentration is appropriate.

It is important to note that the use of default data due to the known high influent ammonia concentrations establishes an effluent limitation necessary to protect the water quality criteria. If a subsequent analysis using actual effluent data indicates that reasonable potential does not exist, it simply illustrates that the effluent limitation developed using the default concentration has historically been met by the facility and that no treatment upgrade is required. The limitation is still appropriate to ensure that biological nitrification is maintained through proper operational controls.

Seasonal tiering of ammonia limits

Because both the ammonia water quality criteria and the control of biological treatment processes in the wastewater facility are impacted by lower temperatures, DEQ has historically allowed for seasonally tiered effluent limitations. The biological treatment process slows down and ammonia is less toxic in cold weather so these factors (along with higher stream flows during winter months) are considered in the calculation of winter ammonia limitations. DEQ proposes to continue this practice which provides significant regulatory relief to permittees.

Calculation of weekly maximum limits

Section 122.45(d)(2) of the federal NPDES regulation requires that effluent limitations for publicly owned treatment works be expressed, unless impracticable, as average monthly and average weekly limitations. For conventional pollutants such as biological oxygen demand (BOD) or total suspended solids (TSS), the difference between the monthly average and average weekly limitations is the application of a multiplier (typically 1.5) that accounts for operational variability. DEQ has received comments requesting the use of a multiplier of 2.5 for ammonia limits based on a provision in the proposed water quality criteria that "the highest four-day average within a 30-day period should not exceed 2.5 times the chronic criterion magnitude . . . more than once in three years on average". These comments mistakenly assume that the monthly average and weekly maximum limitations are addressing different exposure times included in the water quality criteria. In fact, for toxic parameters such as ammonia, the monthly average and weekly maximum limitations both represent the same effluent distribution. As outlined in EPA's *Technical Support Document for Water Quality-based Toxics Control*, DEQ uses a statistical approach and identifies the more limiting of the chronic or acute wasteload allocation. The resulting monthly average and weekly average effluent limitations are based upon the more limiting allocation. The limitations are based upon the 97th percentile of the number of samples taken during the reporting period so any numerical difference between the monthly average and weekly average limitations is a function of the number of samples taken only.

Additionally, while Virginia is adopting the four-day average criteria, DEQ will continue to follow the 1999 implementation guidance from EPA, which provided for the allowance that a 30Q10 stream flow when calculating steady state waste load allocations for dischargers should also be as protective as 2.5 times the chronic criterion in any 4-day period (Federal Register, FRL–6513–6 December 22, 1999-Implementation Guidance). Therefore, the four-day average criterion will not directly be used in WQBEL development.

Antidegradation baselines

Virginia's Water Quality Standards include the Commonwealth's Antidegradation Policy, which requires that DEQ establish effluent limitations that maintain existing high quality waters (9VAC25-260-30). DEQ does this by determining the existing water quality and setting effluent limitations based on antidegradation baselines that maintain the existing high water quality. Comments have been received from the regulated community expressing the position that the antidegradation baselines should not be recalculated for existing dischargers based on the revised water quality criteria. DEQ agrees with this interpretation as the Antidegradation Policy addresses maintaining existing high water quality. Previously established antidegradation baselines for existing dischargers are expected to be fully protective of the new water quality criteria for ammonia in most cases and will maintain existing high water quality moving forward.

Dual application of ammonia and TKN limits

DEQ often limits total Kjeldahl Nitrogen (TKN) in discharges to prevent nitrification of the waste in the stream from depleting too much oxygen and adversely impacting aquatic life. TKN consists of organic nitrogen plus ammonia. Because TKN and ammonia are both forms of un-oxidized nitrogen, it is sometimes, but not always, possible to identify which is the more limiting requirement. In these circumstances DEQ has historically included only the more limiting requirement in the VPDES permit and proposes to continue to do so in the future whenever possible. However, DEQ has evaluated paired TKN and ammonia data from municipal facilities and has not identified a reliable TKN/ammonia ratio that can be used for municipal dischargers in general. The only absolute relationship is that TKN is always greater than ammonia. Beyond that, the ratio is dependent upon the form of organic nitrogen in the wastestream and the degree of nitrification provided. DEQ will continue to only include the more stringent of the TKN or ammonia limitation where it can be identified. If the applicant provides paired data that demonstrates a consistent relationship between TKN and ammonia in the permitted discharge, DEQ will consider that relationship in evaluating appropriate limits.

Conclusion

This report identifies DEQ's current procedures for evaluating ammonia toxicity and establishing effluent limitations in VPDES permits. The current practice used by Virginia and most other states is to determine whether a discharge has the reasonable potential to cause or contribute to an exceedance of water quality criteria and, if so, establish appropriate effluent limitations using a combination of conservative assumptions. DEQ considers the combination of these assumptions reasonable and protective of water quality under a broad range of discharge conditions. The report also identifies several alternatives to determine reasonable potential that may be legally and scientifically defensible on a case-by-case basis. However, DEQ cannot assert that these alternatives would be protective of water quality under all discharge scenarios. VPDES permits are case decisions based upon the information in the permit record and are subject to challenges from the public and EPA. DEQ must be able to demonstrate in the permit record that any alternative approach is protective of water quality on a case-by-case basis. Because of the complexities involved in evaluating reasonable potential and establishing effluent limits, DEQ recommends that the agency's workgroup continue its task of establishing ammonia criteria implementation procedures that prevent instream toxicity as well as minimize the impact to the regulated community to the extent possible under the federal Clean Water Act.