IN THE CIRCUIT COURT FOR MONTGOMERY COUNTY

Case Number: 482915V

ASSATEAGUE COASTAL TRUST

Petitioner

v.

LAND AND MATERIALS ADMINISTRATION, MARYLAND DEPARTMENT OF THE ENVIRONMENT

Respondent

For Judicial Review of the Final Determination of the Maryland Department of the Environment to Re-issue the General Discharge Permit for Animal Feeding Operations, NPDES Permit Number MDG01, State Permit No. 19AF.

MEMORANDUM IN SUPPORT OF ASSATEAGUE COASTAL TRUST'S PETITION FOR JUDICIAL REVIEW

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October 27, 2020

ON JUDICIAL REVIEW OF	)	
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NPDES Permit Number MDG01	)	
State Permit No. 19AF	)	
	)	
Assateague Coastal Trust	)	
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Petitioner	)	
	)	Case No.: **482915V**
v.	)	
	)	
Maryland Department of the Environment	)	
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Respondent	)	
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MEMORANDUM IN SUPPORT OF ASSATEAGUE COASTAL TRUST'S PETITION FOR JUDICIAL REVIEW

Petitioner, Assateague Coastal Trust, ("Petitioner") respectfully submits this memorandum in support of its Petition for Judicial Review ("Petition") of the Maryland Department of the Environment's ("MDE" or "the Department") final determination to re-issue with modifications the General Discharge Permit for Animal Feeding Operations, NPDES Permit Number MDG01, State Permit No. 19AF.

STATEMENT OF THE CASE

Animal Feeding Operation ("AFO") is a term used to generally describe a facility where hundreds or thousands of animals are kept. These facilities have been subject to regulation under the federal Clean Water Act ("CWA") for decades in recognition of their significant impact on our nation's water quality. A modern AFO can produce more waste than a large city and requires a sophisticated permitting process to properly manage and regulate that magnitude of waste. There are more than 500 AFOs in Maryland. The vast majority of these facilities raise chickens on the eastern shore of Maryland on land that drains to the Chesapeake Bay. (R. at 0473.)

The Choptank, Nanticoke, Wicomico, Pocomoke, and other major rivers on Maryland's eastern shore (the "Eastern Shore") are fed by hundreds of thousands of acres into more than 225 miles of rivers as they wind across the Eastern Shore and empty into the Chesapeake Bay, the largest estuary in the United States. Each of these rivers, like the Chesapeake Bay, is designated by Maryland and recognized under the CWA as "impaired" due to nitrogen pollution. The effort to restore the Chesapeake is as unique as the Bay itself, having been recognized as one of the largest ecosystem restoration projects in the world.

This restoration effort, known as the Chesapeake Bay Total Maximum Daily Load ("Bay TMDL"), is widely recognized as the single most comprehensive and rigorous of the more than 70,000 TMDLs in the United States. The federally mandated cleanup plan was established under the CWA after decades of missed deadlines and failed promises by state and local governments. *Id.* The Chesapeake Bay Program, a state-federal partnership, runs one of the most sophisticated watershed models in the world ("Bay Model"), which plays a "critical and valuable" role in implementing the multi-year, multi-jurisdiction Bay TMDL cleanup plan. *Md. Dep't of the Env't v. Riverkeeper*, 447 Md. 88, 107 (2016). The Bay Model estimates that millions of pounds of nitrogen pollution from permitted animal waste reach the Chesapeake Bay every year. (R. at 0706; R. at 0478; Ex.A.)

Chicken waste, like other poultry and livestock waste, releases ammonia gas. To mitigate the high levels of ammonia produced in a poultry AFO house, the gaseous ammonia pollution is blown out through high-powered ventilation fans. Instead of merely blowing "away," most of the ammonia gas ultimately falls onto local lands and waters. Over the last several decades a growing body of scientific literature has enabled researchers, as well as regulatory agencies and the courts, to understand the magnitude of ammonia pollution coming from AFOs. (R. at 0484-85; Ex.B.)

This research is important because ammonia is recognized as one of the most significant pollutants generated by AFOs. 40 C.F.R. § 412.2. Ammonia is a form of nitrogen, one of the three pollutants governed by the Bay TMDL due to its role in creating the "dead zones" that have choked life out of the Chesapeake for decades. (R. at 0228.)

As far back as 2005, the United States Court of Appeals for the Second Circuit described the potential impact of ammonia from AFOs on water quality through "discharge to the air coupled with subsequent redeposition on the landscape." *Waterkeeper All., Inc. v. United States EPA*, 399 F.3d 486, 494 (2d Cir. 2005). Meanwhile, in response to a 2002 National Academy of Sciences report, EPA began in 2005 to examine methods for estimating AFO ammonia emissions. Since at least 2009, Marylanders have been urging MDE to address the significant amount of agricultural ammonia deposition that the Chesapeake Bay Program Watershed Model demonstrated. (R. at 0706.) While different experts might quibble about exactly how much ammonia an average AFO emits, or precisely how far the ammonia travels through the air before depositing on the ground or surface waters, the one thing that is clear through the research is that AFOs deposit an enormous quantity of ammonia, including millions of pounds on Maryland's Eastern Shore and the Chesapeake and Atlantic Coastal bays every year. (R. at 0485; see Ex.C at 2.)

The federal CWA has established an ambitious objective "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" and eventually reach the goal to "eliminate the discharge of pollutants." 33 U.S.C. § 1251. The Maryland General Assembly set an even greater goal. Maryland law incorporates federal law as the minimum level of protection for its waters, requiring effluent standards to be "at least as stringent as those specified by the federal CWA's National Pollutant Discharge Elimination System" ("NPDES"), the federal CWA permit program. Md. Code Ann. Envir. § 9-302(a); COMAR 26.08.04.07. Maryland's water

pollution control ("WPC") laws then go well beyond this floor set by federal law and "provide additional and cumulative remedies to prevent, abate, and control pollution of the waters of this state." Md. Code Ann. Envir. § 9-302(a). In establishing discharge permits, Maryland regulations compel MDE not only to "satisfy the regulatory requirements of the National Pollutant Discharge Elimination System under the Federal Act," but also the "provisions and conditions" in state regulations. COMAR 26.08.04.01(A). Thus, MDE may only issue a discharge permit if it "finds that the discharge meets: (1) All applicable State and federal water quality standards and effluent limitations; and (2) All other requirements of this subtitle." Md. Code Ann. Envir. § 9-324(a). Moreover, MDE regulations governing the issuance of discharge permits are exceedingly strict in requiring a permit before allowing a "discharge into the waters of this State any waste or wastewater regardless of volume." COMAR 26.08.04.01(B)(1).

Another aspect of Maryland's WPC framework that makes it particularly stringent relative to the federal CWA is through much broader statutory and regulatory definitions. In short, a "discharge" of "pollutants" or "wastes" to "Waters of the State" encompasses a much greater amount of pollution from a far larger universe of sources when those definitions arise from Maryland law, compared to a "discharge of a pollutant" to a "navigable water" under federal law. Most notably for this case, Maryland's WPC law is not limited to the discharge of liquid effluent. State WPC law expressly covers "gaseous" substances that are "emitted" from a source and reach surface or groundwater and, with respect to surface waters, it does not matter if the receiving water is navigable or not. Maryland WPC jurisdiction also expressly covers pollutants that deposit in a floodplain or infiltrate to groundwater. Md. Code Ann. Envir. § 9-101(l). Therefore, ammonia emitted from an AFO that deposits onto surface waters, or onto land that drains to waters, requires a permit.

Despite what the law says and what the best available science and data overwhelmingly demonstrate, MDE has declined to regulate ammonia emitted from AFOs even though it is one of the largest sources of water pollution generated by an AFO, and one of the largest sources of nitrogen pollution to the Bay. (R. at 0706.) The permit is silent with respect to ammonia and MDE's response to numerous comments erroneously states that "[a]mmonia emissions/ammonia deposition have been considered and ***addressed to the extent permissible*** under the Clean Water Act and the state's water pollution control law." (R. at 0278.) (emphasis added). Not only has MDE failed to address ammonia to the extent permissible, it has failed to address ammonia to the extent mandated by Maryland law. In so doing, MDE has committed a clear legal error.

MDE has similarly ignored its responsibility under state and federal law to establish pollution controls that are mandatory for permitted facilities located near highly polluted waters designated as "impaired" under the CWA. The Chesapeake Bay is perhaps the most famous impaired waterway in the United States, and is now subject to the Bay TMDL. And, even though agricultural pollution is by far the largest source of nutrient pollution to the Bay, and Maryland's Eastern Shore is significantly lagging behind other regions of the state and Bay watershed in reducing nutrient pollution, MDE has declined to include the required "water quality-based effluent limitations" in the AFO permit as required by state and federal law to aid in the ongoing efforts to clean up the Chesapeake. (Ex.D; Ex.E.) By contrast, other major CWA permits issued by MDE have included such pollution controls for impaired waters. The AFO permit and MDE's response to comments are silent as to why these mandatory pollution controls are missing in this permit, and the only acknowledgement of the massive cleanup effort underway to restore the Chesapeake Bay is one short section that begins with a conclusory statement that "[p]ermit requirements are consistent with existing Total Maximum Daily Loads (TMDLs) for impaired

water bodies" followed by a few provisions that merely provide guidance for management practices for a particular AFO. (R. at 0033.) MDE is attempting to exercise discretion it does not possess under state or federal law. Moreover, despite the undisputed conclusions of best available science reflected in the administrative record showing that AFOs contribute significant pollution to state Waters, MDE purports to regulate AFOs under a "zero discharge" standard in the permit, meaning that MDE has assumed as fact the impossible and factually unsupported proposition that an AFO can operate while generating no pollution reaching Waters of the State.

By ignoring one of the largest sources of pollution and one of the fundamental obligations of a permitting authority in issuing a discharge permit, MDE is abdicating its duties under state and federal law and has abused its discretion in a way that substantially interferes with the enormous regional efforts by dozens of governments and millions of people to restore the Chesapeake Bay and protect local water quality. Because the Department's omission of controls on ammonia and water quality-based effluent limitations are contrary to state and federal law, arbitrary and capricious, and unsupported by the record, we ask this court to remand the Permit to the Department.

QUESTIONS PRESENTED

I. Are gaseous emissions of ammonia from an animal feeding operation that deposit on waters of the State "pollutants" or "wastes" subject to permitting requirements under the state Water Pollution Control subtitle of the Environment Article (§§ 9-322 *et. seq.)*?

II. Did the Department err in failing to require effluent limitations for the control of ammonia emissions in the General Discharge Permit for Animal Feeding Operations?

III. Did the Department err by failing to include water quality-based effluent limitations and other conditions designed to ensure that discharges from permitted operations do not cause or contribute to water quality impairments and are consistent with the assumptions of applicable Total Maximum Daily Loads?

STATEMENT OF FACTS

Clean Water Act and Bay TMDL

Congress enacted the CWA "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a). The CWA requires Maryland to identify those waters that are 'impaired' as demonstrated by their current pollutant concentrations. 33 U.S.C. § 1313(d)(1)(A). The Chesapeake Bay and its rivers and streams are virtually all impaired by nitrogen pollution that robs them of oxygen to support underwater grasses and wildlife habitat. (R. at 0475.) As a result, MDE is required by the CWA to establish the TMDL "at a level necessary" to help the impaired rivers and streams to improve and eventually achieve "water quality standards…." 33 U.S.C. § 1313(d)(1)(C). A discharge is not allowed to an "impaired water body" without a permit containing discharge limitations "necessary to meet water quality standards…or schedules of compliance." *Id*. MDE failed to follow the CWA mandate to assure the actual impaired quality of a receiving water will be taken into account in deciding the appropriate discharge limit to impose on a polluting facility.

The Chesapeake Bay is a "national treasure" that stretches from Havre de Grace, Maryland down to Virginia Beach, with a surrounding watershed of 64,000 square miles, including over 150 rivers and streams that drain into the Bay. Pub. L. 106–457, title II, §202, Nov. 7, 2000, 114 Stat. 1967. The Bay is vital to Maryland's economic health, supporting at least $26 billion of Maryland's economy each year. (Maryland Phase III Watershed Implementation Plan at D-4.) Over the past several decades, it became clear that nutrient pollution (nitrogen and phosphorus) and sediment together were choking the Bay and its tributaries, starving aquatic life of oxygen, blotting out the sunlight to aquatic vegetation, and causing massive dead zones and die-offs of both animals and plants. (R. at 0475.)

To protect the Bay, Maryland, along with Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency ("EPA"), and the Chesapeake Bay Commission signed the Chesapeake Bay Agreement in 1983, beginning a partnership to reduce pollution to the Bay. Under this Agreement, the state-federal Chesapeake Bay Program led an effort to create a suite of models collectively referred to as the Bay Model, an elaborate multiphase modelling program that establishes watershed inputs and impacts to the Bay. But by the late 2000s, it became clear that the voluntary agreement was failing and so the Chesapeake Bay Program and EPA developed a TMDL for the Bay that quantifies how much nitrogen, phosphorus and sediment must be reduced to meet the Bay's water quality standards. *Id.* The plans to meet these requirements are implemented through Maryland's Watershed Implementation Plan.

Poultry AFOs and Ammonia

The poultry industry looms large on Maryland's Eastern Shore. Over the last several decades, agriculture has changed dramatically, with small farms increasingly replaced by industrial-sized facilities that confine hundreds of thousands of animals in small, enclosed areas. Poultry represents most of the AFOs in Maryland, and the vast majority of AFOs on the Eastern Shore. The more than 500 poultry AFOs on the Eastern Shore produce over 300 million birds ("broilers") every year. (R. at 0484-86.) Furthermore, the industry has expanded over the past decade. The standard poultry house is 60 by 600 feet, with a single poultry house density of up to 50,000 birds, per flock; the typical poultry AFO produces over 500,000 broilers annually (R. at 0483-85; see Ex.F at 15-16.) Each year the average broiler weight goes up, increasing 12 percent over the past decade to six pounds each. (R. at 0485, see Ex.F at 17.) With these immense production numbers comes waste, hundreds of millions of pounds of it. In 2017, poultry broiler production in Maryland generated approximately 440 million pounds of manure. *Id.*

One of the largest contributions of nitrogen pollution to the Bay and its tributaries on the Eastern Shore is nitrogen in the form of ammonia emitted from animal waste. (R. at 0706.) Ammonia ("NH_3"), a form of nitrogen, is emitted from poultry waste via a process called volatilization, whereby ammonia changes composition and converts to a gas emitted by manure inside poultry houses and manure storage sheds. (R. at 0290-91; 0484-86.) Everyone has experienced the smell of manure caused by these gases. The ammonia-nitrogen emitted moves through the air and deposits onto the surrounding acreages and surface water. *Id.* (*see* 40 C.F.R. § 122.23(b)(8)). Emissions rates from broiler operations have been studied for decades. (R. at 0483-85; *see* e.g. Ex.B; Ex.F at 14.) Ammonia emissions estimates are derived from a range of studies, both by university agricultural extensions and by EPA. *Id.* Most studies predict daily emissions rates on a per bird, per day basis, between 0.4 and 0.6 grams of ammonia per bird, per day. *Id.* Modelling of ammonia emissions from poultry AFOs on the Eastern Shore alone yields well over 10,000 tons, or 20 million pounds of ammonia emitted, each year. (R. at 0485; *see* Ex.C at 2, 25; Ex.F at 16.) At issue here is the fate of those millions of pounds of ammonia-nitrogen, a large portion of which deposits onto the lands and waters of the Eastern Shore and the Chesapeake and Atlantic Coastal bays. *Id.*

At least 18 percent, and up to 40 percent, of ammonia is deposited within 1.5 miles of a poultry house and up to 70 percent is deposited within 30 miles of the AFO. (R. at 0484-85; *see* Ex.C at *id*.) The amount of ammonia deposition is greatest closest to the source. Even based on the most conservative estimates, lands, wetlands and waters nearest the poultry house are blanketed with at least five pounds of ammonia on average, every year. (R. at 0484; *see* 40 C.F.R. §

122.23(b)(4)).[1] As far out as a quarter-mile from a poultry AFO, ammonia deposits onto every acre of land and/or water at a rate of at least one pound per year.[2] Collectively, the more than 500 poultry AFOs on Maryland's Eastern Shore deposit over 7,000 tons, or 14 million pounds, of ammonia-nitrogen directly onto the Eastern Shore. *Id.* (Ex.C at 50 (Table 1); Ex.G.) Of that total, more than 1,000 tons, or 2 million pounds, falls directly onto the 285,297 acres of freshwater and estuarine tributaries and wetlands on Maryland's Eastern Shore. *Id*. Finally, the Bay Model estimates that millions of pounds of that nitrogen are transported via waters of the State into the mainstem of the Chesapeake Bay, with an additional 400 tons, or 800,000 pounds of ammonia from AFOs directly depositing onto the Bay itself. (R. at 0475, 485; Ex.C at 50 (Table 1).) The immensities of these loadings are difficult to put in perspective. For comparison, all municipal sewage treatment plants combined sent about 8.4 million pounds of nitrogen to the Bay in 2019, according to the Chesapeake Bay Program website.

In 2008, EPA promulgated rules requiring concentrated animal feeding operations ("CAFOs" under federal law) to obtain a NPDES permit. *Assateague Coastkeeper v. Md. Dep't of the Env't*, 200 Md. App. 665, 674 (2011); 73 FR 70418, 70419. Under Maryland law this requirement is applicable to all such facilities in Maryland. On September 4, 2019, MDE made a tentative determination to reissue its General Discharge Permit for AFOs with revisions (the "Permit"). (R. at 0266.) Exhaustive public participation and comments included extensive

[1] The rate of ammonia deposition, or its "deposition velocity", varies based on the surface types onto which the ammonia deposits. (R. at 0484-85; see Ex. C at 7.) Specifically, the deposition velocity is higher for land with thick forest, approximately 2.4 centimeters per second ("cm/s"), while agricultural lands range from 0.7 to 1.4 cm/s, and surface water is 1.0 cm/s. (R. at 0484-85; see Ex. C at 12-13.) Based on the more conservative, lower deposition velocity, 1.0 cm/s, the ammonia loading rate is still staggering. *Id*.

[2] As described above, these estimates are based on the smallest sized federal designation for a poultry CAFO: 125,000 bird capacity, per flock, and also on the more conservative deposition velocity estimate of 1.0 cm/s. (R. at 0485-86.)

discussions about deficiencies and omissions in the Permit, including, inter alia, accounting for and controlling ammonia, compliance with TMDL and impaired waters requirements, siting issues, and others. (R. at 0286-517.) On June 2, 2020, the Permit was issued by MDE with minor revisions. (R. at 0266.)

JURISDICTION AND STANDING

This Court has jurisdiction over this petition for judicial review pursuant to Subtitle 6 of the Environment Article of the Annotated Code of Maryland. A final determination issued by MDE for the issuance or renewal of a permit to discharge to waters of the State is subject to judicial review at the request of any person that meets the threshold standing requirements under federal law and who participated in the public participation process through the submission of written or oral comments. Md. Code Ann. Envir. § 1-601(a)(3),(c). A petition for judicial review may be filed with the Circuit Court for the county where the application for the permit states that the proposed activity will occur. Md. Code Ann. Envir. § 1-601(e). As discussed below, Petitioner has standing under federal law and participated in the comment period through the submission of written and oral comments, which are included in the administrative record transmitted by MDE. This court has jurisdiction because the proposed activity which the permit regulates may occur anywhere in Maryland.

I. Assateague Coastal Trust Meets Federal Standing Requirements.

To satisfy federal standing requirements, one must show that "(1) it has suffered an 'injury in fact' that is (a) concrete and particularized and (b) actual or imminent, not conjectural or hypothetical; (2) the injury is fairly traceable to the challenged action of the defendant; and (3) it is likely as opposed to merely speculative, that the injury will be redressed by a favorable decision." *Patuxent Riverkeeper v. Md. Dep't of the Env't*, 422 Md. 294, 299-300 (2011) (quoting *Friends of the Earth, Inc. v. Laidlaw Envtl. Servs. (IOC), Inc.,* 528 U.S. 167, 180-81 (2000). An

organization has standing if "'its members would otherwise have standing to sue in their own right, the interests at stake are germane to the organization's purpose, and neither the claim asserted nor the relief requested requires the participation of individual members in the lawsuit.'" *Patuxent Riverkeeper*, 422 Md. at 300 (quoting *Friends of the Earth*, 528 U.S. at 181).

Injury in fact may consist of "a negative impact on the organizational representatives' recreational or aesthetic appreciation of the affected area" or a negative impact on a person's economic interests. *Patuxent Riverkeeper*, 422 Md. at 300 (citing *Friends of the Earth*, 528 U.S. at 181-82). Referring to *Friends of the Earth*, the Court of Appeals observed, "[t]he Court noted that an injury to aesthetic, recreational or economic interests need not be consummated, so long as an individual can demonstrate reasonable concerns about the effects of the challenged activity." *Patuxent Riverkeeper*, 422 Md. at 300 (citing *Friends of the Earth*, 528 U.S. at 183-84). In *Patuxent Riverkeeper*, the Court of Appeals held that the organization had standing to challenge a wetlands and waterways permit for a road extension and a stream crossing for a commercial development. The injury that the court found sufficient was harm to the recreational, aesthetic, and economic interests of one of its members who was "'a frequent recreational paddler' on the Western Branch of the Patuxent River" and also had an "'aesthetic interest in the beauty of the river and the cleanliness of its water,'" as well as an economic interest due to maps and guides he made and sold. *Id.* at 308 (quoting in part the Circuit Court's findings). Despite making these findings, the Circuit Court in *Patuxent Riverkeeper* had dismissed for lack of standing, asserting that any injury to the member was conjectural or speculative. *Id*. at 308-09. The Court of Appeals disagreed. It held that the Circuit Court had "failed to credit the reasonable concern that [the member] manifested about future harm to the ecology of the Western Branch" downriver of the permitted project. *Id*. The court found the necessary causal nexus was present because of

allegations that “stream crossings at headwaters and wetlands can cause” adverse impacts on the watershed downstream. *Id.* at 310.

To establish traceability, one need only show that the permit allows the facility to discharge pollution that "causes or contributes to the kinds of injuries alleged in the specific geographic area of concern." *Friends of the Earth, Inc. v. Gaston Copper Recycling Corp*., 204 F.3d 149, 161 (4th Cir. 2000) (internal quotations omitted). The traceability requirement "does not mean that plaintiffs must show to a scientific certainty that defendant's effluent . . . caused the precise harm suffered by the plaintiffs." *Piney Run Pres. Ass'n v. Cty. Comm'rs,* 268 F.3d 255, 263-64 (4th Cir. 2001) (quoting *Natural Res. Def. Council, Inc. v. Watkins*, 954 F.2d 974, 980 n.7 (4th Cir. 1992)) (internal quotation marks omitted). Finally, to demonstrate redressability "it must be likely, and not merely speculative, that a favorable decision will remedy the injury." *Gaston Copper*, 204 F.3d at 154.

Kathy Phillips is a resident of Ocean City, and has lived in Worcester County for more than 40 years. (Ex.H at 1). Ms. Phillips is a frequent recreational user of water in the Atlantic Coastal Bays, Indian River, Herring Creek, and elsewhere in the Chesapeake watershed. *Id.* These activities include swimming, boating, kayaking, and canoeing in the Maryland Coastal Bays and bird watching and hiking throughout the watershed. *Id.* Ms. Phillips also paddles occasionally on the Pocomoke River in the Chesapeake Bay watershed. *Id.* Ms. Phillips is also the Executive Director of the Assateague Coastal Trust and the Assateague Coastkeeper. *Id.* As Executive Director and Coastkeeper, Ms. Phillips is acutely aware of the degraded state of the region’s waters and concerned about the potential impacts polluted waters can have on her health and the health of her organization’s members, who rely on her water quality monitoring to make decisions about whether and when to recreate on waterways. *Id.* Ms. Phillips worries about the health of the waters she recreates on and about the damage caused by nutrient pollution and pathogens, including those

generated by AFO waste. *Id.* at 1-2. Ms. Phillips submitted comments during the comment period and testimony during the public hearing. (R. at 0469-504; 0531.) Remanding the Permit to ensure that it includes sufficient controls on water pollution would help to alleviate Ms. Phillips' concerns and address her injuries. Therefore, Ms. Phillips would have standing to sue in her own right.

Monica Brooks is a resident of Salisbury. (Ex.I at 1.) Ms. Brooks regularly visits and recreates on waters in Wicomico and Somerset counties, including the Wicomico River and Wicomico Creek. *Id.* Ms. Brooks is a member of Assateague Coastal Trust's Board of Directors and also a member of the Concerned Citizens Against Industrial CAFOs. *Id.* Ms. Brooks is well-educated about the environmental and public health impacts of AFO pollution and concerned about the health impacts of gaseous and particulate pollutants emanating from AFO house ventilation fans and runoff carried by stormwater from AFOs, which contaminate local groundwaters that her family and neighbors rely on for drinking water and residential uses. *Id.* Ms. Brooks submitted comments during the comment period. (R. at 0469-504.) Remanding the Permit to ensure that it includes sufficient controls on water pollution would help to alleviate Ms. Brooks' concerns and address her injuries. Therefore, Ms. Brooks would have standing to sue in her own right.

The interests at stake are germane to the Petitioner's mission. The mission of the Assateague Coastal Trust is to promote and encourage the protection of the health, productivity, and sustainability of the Coastal Bays watershed of Delmarva including the Pocomoke, Indian, and Herring Rivers, through advocacy, education, and conservation. (Ex.H at 1.)

Petitioner's members do not need to be individually involved in the lawsuit because Petitioner requests prospective relief, not specific damages or remedies for each person. When an association seeks prospective relief, "it can reasonably be supposed that the remedy, if granted, will inure to the benefit of those members ... actually injured." *Warth v. Seldin*, 422 U.S. 490, 515

(1975). Here, Petitioner seeks a remand of the Permit to MDE with instructions to establish controls on the discharge of ammonia and the inclusion of water quality-based effluent limitations that will help the Assateague and Chesapeake bays and the waters draining to these bodies to attain water quality standards. Therefore, Petitioner meets the threshold standing requirements under federal law.

II. Assateague Coastal Trust Participated in the Public Participation Process.

Petitioner actively participated in the public participation process. Members of the Assateague Coastal Trust provided oral comments at a public hearing following the tentative determination to renew the General Discharge Permit for Animal Feeding Operations. (R. at 0531.) Petitioner also timely filed extensive written comments to MDE during the comment period. (R. at 0469-504.)

STANDARD OF REVIEW

Maryland law provides for judicial review of discharge permits. Md. Code Ann. Envir. § 1-601(a)(3),(c). This review is limited to issues presented in the administrative record before the Department. Md. Code Ann. Envir. § 1-601(d). The standard of review and corresponding levels of deference depend on whether a court is reviewing an agency's fact findings, discretionary decisions, or legal conclusions. *Md. Dep't of the Env't v. Cty. Comm'rs of Carroll Cty.,* 465 Md. 169, 201 (2019) (citing *Riverkeeper*, 447 Md. at 118-21). The substantial evidence and arbitrary and capricious standards apply where a statute provides for judicial review without a contested case hearing or a specified standard of review. *Riverkeeper*, 447 Md. at 118. When reviewing an agency's conclusions of law, a court reviews the correctness of those decisions using the de novo standard. *Schwartz v. Md. Dep't of Nat. Res*., 385 Md. 534, 554 (2005).

An administrative agency's findings of fact must meet the "substantial evidence" standard. *Gore Enter. Holdings, Inc. v. Comptroller of the Treasury*, 437 Md. 492, 504 (2014). In applying

the substantial evidence standard, a reviewing court defers to the facts found and inferences drawn by the agency when the record supports those findings and inferences. *Cty. Comm'rs of Carroll Cty.,* 465 Md. at 201 (citing *Riverkeeper*, 447 Md. at 120). In particular, where factual issues involve scientific matters within an agency's area of technical expertise, the agency is entitled to "great deference." *Riverkeeper*, 447 Md. at 120. Ultimately, a court seeks to understand "whether a reasoning mind reasonably could have reached the factual conclusion the agency reached." *Id.* (quoting *Najafi v. Motor Vehicle Admin*., 418 Md. 164, 173 (2011)). The substantial evidence standard has also been applied by Maryland courts to "mixed questions" of law and fact. *See Gore*, 437 Md. at 504; *Schwartz*, 385 Md. at 553.

A reviewing court applies the "arbitrary and capricious" standard of review with respect to matters committed to agency discretion and to a review of the agency's application of the law to the facts. *Cty. Comm'rs of Carroll Cty.,* 465 Md. at 202; *Para v. 1691 Ltd. P'ship,* 211 Md. App. 335, 354 (2013). The arbitrary and capricious standard of review is "extremely deferential" to the agency. *Harvey v. Marshall*, 389 Md. 243, 296-99 (2005).

In applying the arbitrary and capricious standard, a reviewing court may look for guidance to case law applying the similar standard in federal administrative law. *Cty. Comm'rs of Carroll Cty.,* 465 Md. at 202. The U.S. Supreme Court has held that a reviewing court is not to substitute its own judgment for that of the agency and should affirm decisions of "less than ideal clarity" so long as the court can reasonably discern the agency's reasoning. *Bowman Transp., Inc. v. Arkansas-Best Freight System, Inc.*, 419 U.S. 281, 285-86 (1974). Specifically in the context of a CWA discharge permit, the U.S. Court of Appeals for the Second Circuit applied the Supreme Court's leading case on the arbitrary and capricious standard, by inquiring as to whether the agency: (1) relied on factors which Congress has not intended it to consider; (2) entirely failed to consider an

important aspect of the problem; (3) offered an explanation for its decision that runs counter to the evidence before the agency, or (4) is so implausible that it could not be ascribed to a difference in view or the product of agency expertise. *Riverkeeper*, 447 Md. at 120-21 (citing *Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43 (1983)). Although this standard is highly deferential to the agency, it is not meant to reduce judicial review to a "rubber stamp" of agency action. *Sparrows Point LNG, LLC v. Wilson,* 589 F.3d 721, 733 (4th Cir. 2009) (quoting *Ethyl Corp. v. EPA*, 176 U.S. App. D.C. 373, 541(1976)). While the standard of review is narrow, the court must nonetheless engage in a searching and careful scrutiny of the record. *Id*.

Unlike for agency findings of fact or an exercise of discretion, courts owe less deference to an agency's legal conclusions. A court reviews an agency's conclusions of the law de novo for correctness. *Schwartz*, 385 Md. at 554. A court is under no constraints in reversing an administrative decision based solely upon an erroneous conclusion of law. *People's Counsel for Balt. Cty. v. Md. Marine Mfg. Co.*, 316 Md. 491, 497 (1989). However, a court is to give careful consideration to the agency's interpretation of a statute it has been charged with administering. More deference is appropriate when the interpretation of a statute that the agency administers results from a process of "reasoned elaboration", when the agency has applied that interpretation consistently over time, or when the interpretation is the product of contested adversarial proceedings or formal rulemaking. *Cty. Comm'rs of Carroll Cty*., 465 Md. at 203-04 (citing *Baltimore Gas & Electric Co. v. Public Service Commission*, 305 Md. 145, 161-62 (1986)).

ARGUMENT

I. KEY DEFINITIONS ESTABLISHED IN MARYLAND'S WATER POLLUTION CONTROL LAWS COVER GASEOUS SUBSTANCES SUCH AS AMMONIA AS A WATER POLLUTANT SUBJECT TO REGULATION.

The record contains overwhelming and undisputed evidence that ammonia is emitted in enormous quantities from both poultry houses and manure storage facilities within an AFO. (R. at

0290-91; 0484-85; 1389; and 1522.) Under certain circumstances, the deposition of gaseous emissions represents a discharge of a pollutant to waters of the State. (R. at 0484-85.)

Maryland's WPC law defines a "discharge" much more broadly than the CWA. Under Maryland law, a discharge is defined as "[t]he addition, introduction, leaking, spilling, or ***emitting*** of a pollutant into the waters of this State; or … [t]he placing of a pollutant in a location where the pollutant is likely to pollute." Md. Code Ann. Envir. § 9-101(b) (emphasis added). A pollutant is defined as "***[a]ny waste*** or wastewater that is discharged ***from … [a]n industrial source***; or ***[a]ny*** other liquid, ***gaseous***, solid, or other ***substance*** that will pollute any waters of this State." Md. Code Ann. Envir. § 9-101(g) (emphasis added). This definition is extraordinarily broad and would include ammonia, a well-recognized water pollutant under state and federal law. (R. at 0792; 1359; 1522); *see also* 33 U.S.C. § 1311(g); COMAR 26.08.02.03-2.

In addition to qualifying as a "pollutant" by virtue of being a "gaseous … substance," ammonia is also a "waste" from an "industrial source". "Waste" is defined in Maryland regulations as "industrial waste and ***all other*** liquid, ***gaseous***, solid, ***or other substances*** which will pollute any waters of this State," and "industrial waste" is defined as "***any*** liquid, ***gaseous***, solid, ***or other waste substance***, or combination thereof, resulting from ... [a]ny process of industry, manufacturing, trade or business; or … [t]he development of any natural resource, ***including agriculture***." COMAR 26.08.01.01 (emphasis added). Moreover, it should be noted that the State has specifically established water quality criteria for ammonia. COMAR 26.08.02.03-2. These include criteria for ammonia toxicity at both chronic and acute levels, in both freshwater and estuarine water segments. *Id*.

Finally, Maryland's definition of "Waters of the State" includes:

> Both surface and underground waters within the boundaries of this State subject to its jurisdiction, including that part of the Atlantic Ocean within the boundaries of this State,

> the Chesapeake Bay and its tributaries, and all ponds, lakes, rivers, streams, public ditches, tax ditches, and public drainage systems within this State, other than those designed and used to collect, convey, or dispose of sanitary sewage; and (2) The flood plain of free-flowing waters determined by the Department of Natural Resources on the basis of the 100-year flood frequency.

Md. Code Ann. Envir. § 9-101(l).

Because Maryland's definition of "Waters of the State" is substantially broader than the federal definition of "Waters of the United States," which covers only some subset of surface waters, and neither groundwater nor flood plains, a much greater quantity of pollutants emitted from an AFO will inevitably reach a Water of the State under state jurisdiction than a Water of the United States under federal jurisdiction by depositing into numerous small streams, ponds, wetlands, and other surface waters not subject to federal regulation, as well as into certain floodplains and infiltrating to ground waters.

In sum, Maryland's WPC laws and regulations, which define for key terms "discharge," "pollutant," "waste," "industrial waste," and "Waters of the State," leave no doubt that ammonia is a source of water pollution subject to the state's discharge permitting requirements.

II. THE DEPARTMENT ERRED IN FAILING TO REQUIRE EFFLUENT LIMITATIONS FOR THE CONTROL OF AMMONIA EMISSIONS IN THE GENERAL DISCHARGE PERMIT FOR ANIMAL FEEDING OPERATIONS.

a. The omission of ammonia controls is contrary to the requirements of Maryland's water pollution control laws governing the issuance of discharge permits.

Discharging water pollutants is unlawful unless in compliance with both state and federal law. Md. Code Ann. Envir. § 9-322; 33 U.S.C. § 1311(a). Thus, in Maryland "a person shall hold a discharge permit issued by the Department before the person may construct, install, modify, extend, alter, or ***operate***" specified systems, facilities, or establishments, including an AFO, if the "operation could cause or increase the ***discharge of pollutants*** into the waters of this State." Md. Code Ann. Envir. § 9-323 (emphasis added). MDE is authorized to issue "a discharge permit if the

Department finds that the discharge meets: (1) [a]ll applicable State and federal water quality standards and effluent limitations; and (2)[a]ll other requirements of this subtitle." Md. Code Ann. Envir. § 9-324. MDE regulations further condition its issuance of "State discharge permits or NPDES permits" on consistency with "the provisions and conditions" of several different chapters of state WPC regulations governing water quality standards, discharge limitations, and permitting. COMAR 26.08.04.01. Importantly, the Department's regulations governing effluent limitations in discharge permits contain a prohibition on "[t]he discharge of any wastes or waste waters regardless of volume unless … authorized by a discharge permit." COMAR 26.08.04.01B(2). Once again, the statutory and regulatory definitions in Maryland law clearly demonstrate that the gaseous emission of ammonia that deposits on waters of the State represents a discharge of pollutants subject to regulation.

Because ammonia, after discharge, deposits on waters and watersheds as a form of the pollutant nitrogen ("reduced nitrogen"), it has been recognized by the Chesapeake Bay Program as a major contributor of nitrogen pollution to Maryland's extensive list of nitrogen-impaired waters, including, most notably, the Chesapeake Bay, but also major tributaries to the Bay. (R. at 0705.) A discharge may only be permitted if the "discharge does not contravene the surface water quality standards." COMAR 26.08.03.01C. Thus, MDE is required to ensure that ammonia does not contravene water quality standards by causing or contributing to the impairment of waters of the State for either ammonia or nitrogen.

Despite these clear and explicit statutory and regulatory requirements, MDE reissued the AFO general permit without any limitations on ammonia, or even any discussion of this major source of pollution. Not only is the Permit impermissibly silent with respect to ammonia, in its response to comments MDE erroneously concludes that "[a]mmonia emissions/ammonia

deposition have been considered and ***addressed to the extent permissible under the Clean Water Act and the state's water pollution control law*** and implementing regulations with the requirement of several federal Natural Resource Conservation Service ("NRCS") practices including litter amendments and hedgerows/shelterbelts." (R. at 0278) (emphasis added). This legal conclusion is unsupported by any analysis. Nowhere in the Department's response to comments, or in the rest of the administrative record, is there an explanation as to how ammonia is regulated "to the extent permissible" under state and federal law. Moreover, this statement appears to be a clearly erroneous interpretation of Maryland law. As described above, ammonia is a water "pollutant" and "waste" under Maryland's WPC laws and regulations. Maryland regulations clearly prohibit "the discharge of any wastes or waste waters regardless of volume unless … authorized by a discharge permit." COMAR 26.08.03.01. Finally, providing a list of NRCS "practices" as guidance does not satisfy the requirements that such discharges must have a permit.

b. The omission of ammonia controls is contrary to the Clean Water Act.

Ammonia emissions from concentrated animal feeding operations (CAFOs) are also a discharge of a pollutant from a point source subject to regulation through the CWA permitting program.[3] Ammonia is a statutorily designated water pollutant (listed as a "nonconventional pollutant") under the CWA. 33 U.S.C. § 1311(g).

The United States Court of Appeals for the Fifth Circuit has examined a similar issue of airborne emissions from an AFO. *Nat'l Pork Producers Council v. United States EPA*, 635 F.3d 738 (5th Cir. 2011). The court noted that "[t]he term pollutant is defined very broadly in the CWA." *Id.* at 748 (quoting a January 16, 2009 guidance letter Benjamin H. Grumbles, Assistant

[3] The CWA defines "discharge of a pollutant" as "(A) any addition of any pollutant to navigable waters from any point source, (B) any addition of any pollutant to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft." 33 U.S.C. § 1362(12).

Administrator for the EPA's Office of Water to Senator Thomas R. Carper of Delaware). The Court discussed in detail "EPA letters," which provided guidance that "[p]otential sources of such pollutants at a CAFO could include . . . litter released through confinement house ventilation fans." *Id.* The EPA guidance letters further explained that "stormwater that comes into contact with these materials and reaches waters of the United States ***is a violation of the CWA unless authorized*** by a [permit]." *Id.* (emphasis added). Notably, the EPA letters were written by current Secretary of MDE, Benjamin H. Grumbles.

Ammonia is another example of a pollutant that is "released through ... ventilation fans" of poultry houses, as well as from large manure storage sheds. Both confinement houses and storage sheds are part of the CAFO production area, which is included in the definition of a "point source" under the CWA. 33 U.S.C. § 1362(14); 40 C.F.R. § 122.23(b)(8). To address the water pollution impacts of ammonia emissions from poultry AFOs, courts have specifically found that deposition of ammonia pollution from poultry AFOs are discharges.

The North Carolina Superior Court found that ammonia blowing from poultry house exhaust fans onto the surrounding lands and then discharging into waters and wetlands, constituted an unpermitted discharge. *Rose Acre Farms Inc. v. N.C. Dep't of Env't & Natural Res*., No. 12-CVS-10, 2013 WL 459353 (N.C. Super. Ct. Jan. 4, 2013). In addition, the court in *Rose Acre Farms Inc.* found that the CWA agricultural exemption does not apply to any pollutants expelled by ventilation fans that reach waters of the State. *Id.*

The Sixth Circuit Court of Appeals examined a case where "a chemical pesticide is initially applied to land or dispersed in the air" and "[a]t some point following application, excess pesticide or residual pesticide finds its way into the navigable waters of the United States." *Nat'l Cotton Council of Am. v. United States EPA*, 553 F.3d 927, 936-37 (6th Cir. 2009). The court found that

"pesticides applied in this way and later affecting the water are necessarily 'discarded,' 'superfluous,' or 'excess' chemical" and ultimately subject to CWA jurisdiction. *Id.* at 940. Similarly, the Second Circuit held that the source of aerial pesticide spraying was in fact a point source subject to the CWA. *Peconic Baykeeper, Inc. v. Suffolk Cty*., 600 F.3d 180, 188-89 (2d Cir. 2010).

The undisputed administrative record demonstrates that roughly 40,000 pounds of ammonia are emitted each year from even a small AFO with the capacity to confine 125,000 chickens. (R. at 0484; see Ex.F at 2, 15.) Between 18 and 40 percent of this ammonia emitted by an AFO deposits entirely within a 1.5 mile radius of the AFO. (R. at 0485; Ex.C at 23, Fig.10.) The United States Supreme Court recently discussed the connection or proximity between a point source of pollution and a Water of the United States. *Cty. of Maui v. Haw. Wildlife Fund*, 140 S. Ct. 1462, 206 L.Ed.2d 640 (2020). The Court emphasized the importance of analyzing "time and distance" in querying whether the "result" of a discharge is sufficiently similar to a "direct discharge" and, if so, it constitutes the "functional equivalent" of a discharge subject to CWA jurisdiction. *Id.* at 1476. Given the magnitude of ammonia emissions from an AFO and the relatively short transport distances of ammonia to the waters so prevalent on the Eastern Shore, it was not and cannot be disputed that a substantial quantity of ammonia will deposit directly to the Bay, its rivers and streams, or on non-agricultural fields from which it will percolate or run off to Waters of the State.

c. The omission of controls on ammonia is arbitrary and capricious and cannot be supported by the record.

The Department's omission of controls on a well-known water pollutant that constitutes one of the largest waste streams generated by an AFO is also arbitrary and capricious, and cannot be supported by the facts included in the record before the agency. The record is undisputed

regarding the enormous emissions of ammonia pollution, its deposition to the land, and the loading of pollution directly to waters of the State, from AFOs. MDE cannot offer "an explanation for its decision that runs counter to the evidence before the agency" nor can the Permit be lawfully issued by MDE when it has "entirely failed to consider an important aspect of the problem." *State Farm*, 463 U.S. at 43.

The record refers to guidance documents offering several cost-effective and well-studied pollution controls available to reduce the millions of pounds of nitrogen from ammonia deposition. (R. at 0725; 1134; 3320; Ex. C.). Because MDE refused to acknowledge ammonia emissions, deciding erroneously that gaseous AFO emissions are nothing more than "nuisance odors" or generalized "air quality" concerns, the final determination on the Permit fails to assure that ammonia-controlling practices are required of AFOs to reduce ammonia. MDE suggests that nuisance odor or general air quality management practices could reduce emissions. There is no basis in the record for assuming operators have applied ammonia management to their operations, or whether they have actually implemented any of the NRCS guidance that may address ammonia emissions. As a result, MDE has failed to control the dischargers' enormous ammonia emissions or considered their harmful impact to the Bay.

As a permitting agency with the delegated authority to implement the CWA, MDE has a standard process for controlling the discharge of pollutants through discharge permits, recently described by the Maryland Court of Appeals.

> For technology-based limitations, the reference point is the source, and the strategy is to deploy pollutant-reducing technology at that source regardless of its contribution of pollutants to the waterway. By contrast, for water quality based effluent limitations, the reference point is the waterway, and the strategy is for the point source to implement any additional actions (beyond the already required technologies) necessary to achieve the applicable water quality standard.

Cty. Comm'rs of Carroll Cty., 465 Md. at 187-88.

In the Permit, MDE has required neither technology-based nor water-quality-based effluent limitations for ammonia. As discussed, the Permit is devoid of provisions applicable to ammonia emissions or nitrogen deposition. Even if MDE had included ammonia specifically along with its treatment of "odors" or "air quality" concerns, the provisions in the Permit governing those concerns do not include mandatory effluent limitations. Furthermore, even if the Permit included mandatory management practices for odors and air quality concerns, these would not be effective effluent limitations because most are not designed for the reduction of ammonia emissions from an AFO production area, but are instead designed for land application of fertilizer.

Because every poultry AFO in Maryland emits substantial and significant quantities of ammonia, MDE must at least attempt to regulate these emissions through the use of mandatory management practices understood to reduce ammonia emissions like vegetative buffers, litter amendments, and biofilters. Currently, the Permit requires only that each applicant submit a plan and identify resource concerns. An operator must include practices that are "in accordance with an appropriate NRCS Practice Standard." (R. at 0017.) However, the permit categorically excludes specific controls for ammonia emissions, and nowhere in the Permit does MDE require even a consideration of ammonia controls.

Finally, MDE's explanation for not regulating ammonia emissions provided in its response to comments, set forth below, is misleading, inaccurate, and fails to explain the role of the CWA in addressing ammonia pollution of waterways.

> EPA does not regulate ***odors or air quality*** through its CAFO permitting program. See generally 40 C.F.R. 122.23. While MDE derives much of its NPDES permitting authority from EPA and the CWA, it is authorized, as a delegated program, to impose requirements that are more stringent than what is required by the CWA or EPA's regulations. Therefore, MDE included in the draft General Discharge Permit provisions ***that require*** AFO owners or operators to implement [best management practices] in order to reduce nuisance odors and address any air quality resource

> concerns using appropriate NRCS Practice Standard(s). See General Discharge Permit at Part IV.D.1-2.

(R. at 0277.) (emphasis added).

First, despite this statement that the Permit provisions "require" the implementation of management practices for controlling pollution, the Permit does not do so. The permit leaves discretion to the comprehensive nutrient management plan writer contracted by the AFO owner or operator to decide "if outdoor air quality is determined to be a resource concern." Second, even if an "outdoor air quality resource concern" were identified, the management practices that may be selected by the operator are designed to reduce "nuisance odors" or address "any air quality resource concerns," not reduce water pollution caused by ammonia deposition.

Ammonia is emitted in large quantities by every single AFO. Only by requiring a standard suite of management practices designed to reduce ammonia releases to receiving waters could MDE claim to be addressing ammonia through an effective effluent limitation. Instead, MDE has deliberately mislabeled ammonia pollution of waterways as nothing more than an "odor" or "air quality" concern. By doing so, MDE has covered its eyes and ears and effectively maintains that if it sees no evil and hears no evil, it will not have to speak to ammonia deposition and address one of the single largest sources of nitrogen pollution in the Bay region and a major contributor to water quality impairments.

III. MDE ERRED BY FAILING TO INCLUDE WATER QUALITY-BASED EFFLUENT LIMITATIONS TO PROTECT IMPAIRED WATERS.

a. State and federal law require water quality-based effluent limitations where technology-based limits are insufficient.

The CWA requires that Maryland develop water quality standards for waters within its boundaries that are sufficient to "protect the public health or welfare, enhance the quality of water and serve the purposes of this Act." 33 U.S.C. § 1313(c)(2)(A). Every NPDES permit must ensure

that discharges comply with all applicable water quality standards for the water segment that receives those discharges. 33 U.S.C. § 1342(a)(1). A discharge is unlawful unless it includes "any … limitations … necessary to meet water quality standards." 33. U.S.C. § 1311(b)(1)(C). "No permit may be issued when the imposition of conditions cannot ensure compliance with the applicable water quality requirements of all affected States." 40 C.F.R. § 122.4(d) (internal punctuation omitted).

Water quality standards "by themselves have no effect on pollution; the rubber hits the road when the state-created standards are ***used as the basis for specific effluent limitations in NPDES permits***." *American Paper Inst. v. EPA*, 996 F.2d 346, 350 (D.C. Cir. 1993) (emphasis added). The process of giving effect to these standards begins with the establishment of TMDLs for water quality limited segments, which are part of each state's required continuing planning process under the CWA. 33 U.S.C. § 1313(e). Once a TMDL is established, permitting agencies are required to ensure that discharge permits issued are consistent with the "assumptions and requirements of any available wasteload allocation" contained in applicable TMDLs. 40 C.F.R. § 122.44. These wasteload allocations "constitute a type of water quality-based effluent limitation." 40 C.F.R. § 130.2(h).

State law mirrors these requirements, which is necessary to receive delegation of authority to administer the Clean Water Act. 33 U.S.C. § 1342(b). MDE is authorized to issue "a discharge permit if the Department finds that the discharge meets … [a]ll applicable State and federal water quality standards." Md. Code Ann., Envir. § 9-324; *see also* COMAR 26.08.04.01A. A discharge may only be permitted if "the discharge does not contravene the surface water quality standards established by this state." COMAR 26.08.03.01C(1). If best available technology is determined to be insufficient to achieve "compliance with the established water quality standards," MDE

regulations specify that "additional treatment shall be (i) [r]equired; and (ii) [b]ased on waste load allocation." COMAR 26.08.03.01C(2). Thus, under both state and federal law, where required technology-based effluent limitations are insufficient to achieve the applicable water quality standard, the Permit must include any more stringent permit requirements necessary to achieve those standards. *Cty. Comm'rs of Carroll Cty.*, 465 Md. at 186.

The Chesapeake Bay TMDL is one of many TMDLs in effect in Maryland designed to bring water quality in line with the standards established by MDE. To give effect to these TMDLs, MDE is charged with routinely establishing water quality-based effluent limitations into discharge permits of all types, whether small or large, or individual or general permits. An example of a similar general permit to the AFO permit is the General Permit For Discharges of Stormwater Associated With Industrial Activity, which contains water quality-based effluent limitations, including explicit "Chesapeake Bay Restoration Requirements." (Maryland Discharge Permit No. 12SWA, NPDES Permit NO. MDR000, Part III.) The Court of Appeals recently examined a nearly identical water quality-based effluent limitation written by MDE, and emphasized the importance of such permit requirements to maintain consistency between discharge permits and water quality standards, via TMDLs, even where such limitations are in narrative form and not strictly numeric reflections of waste load allocations within a TMDL. *Cty. Comm'rs of Carroll Cty.*, 465 Md. at 222.

Unlike these other individual and general discharge permits that MDE issues, the AFO permit is silent with respect to water quality-based effluent limitations and only briefly discusses TMDLs or water quality standards. Part VII.K of the Permit opens with a conclusory statement that "[p]ermit requirements are consistent with existing Total Maximum Daily Loads (TMDLs) for impaired water bodies." (R. at 0033.) The Permit then ***authorizes*** MDE to require "additional

[management practices] and controls" based on "the assumptions and requirements of the Chesapeake Bay TMDL" or "additional or alternative controls or monitoring" based on additional TMDLs. *Id.* MDE is interpreting its role with respect to the incorporation of water quality-based effluent limitations into discharge permits not as the mandate that it is, but as a discretionary exercise. This fails to comply with the requirements of Maryland and federal law cited above that the permit must include limitations on discharges which will ensure compliance with applicable water quality standards and TMDLs.

EPA's Permit Writer's Manual clearly envisions inclusion of water quality-based effluent limitations for AFO permits:

> "***Even for CAFOs subject to a no-discharge***, technology-based standard for the production area, situations could arise where the permitting authority needs to impose more stringent requirements for allowable discharges. Specifically, ***more stringent discharge limitations are necessary in instances where CAFOs discharge from a production area to a waterbody listed under CWA section 303(d) as impaired due to nutrients***, dissolved oxygen or bacteria, or where an analysis of frequency, duration and magnitude of the anticipated discharge (consisting of potential overflows of manure, litter, or process wastewater) indicates the reasonable potential to violate applicable water quality standards."

(R. at 0475-76.) (emphasis added).

Thus, even EPA, which administers the less stringent provisions under federal law, directs its permit writers to establish water quality-based effluent limitations for AFOs located in nutrient-impaired watersheds, whether or not the AFOs are governed by a no-discharge permit. Instead of water quality-based effluent limitations, the Permit in this case relies on "best practicable control technology currently available" (BPT) to ensure that no wastewater is discharged from the production area. 40 C.F.R. § 412.43(a); 40 C.F.R. § 412.31(a)(1). These BPTs are implemented through optional management practices incorporated into the Permit by reference to the NRCS recommended practices in the NRCS National Planning Procedures Handbook, Part 600.6,

selected by the operator to potentially address any resource concerns identified by the operator. (R. at 0009).[4] These are manifestly inadequate to satisfy the requirements described above.

Where management practices do not assure a zero discharge of any pollutants from the facility, the Permit must impose water quality-based limits. While the AFO permit references management practices generally, pursuant to 40 C.F.R. § 412.4, the Permit neither addresses discharges of ammonia nor requires management practices. As noted above, the Permit is required to regulate discharges of ammonia because it is a discharged pollutant that lands on the water. However, this Permit provides no requirements at all to limit ammonia emissions or deposition. Instead, the Permit avoids discussion of ammonia entirely.

b. The "no discharge" standard is arbitrary, capricious, and inconsistent with Maryland law because it does not acknowledge ammonia as a pollutant or the fact that AFOs discharge pollutants to Waters of the State.

The AFO Permit's section governing "authorized discharges" establishes a "no discharge" standard and a qualified "no discharge" standard, for new AFOs and existing AFOs, respectively. (R. at 0008.) In essence, the Permit relies on a legal fiction that assumes no discharges are occurring, except for certain AFOs after a rainfall above a certain magnitude. This legal fiction is

[4] The NRCS Handbook includes a discussion of impacts from the AFO production areas on air quality broadly regarding the production area, and specifically for ammonia:

> During the CNMP development process, AFO operators and/or owners need to consider the impact of selected conservation practices on air quality. Air quality in and around structures, waste storage areas, and treatment sites may be impaired by excessive dust, **gaseous emissions**, and odors. Poor air quality may affect the health of workers, animals, and persons living in the surrounding areas. **Ammonia emissions from animal operations may be deposited to surface waters, increasing the nutrient load**.

(R. at 792.) (emphasis added).

Despite this admonition by the NRCS, MDE's Permit requires no controls of ammonia emissions despite the inevitable emissions and subsequent local deposition of significant quantities of this pollutant from the production areas of poultry AFOs into nearby waters.

problematic for a number of reasons important for this case, most notably that it allows MDE to assume ammonia pollution does not exist at all and it negates the need to establish water quality-based effluent limitations.

The "no discharge standard" effectively creates a legal loophole whereby MDE - at its discretion - issues permits without the legally mandated effluent limitations. This may seem like an absurd proposition, yet this is precisely the problem we are confronted with in the present case. Millions of pounds of nitrogen pollution in Chesapeake Bay waters are simply assumed not to exist, thus effectively allowing the Department to justify waiving the requirement to impose water quality-based effluent limitations to control pollution to impaired waters.

The “no discharge” standard is a product of federal law. 40 C.F.R. § 412.46; *see also* 68 FR 7176, 7202 (February 12, 2003). But whatever regulatory practices have evolved at the federal level with respect to AFO permits issued by EPA cannot be sustained when they are less comprehensive or less stringent than Maryland’s law. As discussed above, the definitions in Maryland’s WPC laws and regulations are much more expansive than their counterparts under federal law and Maryland law is far more protective of water quality. Thus, even assuming for the sake of argument the no discharge standard was predicated on sound science applied based on federal standards and definitions, because a “discharge,” “pollutant,” and “Water of the State” are defined under Maryland law to be significantly broader than a “discharge of a pollutant” to “navigable waters" under federal law, MDE cannot simply apply a federal standard to Maryland’s WPC statute. MDE has a duty to issue this discharge permit consistent with all “provisions and conditions” in State WPC regulations governing water quality standards, discharge limitations, and permitting standards. COMAR 26.08.04.01. Nothing in Maryland’s statute or regulations authorizes MDE to ignore certain pollutants or establish exclusions within permits. As stated

above, under Maryland law, ammonia emitted from AFOs meets the legal definition of a discharge of a pollution to waters of the state. Because discharges of ammonia from AFOs are landing in the water and substantially impacting water quality, these discharges must be regulated so as to minimize those adverse impacts.

Moreover, the record contains little to no analysis regarding the validity of, or scientific basis for, this no discharge standard. In response to comments, MDE merely repeats the language of the relevant provisions of the Permit and concludes that their use of the term discharge is "consistent with applicable state and federal law." (R. at 0273-74.) Interestingly, in reissuing the AFO permit, which is generally very similar to the prior permit, MDE inserted the definition of "discharge" contained in Maryland's WPC statute. (R. at 0010.) This new reference in the Permit to "discharge," as it turns out, is quite unhelpful to MDE in justifying the no discharge standard, because, as noted, the state definition of "discharge" is far more expansive than the comparable federal definition, on which the federal "no discharge" standard was derived. *Id.*

The record also includes a document produced in 2011 by EPA staff, titled *Clarification on CAFO Loads and TMDL Allocations*. (R. at 0673.) Rather than explaining or justifying the no discharge standard, this document acknowledges that there are discharges from AFOs. The document posed the question "why, if CAFO permits are 'zero discharge,' the Bay TMDL still assigns loads associated with a CAFO production area?" *Id.* The response provided by EPA states that "there can be discharges from parts of the production area at some CAFOs or other discharges from CAFOs not covered by the 'no discharge' standard; e.g., precipitation-based discharges that come in contact with dust, dander, feathers, and/or manure on the ground between the buildings or in ventilation systems [deposited within the production area]." *Id.*

Given that a "discharge" of a "pollutant" under Maryland law encapsulates an extremely large universe of pollution, it defies logic or physics to explain how an AFO could possibly achieve a "no discharge" standard based on Maryland law. For one thing, knowing that all AFOs emit large quantities of ammonia, a no discharge standard would require assuming that what goes up does not come down. Thankfully the scientists and modelers at the Chesapeake Bay Program do not concern themselves with legal fictions, but are interested in actually developing estimates of pollution based on reality, relying on the best available science and data. Year after year, the annual Bay Model outputs show that "permitted feeding spaces," which is the Model's term for AFOs, discharge hundreds of thousands of pounds of nitrogen from Maryland to the Chesapeake Bay, ***in addition to ammonia***. (R. at 0478; Ex.G.) The Department's failure to establish water quality-based effluent limitations for discharges of ammonia from AFOs in the Permit was arbitrary, capricious, and contrary to the applicable legal requirements.

CONCLUSION

State and federal laws require permitting authorities to effectively regulate water pollution, such as ammonia, when it is discharged from facilities such as AFOs. The record in this case is devoid of any legal or technical justifications for ignoring the massive quantity of ammonia depositing on or flowing into Waters of the State from AFOs. Moreover, the failure to include any water quality-based effluent limitations for permits discharging into highly impaired waters, including those subject to the most visible TMDL in U.S. history, is contrary to state and federal law and lacking any basis of support in the record. For these reasons, the permit should be remanded for the agency to mandate effluent limitations for ammonia and other water quality based effluent limitations to protect impaired waters.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that on this 27th day of October 2020, I caused a copy of the foregoing Memorandum in Support of the Assateague Coastal Trust's Petition for Review to be mailed via electronic mail to the following:

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APPENDIX A

TABLE OF CONTENTS

APPENDIX B

TABLE OF AUTHORITIES

FEDERAL STATUTES

FEDERAL REGULATIONS

FEDERAL CASES

STATE CASES

STATE STATUTES

STATE REGULATIONS

EXHIBIT A

Chesapeake Bay Model Estimate of Nitrogen Pollution from Animal Feeding Operations
(R. at 0478.)

This exhibit shows the number of pounds of nitrogen pollution from Animal Feeding Operations in Maryland, by county, estimated by the Chesapeake Bay Model, as discussed in the Administrative Record on page 0478 and referenced in the memorandum of law on page 2 and 34.

To access this information, see:
https://cast.chesapeakebay.net/.

Data Source Version	CAST-2019					
File Creation Date	10/20/2020					
Summary Loads Report	This report provides scenario-specific data on loads. The loads are provided for the aggregations, geography, and scenarios that you selected. Definitions for aggregations and geographies are available at https://cast.chesapeakebay.net/Reports/RetrievePublicReport?reportType=1. The edge of stream (EOS) and edge of tide (EOT) loads are provided for total nitrogen (N), total phosphorus (P), and total suspended solids (S). The loads are pounds per year. The unit column is the measurement only for the amount column.					
Geography	**Sector**	**LoadSource**	**Allocation**	**Agency**	**2019 Progress_NLoadEOS**	**2019 Progress_NLoadEOT**
Allegany, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Anne Arundel, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Baltimore City, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Baltimore, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	4,551	1,959
Calvert, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Caroline, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	69,984	52,635
Carroll, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	8,909	4,802
Cecil, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	16,696	14,642
Charles, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Dorchester, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	11,835	7,424
Frederick, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	51,925	37,742
Garrett, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Harford, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Howard, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Kent, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	28,042	23,534
Montgomery, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Prince Georges, MD (CBWS Portion Only	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Queen Annes, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	7,261	5,573
Somerset, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	22,653	18,002
St. Marys, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Talbot, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	1,566	1,440
Washington, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	4,033	3,616
Wicomico, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Worcester, MD (CBWS Portion Only)	Agriculture	Permitted Feeding Space	Waste Load Allocation	Non-Federal Agencies	-	-
Total					**227,454**	**171,370**

EXHIBIT B

Wheeler, Eileen F., et al. "Ammonia emissions from twelve US broiler chicken houses." Transactions of the ASABE 49.5 (2006) 1495-1512.

(R. at 0484. n.38)

This exhibit includes a single table from a leading study exploring ammonia emissions from U.S. broiler operations. Emissions factors from broiler operations has been studied exhaustively over the past 20 years, as discussed in the Administrative Record on pages 0484 to 0485 and referenced in the memorandum of law on page 3.

To access the full publication, see:
https://pdfs.semanticscholar.org/f17a/d0a9a7eac8fca63ad5e8533554117aab2315.pdf

Daily Ammonia Emission Rate Estimate

An estimate of daily NH_3 emissions per bird (± std. error) from all data from all four farms, as shown in figure 9c, is thus:

$$ER_b = 0.031\ (\pm 0.0011) \cdot age \qquad (4)$$

where

ER_b = emissions rate (g NH_3 $bird^{-1}$ d^{-1})

age = flock age (d) if built-up litter is used:

age = 0 d if new litter and flock age is <7 d;

age = (flock age − 6) d if new litter and flock age is ≥7 d.

Table 4 provides comparison of ammonia emission rates measured during field trials in commercial broiler houses in the U.S. and Europe during the past 15 years. All study data are expressed in terms of ammonia emission per bird per day, which usually required conversion of the originally reported results based on information provided (or inferred) from the research article. One of the challenges in understanding and reporting emission data is the wide variation in reporting units that are not always inter-convertible depending on the supporting information provided in the article. Annual data was problematic for conversion of broiler emission data since buildings are unoccupied during cleanout between flocks, with reduced (typical) emissions due to cooler interior temperatures, no additional manure deposition, opportunity to reduce litter moisture content with no further moisture addition, and eventually spent litter removal (for houses using new litter each flock), which eliminates the ammonia source. The report for annual emission factors should indicate the number of days in a year, since it may range from about 250 to 290 days when based on bird occupancy, instead of 365. In conversions of data (table 4) that were originally expressed in terms of 500 kg animal unit (livestock unit), average bird weight during a flock grow-out was estimated as one-half the finished market weight. Although this may underestimate average broiler weight due to rapidly increasing growth rate after about two weeks of age, it is the simplest available means when detailed growth curves are not provided with the data. The techniques and challenges of estimating annual emissions from broiler facilities are included in Gates et al. (2005b).

Table 4. Summary of ammonia emission rates from broiler houses as determined via actual measurements (rather than mass balance) expressed in terms of flock average emission while birds occupied the house. Where necessary, data were converted from original units to common expression using average bird mass.

	Flock Characteristics					Monitoring				
						Number of:				
Reference and Study Location	Market Age[a] (days)	Final Weight (kg)	Stocking Density (b m^{-2})	Litter[b]	Emission Rate (g NH_3 b^{-1} d^{-1})	Houses (Flocks)	Seasons[c]	Periods	Duration	Method[d]
Wheeler (this study), U.S. (Pennsylvania and Kentucky)	42 (1-45)	2.2	14.7	N	0.47	2 (5 each)	All	13	48 h	C-EC
	42 (2-42)	2.2	14.7	B, T	0.65	2 (6 each)	All	13	48 h	C-EC
	49 (1-53)	2.5	13.4	B, T	0.76	4 (6 each)	All	17	48 h	C-EC
	63 (1-55)	3.3	10.8	B, T	0.98	4 (5 each)	All	20	48 h	C-EC
Seifert et al (2004), U.S. (Delaware)	42 (29-37)	n/a	20.0	B?	1.18	1 (1)	Sp, Su	7	6-12 h	S-CM[e]
Müller et al (2003), Germany and Czech Rep.	32 (13-30)	1.6	n/a	N?	0.09	2 (1)	W	5	1 h	C-PS?
Lacey et al (2003), U.S. (Texas)	49 (8-47)	2.4	13.5	B	0.63	4 (3 each)	Su, F	10	3 S/d	S-CM
Burns et al (2003), U.S. (Tennessee)	42 (1-42)	2.3	16.1	B	0.92	1 (9)	All	9	42 d	C-EC
Demmers et al. (1999), United Kingdom	32 (1-32)	1.9	25	N	0.11	1 (1)	Su	1	32 d	C-CL
Wathes et al (1997), United Kingdom	32 (24-35)	1.1W 1.4 Su	9.3 W 9.4 Su	N?	0.26	4	Su, W	2	24 h	C-CL
Groot Koerkamp et al (1998)										
United Kingdom	–-[f]	––	––	N?	0.48	4	Su, W	2	24 h	C-CL
The Netherlands	––	––	––	N?	0.27	4	Su, W	2	24 h	C-CL
Denmark	––	––	––	N?	0.21	4	Su, W	2	24 h	C-CL
Germany	––	––	––	N?	0.44	4	Su, W	2	24 h	C-CL

[a] Age during measurement shown in parentheses.
[b] Litter: N = new, B = built-up, and T = treated.
[c] Season: Sp = spring, Su = summer, F = fall; W = winter, and All = all seasons.
[d] Monitoring method: C = continuous, S = sample, discrete, EC = electrochemical extraction, PS = photoacoustic extraction, CL = chemiluminescence extraction, and CM = colormetric tube.
[e] Downwind passive samplers and Gaussian plume model back-calculation of emission at building.
[f] Flock characteristics not provided, so data not converted to average bird weight basis.
? = Not explicitly stated but inferred from data, statements in article, or common practice.
n/a = Not available.

EXHIBIT C

Baker J, Battye WH, Robarge W, Pal Arya S, Aneja VP. ***Modeling and measurements of ammonia from poultry operations: Their emissions, transport, and deposition in the Chesapeake Bay.*** **Sci Total Environ. 2020 Mar 1; 706:135290.**
(R. at 0485 n.45)

This exhibit includes several sections of the leading study on ammonia deposition estimations on Maryland's eastern shore. It demonstrates both the quantities of ammonia deposited onto the Eastern Shore, as well as the percent of total emissions deposited in a given distance from a CAFO, as discussed in the Administrative Record on pages 484 to 486 and cited in footnote 45 and referenced in the memorandum of law at pages 3, 9, 10, 23 and 24.

For the full report see:
https://www.sciencedirect.com/science/article/pii/S0048969719352829.

Modeling and Measurements of Ammonia from Poultry Operations: Their Emissions, Transport, and Deposition in the Chesapeake Bay

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For submission: Science of the Total Environment
Special Issue "VSI: Reactive N deposition"

First Submitted: April 2019
Revised: July 2019
Second Revision: October 2019

ABSTRACT

The goal of this study is to determine how much ammonia/nitrogen is being deposited to the Maryland Eastern Shore land and the Chesapeake Bay from poultry operations on Maryland's Eastern Shore. We simulated the fate of ammonia/nitrogen emitted (using emission factors from the U.S. EPA in conjunction with Carnegie-Mellon University) from 603 poultry facilities using the air quality model, AERMOD. The model domain was approximately 134 km by 230 km (and covers the full land area of Maryland's Eastern Shore), with a horizontal resolution of 2 km by 2 km. Ammonia concentration observations were made at 23 sites across Maryland's Eastern Shore during two periods (September and October 2017) in order to calibrate the model. An ammonia deposition velocity of 2.4 cm/sec was selected based on the sensitivity analysis of results for the simulation of a large poultry facility, and this value fell within the range of measurements reported in the scientific literature downwind of Concentrated Animal Feeding Operations (CAFOs). The ammonia deposition velocity of 2.4 cm/s leads to an estimated total annual ammonia deposition of 11,100 Megagrams/year (10,600 Mg/yr deposition to land, and 508 Mg/yr deposition to water (1Mg = 1,000,000g = 1.1023 US Tons)). In addition, model simulations indicate that ~72.4% of ammonia emissions from poultry animal feeding operations would be deposited within the modeling domain. However, this deposited ammonia/nitrogen may be transported through waterways from the land mass and ground water to the Chesapeake Bay. A comprehensive sensitivity analysis of the assumed ammonia deposition velocity (ranging from 0.15 to 3.0 cm/s) on estimated ammonia annual deposition is provided. Using the lower limit of an ammonia deposition velocity of 0.15 cm/s gives much smaller estimated total annual ammonia deposition of 2,040 Mg/yr (1,880 Mg/yr deposition to land and 163 Mg/yr deposition to water).

1.0 Introduction and Background

The Chesapeake Bay is the nation's largest estuary, but like many waterbodies in the U.S. it is plagued with poor water quality due to excess loads of nitrogen and phosphorus (Sheeder et al., 2002; U.S. EPA, 2010, Da et al., 2018). These excess nutrients cause algal blooms that reduce water clarity, contribute to the Bay's dead zone i.e. areas in the Bay and its tidal rivers with insufficient levels of dissolved oxygen, and drinking water concerns (Boesch et al., 2001; US EPA, 2011; Linker et al., 2013; Beachley et al., 2019; and Walker and Beachley, 2019). Because of these water quality problems, in 2010 the U.S. Environmental Protection Agency (EPA) worked with the six Bay states and the District of Columbia to develop the Chesapeake Bay Total Maximum Daily Load that requires significant reductions in nitrogen, phosphorus and sediment in order to meet water quality standards (US EPA, 2010). Roughly one-third of the nitrogen entering the Bay and its tidal rivers comes from atmospheric deposition, and recent estimates indicate roughly one-half of this is due to ammonia (Paerl et al., 2002: Linker et al., 2013). The main source of this ammonia is animal operations (Aneja et al., 2001; Bittman and Mikkelsen, 2009; Battye et al, 2017).

Although agricultural production is widespread throughout the Chesapeake watershed, there are three major animal production regions with the greatest concentrations of animals: the Lower Susquehanna River in Pennsylvania, the Shenandoah Valley in Virginia and West Virginia, and the Delmarva Peninsula in Delaware, Maryland, and Virginia (Figure 1). The Delmarva Peninsula is dominated by integrated poultry (mostly broilers) production (Figure 3).

To determine transport, dispersion, and deposition of emitted ammonia requires air quality modeling. Emitted pollutants in the atmosphere are transported by winds and dispersed by turbulent fluctuations in all directions (Aneja et al., 2001; National Research Council, 2003;

Yao et al., 2018). Energy exchanges at the earth's surface influence the planetary boundary layer (PBL) height and turbulent exchanges of momentum, heat and mass (pollutants), thus carrying the pollutants to large horizontal distances and spreading them through the depth of the PBL (Arya, 1999). Model simulated ground -level concentrations (GLC) and deposition of ammonia are analyzed to evaluate their impacts to sensitive ecosystems such as the waterways and the Chesapeake Bay. The objective of this study is to estimate the deposition of ammonia/nitrogen (the "nitrogen" signifies that the parameter is expressed based on mass of N) to the Chesapeake Bay and adjacent lands from poultry animal feeding operations (AFOs) located on the Maryland Eastern Shore (yellow region in Figure 1).

1.1 Emission Factors

The U.S. EPA has been working with Carnegie-Mellon University (CMU) to develop NH_3 emission factors that take into account local meteorological conditions at the county level (these are referred to as EPA/CMU emission factors). More recently, EPA and CMU have produced a Farm Emission Model (FEM), which takes into account meteorological conditions and potential emission control practices, such as the addition of aluminum sulfate to poultry waste (McQuilling et al, 2015). Each emission factor or emission model covers three components that contribute to the total emission factor: (1) Confinement refers to the emission from animals residing inside of a Confined Animal Feeding Operation (CAFO) and emission from the waste produced within the contained area; (2) Storage refers to the emission of ammonia/nitrogen from the storage of the waste removed from the CAFO; (3) Land application, as implied, is the emission of ammonia/nitrogen after waste is applied to a field as fertilizer. The total emission factor is the sum of confinement, storage, and land application. We assume that farms in the study region generally do not use waste management amendments, such as

aluminum sulfate, and that the farms store and apply waste in the vicinity of the original confinement area.

Ammonia emission factors are subject to considerable variability and uncertainty. Previous studies give emission factors as high as 0.789 kg NH_3 per bird per year (Gates et al., 2005), and as low as 0.035 kg NH_3 per bird per year (Burns et al., 2007). We have adopted an emission factor of 0.20 kg NH_3 per animal per year which is the average annual emission factor developed by CMU and EPA for the counties in the study region. This factor is a composite of emission factors for broiling chickens and laying chickens, with broilers accounting for about 90% of poultry emissions in the region. McQuilling et al (2015) have calculated the mean fractional error of the CMU/EPA FEM currently used to estimate animal emission factors, at 69% based on comparison with measurements at broiler operations.

1.2 Fate of Atmospheric Ammonia/Nitrogen

At the earth's surface, NH_x (= ammonia (NH_3) + ammonium (NH_4^+)) has a range of beneficial and detrimental consequences for humans and the environment (Tomich et al., 2016; Battye et al., 2017). For example, nitrogen fertilizers have had a beneficial effect on agriculture globally by increasing crop yields. However, the high loading of reactive nitrogen (reactive nitrogen includes all biologically active, chemically reactive, and radiatively active nitrogen compounds in the atmosphere and biosphere of the earth, in contrast to non-reactive gaseous dinitrogen (N_2)), has led to deleterious effects on the environment, such as acidification of soils, forest decline, decreased visibility from increased aerosol production, and elevated nitrogen (both ammonia/nitrogen and oxides of nitrogen (NO_x)) concentrations in ground and surface waters, possibly leading to enhanced eutrophication in downwind ecosystems (Asman et al., 1998; Aneja et al., 1998; Krupa, 2003; Baek and Aneja 2004). Thus, there is a need to study the

NH_x deposition changes, spatial distribution, and transport of ammonia from agricultural sources (both crop and animal) to gain a better understanding of effective means to control or reduce excess amounts of ammonia and ammonium deposition.

Any atmospheric ammonia that is not dry deposited or scavenged by raindrops is converted into atmospheric ammonium (Seinfeld and Pandis, 2016). This is done through the interaction of gaseous ammonia with small water particles not large enough to effectively dissolve gaseous ammonia. The conversion of ammonia to atmospheric ammonium (NH_4^+) is important because the ammonium aerosol has a much longer lifetime than ammonia and is an alkaline species that is readily used in the process of $PM_{2.5}$ formation, especially in the presence of sulfuric acid and nitric acid (Jacobson, 1999; Baek and Aneja, 2004; Paulot and Jacob, 2013).

Dry deposition is another process which is important to understand the fate of atmospheric ammonia. Depending on an area's temperature, humidity, and precipitation, dry deposition may be the largest contributor to nitrogen deposition from ammonia releases (Duyzer, 1994). Dry deposition refers to the removal of atmospheric gases or particles without the presence of moisture in the atmosphere. Given that ammonia is highly soluble, it is important to consider dry deposition to both vegetation and to water bodies. Water bodies on which ammonia is deposited can cause dissolution of ammonia and lead to an additional nitrogen deposition mechanism (Larsen et al., 2001). With no natural surface resistance due to the solubility of the species, ammonia uptake by water bodies is efficient and is an important factor in areas where wetlands, rivers, lakes, or other large ocean bodies are present (Larsen et al., 2001). This fact coupled with the concentration of emission sources on the Delmarva Peninsula makes dry deposition a vital topic of this study.

Deposition of ammonia/nitrogen to water and land surfaces with vegetation is expressed using a resistance model approach. When expressing deposition to vegetation, atmospheric gases encounter several factors (resistances) influencing their deposition fluxes. These are aerodynamic resistance (r_a), quasi-laminar resistance (r_b), and surface resistance (r_c). The resistance of gases to transport from the atmosphere to the surface is r_a. Once a gas molecule makes it to the surface for exchange, it must overcome resistances to molecular diffusion across the quasi-laminar boundary layer of air at the leaf surface (r_b) and uptake to the surface (canopy) itself. The r_c is determined by the characteristics of the surface (e.g., presence of moisture, acidity of the surface, leaf stomatal processes) to which the gas is depositing. There are separate resistances that make up r_c, which include water resistance, ground resistance, and foliar resistance. Typically, a vegetative canopy exists which involves additional complex resistances, but is usually referred to collectively as the canopy resistance (Seinfeld and Pandis, 2016).

In addition to the resistance model of dry deposition flux, the bi-directional flux of ammonia may have to be considered. When the concentration of ammonia in the atmosphere is higher than the ammonia compensation point at the surface, ammonia will deposit to the vegetation-soil system whereas when the compensation point of ammonia is higher in the soil and vegetation, ammonia will be emitted to the atmosphere (Pleim et al., 2013; Farquhar et al., 1980). In the scope of this study, bi-directional flux was not considered to be important.

1.3 Previous Research

This study builds off initial research conducted on the Delmarva Peninsula in 2004 by Siefert et al. (2013). Siefert et al. used inverse modeling to determine the emission strength of the initial poultry operation, while the model used in this study infers the original strength of the emission source from Maryland AFO population data and emission factors from CMU/EPA.

O'Shaughnessy and Altmaier (2011) also used inverse modeling using the American Meteorological Society (AMS)/U.S. EPA Regulatory Model (AERMOD). The objective of this study is to simulate the concentrations and deposition at points downwind and later in time assuming the initial strength with emission factors from the U.S. EPA/CMU. Unfortunately, due to the large differences in emission strength, the results of Siefert et al. (2013) and this study are expected to be too different to be compared.

Overall, few studies have attempted to apply AERMOD to horizontal scales of >100km. The main concern is the application of implied horizontal homogeneity assumption in similarity theories and relations used in AERMOD. However, these assumptions are likely to be valid over Delmarva Peninsula due to its flat terrain. In addition, AERMOD has not been used to simulate the dispersion of atmospheric ammonia, as compared to its applications to other compounds. Sutton et al. (1998) conducted a study utilizing AERMOD's dispersion calculations in the United Kingdom (U. K.) to model ammonia in a rural landscape, locally. That study found that AERMOD shows accuracy despite no inclusion of the bi-directional flux and land-cover data which would influence the transport distances.

It is also important to keep in mind that an important assumption of this study is that no waste management practices or environmental technologies are used to mitigate ammonia emissions throughout the modeling domain, and that the facilities are producing at maximum animal capacity at all times throughout the duration of the simulation. This will provide an upper-limit scenario for ammonia/nitrogen deposition and concentration values.

1.4 Dispersion Modeling

AERMOD is EPA's preferred dispersion model for near-field applications, promulgated in 2005 and revised in 2017 (U.S. EPA, 2005, 2017). It is similar to other dispersion models in

that they are designed to model the transport of certain chemicals. Initially, the U.S. Military began to experiment with dispersion modeling due to fear of chemical weapons (U.S. EPA, 2013). This led to scientists becoming aware of atmospheric dispersion. At first, gradient transport theories with constant and variable eddy diffusivities were proposed. More sophisticated statistical theories were developed by Taylor (1922). Both horizontal and vertical dispersion were later investigated using the Gaussian and non-Gaussian plume dispersion equations that are utilized in AERMOD (Arya, 1999).

AERMOD uses steady-state plume modeling to calculate concentrations and depositions with the goal of minimizing errors in model output due to small changes in input parameters (U.S. EPA, 2013). The horizontal and vertical concentration distributions are assumed to be Gaussian in the stable boundary layer (SBL) and unlike many dispersion models, it is assumed to be a bi-Gaussian probability density function following statistical concentration distributions in the convective boundary layer (CBL) (Deardorf and Willis, 1985; Briggs, 1993). The general form of concentration distribution in AERMOD within both the SBL and the CBL is:

$$C(x,y,z) = \frac{Q}{U} P_y(y,x) P_z(z,x) \quad (1)$$

where C is the average concentration, Q is emission strength, U is the average wind speed, and P_y and P_z are the probability density functions describing the concentration as a statistical expression away from the model centerline (Peters, 2015). Divisions occur between the CBL, SBL capping the CBL for pollutants emitted by near-surface sources, and the transition between the two. However, most time is spent in the CBL and final concentrations are determined by several forms of dispersion equations describing vertical dispersion, lateral dispersion, and natural centerline fade dispersion (U.S. EPA, 2013). While concentration calculations are at the forefront of the AERMOD formulation, deposition is the most important parameter discussed in

this study. Chamberlain (1953) describes the simple deposition model used in AERMOD's formulation involving calculations of ground-level concentrations (GLC) due to a continuous point source:

$$C_0(x,y,0) = \frac{Q_x}{\pi\sigma_y\sigma_z U}\exp\left(-\frac{y^2}{2\sigma_y^2}\right)\exp\left(-\frac{H^2}{2\sigma_z^2}\right) \quad (2)$$

where Q_x is the depleted source strength downwind at a distance of x and governed by the mass equation:

$$\frac{\partial Q_x}{\partial x} = -\int_{-\infty}^{\infty} F_d(x,y)\,\partial y \quad (3)$$

And the dry deposition flux:

$$F_d(x,y,0) = v_d C_0(x,y,0) \quad (4)$$

This is termed as a source-depletion model and is a linear relationship allowing deposition to be calculated from GLC calculations with previous determination of SBL and CBL contributions within AERMOD calculations and a prescribed deposition velocity (v_d) (Cimorelli et al., 2005).

Several studies in the past have used AERMOD's dispersion capabilities. Many studies have modeled hydrogen sulfide (H_2S) emissions and dispersion using AERMOD. Some studies have used AERMOD to determine emission factors for better representation of emission from agricultural practices, using an inverse modeling approach. O'Shaughnessy and Altmaier (2011) found that AERMOD worked effectively when using inverse modeling, especially at distances of less than 6,000 m. Other studies have used AERMOD at local scales, but our literature search did not find any AERMOD-related studies that incorporated areas larger than 50 x 50 km^2. Attempting to apply AERMOD to larger domains makes this study unique. Other studies have successfully applied AERMOD to a local application of ammonia. Bajwa et al. (2008) used AERMOD to determine deposition velocities under different seasons and stability conditions. Deposition velocities were modeled on a local scale and found that total deposition occurred

within 2,500 m of the source. Theobald et al. (2012) compared AERMOD, Atmospheric Dispersion Modelling System (ADMS), Local Atmospheric Dispersion and Deposition (LADD), and the Operational Priority Substances model (OPS-st) in terms of concentration within 1,000 m of a source. Input processes were varied throughout their study which found that for area and volume sources, AERMOD and OPS-st predicted larger concentrations for a case study. Overall AERMOD, ADMS, and OPS-st performed well within the range of acceptability criteria. Hanna et al. (2001) compared ADMS, AERMOD, and Industrial Source Complex (ISC3) at downwind distances of 10 to 20 km. A total of 6 sites were used in their comparison. AERMOD shows better performance at 3 of these 6 sites over ADMS and ISC3.

AERMOD utilizes three forms of meteorological data: (1) site-specific data, i.e. a local meteorological tower, (2) National Weather Service (NWS) or Federal Aviation Administration sites, or (3) prognostic meteorological data. The most readily available data is NWS data, which was used in this study.

AERMOD does not include a system for simulating the conversion of NH_3 to NH_4^+ or the formation of particulate matter from NH_4^+ salts. Therefore, we have only simulated atmospheric concentrations of NH_3 and dry deposition of gaseous NH_3. This neglects the formation of NH_4^+ particulate matter and the potential dry and wet deposition of NH_4^+ particulate matter, and may result in some overestimation of gaseous NH_3 concentration and NH_3 dry deposition. These effects are minor at close proximity to the emission sources, such as where monitor to model comparisons are made in this study.

1.5 Deposition Velocities

Schrader and Brummer (2014) reviewed published ammonia deposition velocities for various land use types and found annual mean values ranging from 0.1 to 1.8 cm/s for semi-

natural, 0.4 to 3.0 cm/s for mixed forests, and 0.2 to 7.1 cm/s for agricultural sites. Deposition velocities span more than an order of magnitude within and across land use types. Phillips et al. (2004) conducted their study in an area similar to the Maryland Eastern Shore, which was described as a semi-natural site downwind of the North Carolina State University Research Farm in central North Carolina. Measurements were not taken at the facility but were taken downwind over turf grass. They did not take direct measurements at a CAFO, but several samplers were located downwind (~ 1km) of large facilities and in open grass fields.

In general, semi-natural sites have a relatively low deposition velocity with many ranging from about 0.6 – 1.8 cm/s (Bajwa et al., 2008; Benedict et al., 2013; Kirchner et al., 2005; Myles et al., 2011). Variation is due to the area of study and time of year. Most studies report deposition velocities during the fall season with some reporting annual means for comparison (Bajwa et al., 2008; Phillips et al., 2004; Myles et al., 2011). Phillips et al. measured a deposition velocity of 2.8 cm/s during the daytime in the fall. Stability, ground temperature, moisture, and other factors may also limit or amplify deposition velocities.

Our main area of interest in the literature review involves agricultural production. In areas downwind of agricultural soils, deposition velocities are expected to be lower than any other type of land types considered unless the measurements are taken downwind of the ammonia source or in areas of intensive agriculture (Schrader and Brummer (2014)). This is reflected in a study done by Myles et al. (2011) which reported a deposition velocity at 7.1 cm/s over a fertilized soil. Other studies such as Baek et al. (2006) found a deposition velocity of 6.3 cm/s downwind fetch of an ammonia source. Studies with deposition velocities below 1 cm/s are likely located within a few hundred to 1,000 m of an ammonia source or in soils with a high ammonia concentration (Bajwa et al., 2008). Theobald et al. (2012) used a deposition velocity of

0.15 cm/s in a study that compares local transport of ammonia within 1 km of a source using different dispersion models. Pleim et al. (2013) provide some reasoning for this with more in-depth analysis provided by Cooter et al. (2010) for agricultural soils specifically. The ammonia/nitrogen bi-directional flux can cause areas of low deposition velocities near ammonia/nitrogen sources. High concentrations tend to increase the surface resistance, which will decrease the effective dry deposition velocity and decrease the overall deposition to an area. Therefore, a constant deposition velocity may not capture the extent of ammonia transport near areas of high concentration such as downwind of intensive animal operations. This difference can be as high as a factor of 10 at the source and a factor of 2, 60 m downwind of the source (Jones et al., 2007). Furthermore, it would be an additional benefit to include variable deposition velocities based on land-use categories. Within the model formulation, the user is allowed to define land-use characteristics in relation to the source. With a large quantity of modeled sources and unknown land-use characteristics of each individual site, the same land-use is assumed for the entirety of the region. Defining land-use at each site individually will improve the quality of modeled transport and provide more detailed surface characteristics that are used in the model output calculation.

2. Methods

2.1 Measurements

Ambient ammonia concentration was measured at 23 sites on Maryland's Eastern Shore during two sampling events of two weeks each i.e. September 8 to 22, 2017 and September 22 to October 6, 2017 (Figure 3). Data were used to calibrate AERMOD. The CEH Adapted Low-Cost Passive High Absorption (ALPHA) sampler (Figure 2) (a passive sampler) was used to measure NH_3 in air. The sampler uses a phosphorus acid-coated filter, which serves to capture

results from the AERMOD simulation show that 72.4% of nitrogen is deposited due to ammonia/nitrogen release from poultry CAFOs. A comprehensive sensitivity analysis of the effect of ammonia deposition velocity on estimated annual ammonia deposition is provided (Table 1) over the 2 km by 2 km modeling domain covering the Maryland Eastern Shore and Chesapeake Bay. These additional deposition velocities include 1.0 cm/s, 2.0 cm/s, and 3.0 cm/s.

3.3 Simulation Results for a Single Facility

Annual averages were calculated for a single facility in central Maryland Eastern Shore using a modeled deposition velocity of 2.4 cm/s. For this single facility, multiple attributes were investigated to better understand deposition and concentration. The main area of investigation is deposition as a function of distance from the poultry facility. Results show that for the average meteorological conditions on the Maryland Eastern Shore, and a deposition velocity of 2.4 cm/s, homes and businesses within 2,500 m of the facility will experience average ammonia concentrations of 2.8 $\mu g\ m^{-3}$ (4.0 ppb). Under certain conditions, the short-term concentration can be much higher and above the threshold for human detection (which is approximately 5,000 ppb) of ammonia/nitrogen. While this has no known health effects, it is a significant nuisance for communities near poultry CAFOs (National Research Council, 2003). Concentrations quickly decline from this value to below 1.0 ppb beyond 2,500 m in either direction away from the source facility.

Approximately 40% of total emissions were found to be deposited within 2,500 m of an AFO source. Figure 10 shows the cumulative ammonia deposition (% of emission) as a function of distance (m) from the source (for a deposition velocity of 2.4 cm/s) for a single poultry facility. Bajwa et al. (2008) found, on average, that approximately 9% of the total emissions from the source was deposited within 2,500 m of the source. Figure 11 provides average annual

ammonia deposition flux (g $m^{-2}yr^{-1}$) as a function of distance (m) from the source (for a deposition velocity of 2.4 cm/s) for a single poultry facility. Deposition fluxes decrease exponentially from the source as described by the Gaussian plume equation relating concentration and deposition described above in equations (2) and (4). This is an expected result and a function of the model formulation. It is important to note that the model does not incorporate the ammonia bi-directional flux. The highest amount of deposition occurred immediately adjacent to the source where concentrations were at their highest. This is corroborated by Theobald et al. (2012) which found that concentrations will decrease to 1 μg m^{-3} or less at 1,000 m from a ground-level area source.

In the single facility simulation, total deposition within 50 km was found to be about 70% of the total emissions.

3.4 Simulation Results for the Larger Domain

Concentration results (Figure 12 A, B) for a deposition velocity of 0.15 cm/s and 2.4 cm/s show an average ammonia concentration of 1.40 μg m^{-3} and 0.48 μg m^{-3} respectively across the entire modeling domain. As Figure 12 (A, B) shows, the highest concentrations occur over the Eastern Shore with a minimum in concentration over the Chesapeake Bay. The amount of ammonia/nitrogen reaching the Bay waters is likely higher owing to the deposition to the landmass or other inland water bodies and subsequent transport into the Chesapeake Bay. Unfortunately, determining the deposition to rivers, streams, and tributaries would be very difficult without land-use satellite data. Furthermore, understanding how this ammonia/nitrogen is transported to the Bay waters itself is a separate issue as it is not advised to assume that all the nitrogen from ammonia/nitrogen deposited on land is ultimately transported to the Chesapeake Bay (Nus and Kenna, 2012). Additionally, meteorological factors such as land-sea breeze would

limit transport to the Bay in general. Winds will blow perpendicular to the shore during the day where temperature gradients between the land and the water occur (a common condition met in the area, but not measured in meteorology used in AERMOD simulations). This would protect Bay waters during appropriate atmospheric conditions. Winds from the southwest will enhance this push away from the Bay waters as strong southwesterly winds advect ammonia concentrations toward southwestern Delaware (Figure 9).

AERMOD reports average deposition fluxes for each receptor within the modeling domain. The use of a constant Vd implies a linear relationship between flux and concentration. Because of the linear relationship between deposition flux and concentration, the spatial patterns of deposition are similar to the spatial pattern of concentration. Using a deposition velocity of 0.15 cm/s and 2.4 cm/s (Figure 12 C, D) provides annual average deposition flux (including both dry and wet deposition) over the course of a single year from poultry AFOs on the Maryland Eastern Shore. Deposition fluxes are calculated hourly and averaged over the entirety of the modeling period and reported as an average deposition flux. Average deposition fluxes show that throughout the year with meteorological observations and a deposition velocity of 0.15 cm/s, deposition over the modeling domain is calculated to be approximately 2,044 Mg (2,252 U.S. Tons); and for a deposition velocity of 2.4 cm/s, deposition over the modeling domain is calculated to be approximately 11,086 Mg (12,220 U.S. Tons). Overall emissions totaled to 15,345 Mg (16,914 U.S. Tons). Figure 13 shows the impact of increasing deposition flux on the domain-wide deposition as a fraction of emissions. Using a deposition velocity of 2.4 cm/s, the fractional deposition was calculated as ~72% within the modeling domain. Moreover, modeling suggests that for a deposition velocity of 2.4 cm/sec for a single poultry facility, 30% of emissions will be deposited ~500m distance and ~38% of emissions will be deposited ~2,000 m

from the source (Figure 10). Walker et al. (2008) found that about 10% of the emitted ammonia from a swine production facility deposited to the surface within about 500 m of the source. Fowler et al. (1998) found that about 3-10% of the locally emitted ammonia will deposit back locally. Asman (1998) incorporates much of the improvement in understanding of NH_3, emission, transport and deposition over the last two decades and shows that up to 60% of the NH_3, emitted from sources up to 3 m in height, may be deposited within ~2000 m of the source. Using a regional chemical transport model, Dennis et al. (2010) found that a fractional deposition of around 8-15% of total emissions will occur within 12 km of a source facility.

Linker et al. (2013) estimated roughly 2,830 Mg of ammonia/nitrogen was directly deposited to the Chesapeake Bay's tidal surface waters. By comparison, we estimated total ammonia deposition per year to the Chesapeake Bay is approximately ~508 Mg (418 Mg of nitrogen) using a deposition velocity of 2.4 cm/s. Worth noting is that our source inventory was limited to Maryland poultry AFOs and the mainstem of the Chesapeake Bay, whereas Linker et al. (2013) included all animal sources within the watershed and all tidal waters.

A comprehensive sensitivity analysis of ammonia deposition velocity on estimated annual ammonia deposition is provided (Table 1) over the regional modeling domain covering the Maryland Eastern Shore and Chesapeake Bay. This indicates that ~5% of the total deposition that occurs within the domain is depositing to the Chesapeake Bay waters directly. Moreover, this does not include the additional input from indirect deposition to rivers, streams, and groundwater which will likely transport to the Chesapeake Bay. It is important to note that all poultry houses are assumed to be at capacity year-round with constant emissions. Emission factors also introduce error into the model as they can vary based on waste management practice,

weather, and poultry growth state. Finally, we did not assume any facilities were using waste amendments, such as aluminum sulfate, to control ammonia emissions.

Meteorological effects will have a significant impact on the deposition (both wet and dry) over the domain. The most critical of these meteorological parameters affecting atmospheric dispersion and deposition are wind speed, wind direction, and stability (Arya, 1999). Figure 9 A shows the wind rose of the meteorology (wind speed and direction) used in the main simulation. A predominant wind from the southwest is seen approximately 5% of the time. This will transport ammonia away from the Chesapeake Bay, and cause higher concentrations to exist over the terrestrial surface northeast of the concentration of sources. This is similar to wind rose during the measurement period (Figure 9 B). The second most common wind direction is from the north/northwest. More stable conditions at night will tend to increase concentrations at the surface and lead to more deposition at this time of day (Arya, 1999). Unstable conditions will allow the plume to disperse more effectively and lead to low concentrations (Arya, 1999).

4.0 Conclusions

This analysis is a combination of measurement and modeling of ammonia concentration/deposition to the Maryland Eastern Shore land and the Chesapeake Bay from poultry operations over the Delmarva Peninsula. The application of AERMOD to estimate fate and transport of ammonia from poultry operations has promise. The model was able to reliably predict ammonia concentrations from sites (samplers 8 and 9) that were closest to the source has proven to be accurate in predicting concentrations when validating with meteorology and sampling results close to the source (Figures 3, 7 and 8). However, AERMOD's concentration predicting capability decreases when applied to a regional scale. AERMOD's ability to predict concentration drastically improved when considering sampled concentrations near the source

cluster. Figure 6 shows the mean bias applied to only samplers 8 and 9 and reports mean bias near 0 for a deposition velocity of 2.4 cm/sec. This is an encouraging result when applying the model to localized areas. Significantly higher mean biases in samplers at large distances from the source region are likely due to localized sources and the location of samplers being upwind of the largest cluster of poultry AFOs (Figure 7).

Direct annual deposition to the Chesapeake Bay is estimated to range from ~163 Mg (180 U.S. Tons) for a deposition velocity of 0.15 cm/s to ~508 Mg (560 U.S. Tons) for a deposition velocity of 2.4 cm/s. These values, especially the estimate using the 2.4 cm/s deposition velocity, are within the range of Linker et al. (2013) who estimated roughly 2,830 Mg of nitrogen in the form of ammonia was directly deposited to the Chesapeake Bay's tidal surface waters. However, it is known that AERMOD is unable to calculate mesoscale meteorological features without being provided with appropriate weather data. Location of weather data used for this study was limited to an area in the center of the peninsula. In areas near the coast, sea breezes and other weather features of the marine environment will likely affect deposition calculations to the Bay. During the daytime, winds blowing inland will likely limit deposition to the Bay, but some conditions such as marine instabilities during the fall and early winter could exist to significantly increase deposition to the Bay surface. From this study, it is clear that direct deposition of ammonia/nitrogen to the Chesapeake Bay is less than the deposition to land, rivers and tributaries within the watershed.

A single facility analysis was performed using a deposition velocity of 2.4 cm/s; which was determined from a sensitivity analysis of measured concentrations in an attempt to determine transport distances of ammonia from broiler CAFOs (Figure 10). We estimate that approximately 40% of the ammonia/nitrogen deposition occurs within 2,500 m of the source.

Overall, the emissions from poultry totaled to 15,345 Mg/yr. When using a deposition velocity of 2.4 cm/s, deposition over the modeling domain is calculated to be approximately 11,086 Mg/yr. This result is consistent with previous studies (Linker et al, 2013). However, it is interesting to compare and contrast these results for a lower deposition velocity e.g. deposition velocity of 0.15 cm/s. The deposition to the modeling domain is estimated to be around 2,044 Mg/yr. Indirect deposition due only to broiler CAFOs to the Chesapeake Bay remains unknown. Of the emitted ammonia, 13% is deposited back to the domain (using a deposition velocity of 0.15 cm/s); while ~72% is deposited back to the domain (using a deposition velocity of 2.4 cm/s). With nearly ~90% of the modeled deposition settling to the landmass, indirect deposition will clearly provide the largest proportion of deposition to the Chesapeake Bay from river transport. Unfortunately, AERMOD does not allow users to get a specific land-use data set to be used in the analysis phase of the output. Additionally, vegetation is an important consideration of this study. Dense forests will likely limit direct deposition to the Bay by taking up ammonia that would otherwise deposit to the water surface. These dense forests are near rivers and water bodies and may further limit deposition to the Chesapeake Bay. Moreover, use of Best Management Practice (BMP) of using aluminum sulfate in the poultry houses for reducing ammonia emissions was not accounted for.

Poultry CAFOs were assumed to be at capacity during the duration of the model simulation. This is not a realistic approach, since it is difficult to model the temporal emissions from a single facility for 603 separate facilities. Modeling scenarios, however, could be improved in several ways. For future research, it is suggested that the simulation is run for a single growing cycle rather than an entire annual rotation. Additionally, seasonal variation, particularly in deposition velocities, is an important variable to include. Second, we assumed all

AFOs were at capacity during the model simulation. More realistic estimates would be achieved if simulations reflected the growing cycle of the birds. Third, an estimate of the number of facilities that use waste amendments to control ammonia would improve model accuracy. Lastly, additional monitoring data would allow for better model calibration. This should address seasonal changes in emissions as well as deposition velocities. Regardless of whether realistic estimates of deposition to the Chesapeake Bay can be produced exactly in a model environment, an increase in emission will lead to an increase in deposition. Therefore, it is increasingly important to understand the effects of ammonia/nitrogen-nitrogen deposition to the Chesapeake Bay area both as the DELMARVA Peninsula experiences growth and the construction of new sources of ammonia continues.

ACKNOWLEDGMENTS

This research was supported by the Chesapeake Bay Foundation (CBF). We would like to thank CBF for providing the necessary resources to conduct the study. We sincerely thank Dr. John T. Walker, U.S. EPA, for his continued and ongoing assistance and advice during the course of this study. We thank the Soil Sciences Laboratory, North Carolina State University for providing the passive ammonia samplers; their preparation and analysis (including QA/QC) during the duration of the project's sampling campaign. We sincerely thank Mr. Alberth Nahas, Ms. Uttamang, and members of the Air Quality Research Group, North Carolina State University. The United States Department of Agriculture, North Carolina State University's High

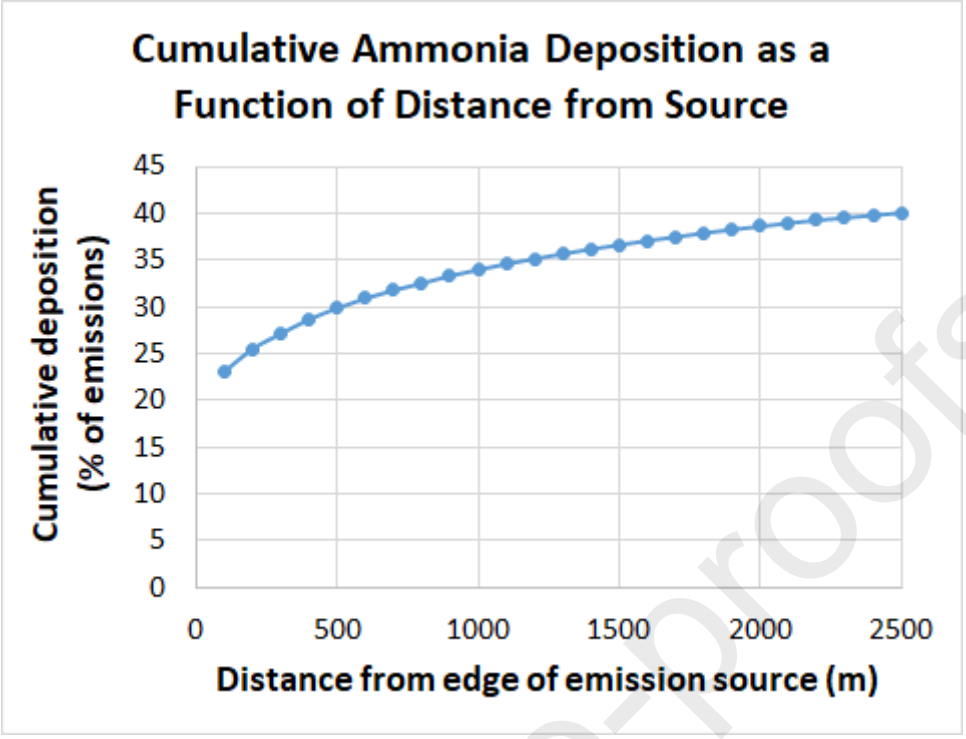

Figure 10. Cumulative ammonia deposition (% of emission) as a function of distance (m) from a source (for a deposition velocity of 2.4 cm/s), for a single poultry facility.

Table 1. Total Estimated Deposition of ammonia to the modeling domain based on AERMOD simulations for a range of deposition velocities 0.15 cm/s to 3.00 cm/s. Column A indicates the simulated deposition velocity for a single AERMOD simulation. Column B indicates the estimated annual deposition in (Mg/yr) that includes deposition during calm conditions (this required an extrapolation of average deposition flux during hours with wind speeds equal to 0 cm/s). Column C indicates the estimated annual deposition as a fraction of emissions. Column D indicates the estimated annual deposition that occurred over the Bay waters (this can be viewed as direct deposition to the Bay water surface). It is assumed that any location within the modeled domain that has an elevation ≤0 meters is the water surface of the Chesapeake Bay. Column E indicates the estimated annual deposition to the landmass (i.e. deposition to the modeling domain landmass other than the Bay). Column F gives the percent of estimated annual deposition that deposits directly to the Chesapeake Bay water surface based on column D and column B. Column F estimate does not include rivers, marshland, minor tributaries, or other water bodies, or ground water flow to the Bay.

A. **Deposition Velocity (cm/s)**	**B.** **Estimated Annual Deposition (within the modeling Domain) (Mg/yr)**	**C.** **Deposition as a Fraction of Emissions (within the modeling Domain) (%)**	**D.** **Estimated Annual Deposition to the Chesapeake Bay (Mg/yr)**	**E.** **Estimated Annual Deposition to the Remainder (other than the Bay) of the Modeling Domain (Mg/yr)**	**F.** **Percentage of Estimated Annual Deposition that Deposits to the Chesapeake Bay (%)**
0.15	2,040	13.4	163	1,880	7.97
1.00	7,400	48.4	401	7,000	5.42
2.00	10,260	67.0	486	9,770	4.73
2.40	11,100	72.4	508	10,600	4.58
3.00	12,100	79.2	531	11,600	4.37

(1 Mg = 10^6 g = 1.1023 U.S. Tons)

EXHIBIT D

United States Geological Survey Short Term and Long Term Pollution Monitoring Trends of Major Chesapeake Bay Tidal Tributaries
(R. at 0474.)

This exhibit shows the short-term and long-term nitrogen and phosphorus pollution trends from the nine "River Input Monitoring" stations operated by the U.S. Geological Survey for the Chesapeake Bay Program, including increasing pollution for the Choptank River over the short term and long term for both forms of nutrient pollution, as discussed in the Administrative Record on page 0474 and referenced in the memorandum of law on page 5.

To access this information, see:
https://www.sciencebase.gov/catalog/item/5ed6bcd882ce7e579c6499ea

Table 1. Summary of long-term (1985-2019) and short-term (2010-2019) trends in nitrogen, phosphorus, and suspended-sediment loads for the River Input Monitoring stations.

[Improving or degrading trends classified as likelihood estimates greater than or equal to 66 percent]

Monitoring station	Total nitrogen load		Total phosphorus load		Suspended-sediment load	
	Long term	Short term	Long term	Short term	Long term	Short term
SUSQUEHANNA RIVER AT CONOWINGO, MD	Improving	No Trend	No Trend	Improving	Degrading	Improving
POTOMAC RIVER AT WASHINGTON, DC	Improving	Improving	Improving	Improving	Improving	No Trend
JAMES RIVER AT CARTERSVILLE, VA	Improving	Improving	Improving	Improving	No Trend	Improving
RAPPAHANNOCK RIVER NR FREDERICKSBURG, VA	Improving	No Trend	Degrading	No Trend	Degrading	No Trend
APPOMATTOX RIVER AT MATOACA, VA	Degrading	Degrading	Degrading	Degrading	No Trend	Degrading
PAMUNKEY RIVER NEAR HANOVER, VA	Degrading	No Trend	Degrading	Improving	Degrading	Improving
MATTAPONI RIVER NEAR BEULAHVILLE, VA	No Trend	Degrading	No Trend	No Trend	No Trend	Degrading
PATUXENT RIVER NEAR BOWIE, MD	Improving	Improving	Improving	Improving	Improving	Improving
CHOPTANK RIVER NEAR GREENSBORO, MD	Degrading	Degrading	Degrading	Degrading	Improving	Degrading

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Moyer, D.L. and Blomquist, J.D., 2020, Nitrogen, phosphorus, and suspended-sediment loads and trends measured at the Chesapeake Bay River Input Monitoring stations—Water years 1985–2019: U.S. Geological Survey data release, https://doi.org/10.5066/P9VG459V.

Additional Information and USGS Contacts

For more information on this topic, visit the "Water-Quality Loads and Trends at Nontidal Monitoring Stations in the Chesapeake Bay Watershed" website at https://cbrim.er.usgs.gov/., or contact:

Doug Moyer **dlmoyer@usgs.gov**
Joel Blomquist **jdblomqu@usgs.gov**

For more information on USGS Chesapeake Bay studies, visit http://chesapeake.usgs.gov/, or contact

Scott Phillips, **swphilli@usgs.gov**.

EXHIBIT E

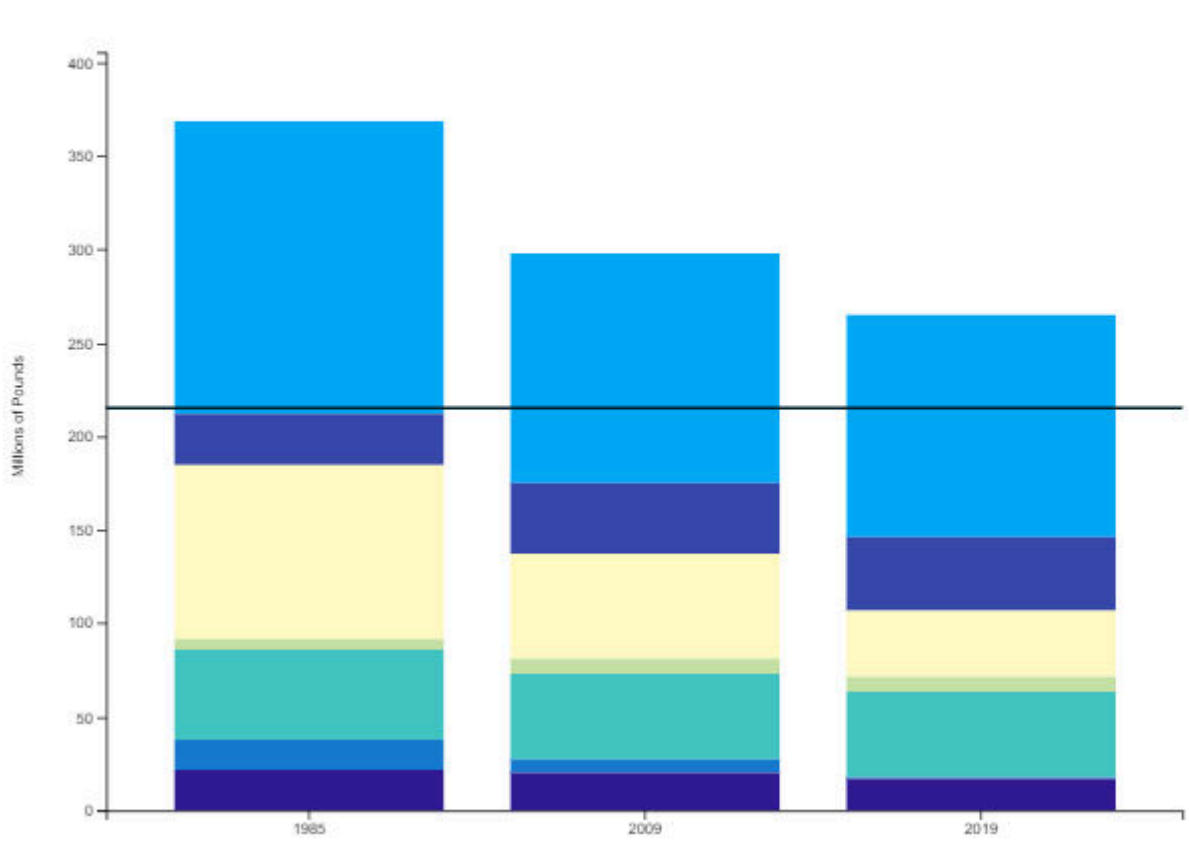
Chesapeake Progress: Modeled Nitrogen Loads to the Chesapeake Bay (2009-2017)
(R. at 0473 n.3)

This exhibit shows the Bay Model loads by sector discussed in the Administrative Record on page 0473 and cited in footnote 3 and referenced in the memorandum of law on page 5.

For more information, see:
https://www.chesapeakeprogress.com/clean-water/2017-watershed-implementation-plans

Modeled Nitrogen Loads to the Chesapeake Bay (1985-2019)

Loads simulated using CAST17 and jurisdiction-reported data on wastewater discharges.



Loads by Source

Loads by Jurisdiction

- Agriculture
- Urban Runoff
- Wastewater/Combined Sewer Overflow
- Septic
- Forest/Non-Tidal Water Atmospheric Deposition
- Atmospheric Deposition to Watershed
- Atmospheric Deposition to Tidal Water

.

EXHIBIT F

Abel Russ and Eric Schaeffer, Ammonia Emissions from Broiler Operations Higher than Previously Thought, Environmental Integrity Project (Jan. 2018).
(R. at 0484-0485.)

This exhibit is a brief report exploring ammonia emissions from broiler operations. Monitoring data from U.S. broiler operations show that broiler operations emit twice as much ammonia as EPA has traditionally assumed. A typical broiler operation on the Delmarva Peninsula emits roughly 20 tons of ammonia each year, as discussed in the Administrative Record on pages 0484 to 0485 and referenced in the memorandum of law on page 8, 9 and 23.

To access this information, see:
https://www.environmentalintegrity.org/wp-content/uploads/2017/12/Ammonia-Emissions.pdf

Ammonia Emissions from Broiler Operations Higher than Previously Thought

Executive Summary

The Chesapeake Bay has long suffered from algae blooms, dead zones, and other effects on aquatic life that are caused by excess nitrogen and phosphorus pollution. The Total Maximum Daily Load (TMDL), often described as a "pollution diet" for the Bay, has resulted in significant pollution reductions, but further reductions will be necessary to restore the health of the Bay.

Ammonia, the pungent gas released from animal waste, is responsible for a significant fraction of the nitrogen load to the Chesapeake Bay each year. Airborne nitrogen is responsible for roughly one third of the nitrogen load. Historically, most of that nitrogen has been in the form of nitrogen oxides (NOx) from fossil fuel combustion and other sources. Clean Air Act regulations have produced steady declines in NOx, but ammonia has been increasing, and ammonia will soon be the dominant form of atmospheric nitrogen loads.

The largest source of ammonia emissions is livestock waste, and a large component of that source category comes from the factory farms that produce broiler chickens. Since ammonia from broilers is a significant pollution problem, we attempted to determine whether the Environmental Protection Agency was accurately estimating these emissions in its TMDL model. This report reaches the following conclusions:

A broiler chicken operation located on Maryland's Eastern Shore.

1. Broiler barns emit much more ammonia than EPA has traditionally assumed. The Chesapeake Bay model assumes that local broiler confinements emit the same amount of ammonia, per broiler, as similar facilities in Europe. Yet we know that American broiler emissions are much higher than European broiler emissions. This is due to a number of factors: We raise larger birds, and larger birds emit more

ammonia; we re-use the bedding (litter) in broiler confinements much more than European operations; and we raise our broilers in a warmer climate.

2. EPA has traditionally assumed that broilers emit 0.27 grams of ammonia per bird, per day. Based on our survey of the literature on American broiler operations, we believe that a more realistic estimate is 0.54 grams of ammonia per bird, per day.

3. Using alternative emissions factors, ammonia emissions are equal to 34.3 grams of ammonia per broiler sold, or 14.2 grams of ammonia for every kilogram of broiler sold.

4. Applying these factors to broiler statistics for the Bay states, we determined that actual ammonia emissions are roughly twice as high as what EPA assumes: EPA's emissions factor predicts emissions of roughly 20,000 tons per year, while our factors predict emissions of roughly 40,000 tons per year.

5. A typical broiler CAFO on the Delmarva Peninsula – producing 500,000 broilers each year at an average weight of six pounds – is likely emitting between 19 and 24 tons of ammonia each year. Yet EPA's emissions factor would only predict 12 tons.

In order to ensure that the EPA is accurately accounting for this important source of pollution, we urge EPA to clarify its assumptions about broiler confinement emissions, and if necessary adjust its assumptions to reflect the current state of the science with regard to American broiler operations.

Introduction

Ammonia emissions from factory farms present a clear threat to environmental quality. The prime example of this threat may be the Chesapeake Bay, where ammonia is a major contributor to persistent algae blooms and dead zones. According the U.S. EPA's Total Maximum Daily Load (TMDL) for the Chesapeake Bay, "[a]ir sources contribute about a third of the total nitrogen loads delivered to the [] Bay."[1] Specifically, using the models they had at the time, EPA estimated that atmospheric deposition was responsible for 31-36% of the total nitrogen load. Of that, the majority (78-81%) was deposited on land or non-tidal waterways and then transported to the Bay.[2]

Nitrogen deposits in various forms, mainly nitrogen oxides (NOx) and ammonia. Table 1 shows TMDL estimates of nitrogen deposition over time. Two things stand out. First, while NOx has historically been the dominant source of nitrogen deposition, ammonia is expected to be the dominant source now or in the near future. Second, while NOx deposition is falling over time, and wet ammonia deposition (ammonia that falls with precipitation) is

roughly constant, dry ammonia deposition (ammonia that deposits in gaseous form) is increasing.

Table 1. Atmospheric deposition loads of nitrogen (millions of pounds as N) to the Chesapeake Bay watershed. Adapted from TMDL Table L-3.[3]

Year	Dry NOx	Wet NOx	Dry ammonia	Wet ammonia	Total N	Ammonia/total
1985	293	154	66	79	592	24%
2002	208	102	66	76	452	31%
2010	135	67	85	73	360	44%
2020	97	50	98	76	321	54%

The TMDL estimates in Table 1 suggest that ammonia deposition is currently responsible for roughly half of the atmospheric contribution, or roughly 17%, of the total nitrogen loads to the Bay.[4]

Why are ammonia emissions and deposition increasing?

Ammonia deposition is increasing for two reasons. First, changes in atmospheric chemistry, including a decline in atmospheric NOx concentrations, increase the likelihood that ambient ammonia will deposit in gaseous form. Second, ammonia emissions are increasing, due mainly to an increase in animal production and a parallel increase in manure production.[5]

Ammonia is a highly reactive gas that tends to form fine particles by combing with NOx and other gases in the air.[6] As NOx emissions fall, less ammonia is "captured" in fine particle formation. This is significant because gaseous ammonia has a short residence time in the atmosphere and deposits close to the source of emissions, while fine particles stay aloft for much longer and can travel far from the source.[7] The steep decline in NOx levels is a major victory for public health, helping to reduce smog and acid rain as well as the deadly fine particles linked to heart disease and premature death. NOx is also contributing less to nitrogen loadings in the Bay as emissions decline. But those water quality benefits will be largely offset by increases in the local deposition of ammonia no longer reacting with NOx to make fine particles.

The other factor causing an increase in ammonia deposition is the increase in ammonia emissions. Most of the ammonia in the air comes from agriculture. According to the most recent National Emissions Inventory, out of a national total of 3.9 million tons of ammonia that are emitted each year, 1 million tons come from synthetic fertilizer and 2.2 million tons come from livestock waste.[8] When animal production increases, ammonia emissions also

increase. The Bay TMDL doesn't include any limits on ammonia emissions from agriculture, although EPA estimated emissions could be cut about 30% at fairly low cost.[9] Instead, EPA is counting on the NOx reductions driven by Clean Air Act rules to keep the airborne nitrogen load low enough to meet cleanup goals by 2025. That scenario will be undermined if ammonia emissions prove to be higher than EPA expects.

Within the livestock sector, one of the largest sources of ammonia is the production of chickens for meat ("broilers"). On a per-weight basis, broilers excrete more nitrogen than any other major animal production group – more than twice as much as pigs, and more than three times as much as most cows.[10]

Since 2002, broiler production in the Chesapeake Bay watershed (in pounds) has increased by 25%, driven in part by a 17% increase in the average size of the broilers being sold (see Appendix A). As we show in more detail below, this has led to a large increase in ammonia emissions over the same time period.

Estimating Ammonia Emissions from Broiler Operations

Background

The amount of ammonia released from broiler confinements can be estimated in different ways. The most direct way is to simply measure the ammonia. This has been done in several studies, described below. For most broiler production facilities, however, routine monitoring is too expensive and technically challenging. It is therefore necessary to derive more generic emissions estimating methods that can be applied to facilities without monitors.

Methods for estimating emissions come with important trade-offs. The most accurate methods are complicated and data-intensive. Other methods are easier to use, but may be less accurate. The more complicated methods have to account for the long list of variables influencing emissions. To begin with, ammonia emissions from broiler CAFOs change over time. A typical broiler operation will raise multiple flocks of broilers each year. Older, heavier birds emit more ammonia than younger, smaller birds. This means that the emissions from a broiler house will increase as a flock of birds inside the house ages. After a flock is sold, the broiler house is cleaned out, either superficially ("decaking") or with a full removal of built-up manure and bedding. The cleanouts produce pulses of ammonia emissions that depend on, among other things, the number of flocks since the last full cleanout. Other factors affecting ammonia emissions include temperature and humidity.

These variables can be accounted for in emissions models, which can be either process-based or statistical. Process-based models attempt to estimate ammonia emissions using

basic physical and chemical principles and the input data described above. For example, researchers at Carnegie Mellon University have developed a model that predicts emissions based on the density of livestock in a barn, the nitrogen content of the waste, and ambient temperature.[11] Statistical models start with emissions monitoring data and attempt to predict emissions on the basis of a similar list of factors. The EPA draft Emissions Estimating Methodology (EEM) for broilers is an example of a set of statistical models.[12] In the draft EEM, EPA presented three models of increasing complexity that used between 11 and 31 regression coefficients, including average bird mass, confinement clean-out history, temperature, and humidity.[13] Whether process-based or statistical, emissions models can only be used when all of the input variables can be quantified. This is often not possible. For example, we may want to estimate how much ammonia a planned, but not yet built, broiler CAFO will emit. We will know some things, like the number of chickens that the barns can hold, but we would only be guessing about variables like pounds of broilers produced each year, the schedule of barn cleanouts, and weather. Or we may be interested in aggregate emissions for a large, diverse area like the Chesapeake Bay watershed. Given the data and computational limitations at that scale, a complex emissions model may be too difficult to implement.

The simplest way to estimate emissions is to use an "emissions factor." Emissions factors are basic coefficients, expressed (for broilers) as some variation on 'pounds of ammonia per chicken.' Emissions factors can be derived from monitoring data or models, but in either case they are meant to approximate an average facility. Emissions factors are less precise than detailed models, but on the other hand they are easier to use, and they can produce reasonably accurate emissions totals, particularly for large areas like states or the Bay watershed.

In the case of broiler confinements, emissions factors might have one of three denominators:

- **Inventory:** The EPA has traditionally used an inventory-based emissions factor, described in more detail below, in the form of kilograms of ammonia per broiler per year, or kilograms of ammonia per broiler per month, with broiler "inventory" being the average population of broilers in a confinement, or the capacity of broiler barns at a confinement. At the county or state level, inventory statistics can be found in the USDA Census of Agriculture, which is compiled every five years.[14]
- **Production (Sales):** It may be preferable to estimate emissions based on production rather than inventory. There can be several cycles or flocks of broiler production over the course of a year. For example, in 2012, Maryland had an average statewide broiler inventory of 64.2 million broilers, but it produced (sold) 304.7 million birds (Appendix A), suggesting that there were, on average, about five flocks of broilers at each confinement. In order to account for differences in the number of flocks per

year – differences that are not apparent in basic inventory statistics – ammonia emissions can be approximated as "pounds of ammonia per broiler sold."[15]

- **Production (Weight):** Not all broilers are the same weight when they are sold. For example, the average broiler in Delaware weighs almost twice as much as the average broiler in West Virginia (see Appendix A). And we know that larger broilers excrete more ammonia. So a third emissions factor would be expressed as "pounds of ammonia per pound of broiler sold" over the course of a year.

In the discussion that follows we attempt to derive all three types of emissions factor from available monitoring studies.

EPA Emission Factors

The EPA has historically used an inventory-based emissions factor. Athough the Agency has chosen to express the factor in different ways, the factor itself was constant from as early as 2004 through at least 2011.

In 2004, EPA published a draft report documenting the technical basis for its National Emissions Inventory (NEI). At that time, EPA expressed the ammonia emissions factor for broiler confinements as 0.22 pounds of ammonia per broiler per year (0.22 lb NH_3/head/yr).[16] It is important to note that this emissions factor was derived entirely from European studies.[17] American and European agricultural practices (and meteorological conditions) are quite different. European broiler operations tend to replace the litter after each flock, while American broiler operation reuse litter for up to a year.[18] European operations generally grow lighter birds.[19] Temperatures in Europe are cooler.[20] All of these factors cause American broiler emission rates to be significantly greater than European emission rates. Wheeler et al. (2006) presented seven American estimates alongside seven European estimates.[21] The mean ammonia emissions rate from the American studies was 0.64 pounds per broiler per year, three times higher than the mean from the European studies (0.21 pounds per broiler per year).[22]

In the documentation for the 2011 NEI, EPA stated that it was using Carnegie Mellon's emissions model, but it listed a single emissions factor for broiler confinements.[23] The new emissions factor – 8.32E-03 kg NH_3/bird-month – is, after converting kilograms to pounds and months to years, equal to the old emissions factor. In the documentation for the 2014 NEI, EPA claims to have changed the way it uses the Carnegie Mellon model to estimate poultry emissions, but there is no evidence that the emissions factor for broiler confinements has changed.[24]

For purposes of EPA's Chesapeake Bay model, the Agency is using the 2011 NEI for at least part of its simulations,[25] and maybe for all of its simulations.[26] In short, it appears that

EPA continues to assume that broiler confinements emit 0.22 pounds of ammonia per broiler per year, an assumption based on outdated European data. As discussed in detail below, that assumption is probably far too low.

Monitored emissions from broiler houses: Total emissions

Ammonia emissions from broiler houses have been measured many times, in different locations (inside and outside the United States) and using different methods. We reviewed studies from within the United States in order to evaluate whether the current EPA emissions factor is still valid, and in order to approximate a more reasonable emissions factor. As a preliminary matter, it is important to note that some studies attempted to capture the full cycle of a broiler confinement, including the cleanout period that can cause a pulse in ammonia emissions, while other studies only looked at emissions while there were broilers in a barn. This section only looks at the studies that monitored the total emissions over full cycles, including the periods between flocks. The following section discusses studies that only looked at the grow-out period.

NATIONAL AIR EMISSIONS MONITORING STUDY (NAEMS)

Between 2007 and 2009, researchers working with the EPA monitored the emissions of ammonia and other pollutants from four broiler houses, two in California and two in Kentucky.[27] Ammonia emissions were calculated by subtracting ambient air concentrations from exhaust air concentrations. In 2012, EPA released a draft Emissions-Estimating Methodology (EEM) for broilers.[28] In that 2012 document, EPA provided the following simple summary statistics that include all periods (growout, decaking, and full cleanout):

Table 2: Summary ammonia data for NAEMS broiler studies.[29]

	Average house inventory	Average daily emissions (lb/d-house)	Grams per day per bird
California barn 1	21,000	22.49	0.49
California barn 2	21,000	19.82	0.43
Kentucky barn 1	23,000	26.76	0.53
Kentucky barn 2	24,500	27.29	0.50

It is also possible to represent NAEMS emissions as a function of broiler production statistics. The Kentucky study derived a sales-based emissions factor of 35.4 grams of ammonia per bird marketed,[30] and a weight-based factor of 12.5 grams of ammonia per kilogram of broiler.[31] The study of California barns did not provide comparable estimates, but the California study did provide daily data on bird counts and bird weight, from which

we can estimate production statistics. Appendix B provides an example of the data, and explains how we derived emissions factors from the data. Based on the raw data, it appears that production-based emissions factors for the California study would be 29 grams of ammonia per bird marketed, and 11 grams of ammonia per kilogram of broiler.

MOORE ET AL. (2011)

Moore et al. monitored four broiler barns in Arkansas in 2005 and 2006, over five flock cycles, including the periods between flocks.[32] The authors present a production-based emissions estimate of 37.5 grams of ammonia per bird,[33] and they also provide average bird weight (2.582 kg), from which a weight-based estimate can be derived (14.5 grams of ammonia per kg of broiler). In order to translate these values into an inventory-based estimate, we had to make two calculations. First, since inventory generally refers to the number of birds placed in a barn, rather than the number that survive to be sold, and the broiler in this study had a mortality rate of roughly 4 percent, we had convert 37.5 grams of ammonia per bird *sold* to 35.9 grams of ammonia per bird *placed*. Second, we had to determine how many days of emissions each bird was responsible for, including both the grow-out and the between-flock periods. The authors provide start dates for each of the five flocks in their study, from which we were able to calculate the lengths of the first four flock cycles (from one start date to the next).[34] The average flock cycle was 70.5 days. An inventory-based emissions factor would therefore be roughly 35.9 grams per bird divided by 70.5 days, or 0.51 grams of ammonia per bird per day.

Table 3: Summary of monitoring data and emissions factors for the full broiler cycle, including both grow-out and between-flock periods

Source	Location	No. of barns	Average age of flock (days)	Average flock size (per barn)	Average market weight (kg)	g NH3/bird-day	g NH3/bird sold	g NH3/kg market weight
EPA (2012)	CA	2	47.0[35]	21,000[36]	2.65[37]	0.46[38]	29.0[39]	11.0[40]
EPA (2012)	KY	2	51.5[41]	25,100[42]	2.76[43]	0.52[44]	35.4[45]	12.5[46]
Moore et al. (2011)	AR	4	50.4[47]	26,300[48]	2.58[49]	0.51[50]	37.5[51]	14.5[52]

Monitored Emissions from Broiler Houses: Grow-Out Period Only

Several studies have measured ammonia emissions during the grow-out period only (i.e., not during the between-flock barn cleanouts). Lacey et al. (2003) measured ammonia emissions from four broiler houses in Texas in 2000, and derived an emissions factor of 31 grams of ammonia per bird.[53] Siefert et al. have published two studies on the Delmarva peninsula with quite different results. The first study, published in 2004, derived an emissions factor of 38 grams of ammonia per bird, while the second study, published in 2008, derived an emissions factor of just 5 grams of ammonia per bird. The authors attribute the difference in part to the fact that the newer study took place at a tunnel-ventilated broiler barn, while the earlier study took place at a side-wall ventilated house.[54] Yet all of the studies in Table 4, below, with the exception of the 2004 Siefert et al. study, were conducted at tunnel-ventilated houses, and all show much higher emissions rates. The 2008 Siefert and Scudlark study appears to be an outlier for some other reason, which may include errors in the analysis. Wheeler et al. (2006),[55] in a study funded by the U.S. Department of Agriculture, measured ammonia emissions from twelve barns in Pennsylvania and Kentucky in 2002 and 2003. The authors only assessed emissions during the grow-out period, but found a relatively wide range of daily emissions rates, from 0.47 to 0.98 grams of ammonia per bird per day. Miles et al. (2014) measured ammonia emissions from a single barn in Mississippi in 2007 over the course of five flocks.[56]

Table 4: Summary of monitoring data and emissions factors for only the grow-out period

Source	Location	No. of barns	Average age of flock (days)	Average flock size (per barn)	Average weight (kg)	g NH3/ bird-day	g NH3/ bird sold	g NH3/kg market weight
Lacey et al. 2003[57]	TX	4	49	27,500	2.4	0.63[58]	31.0	12.9[59]
Siefert et al. 2004[60]	MD	1	42	11,155	*not available*	0.90[61]	37.8[62]	*not available*
Wheeler et al. 2006[63]	PA	4	42	32,600	2.2	0.56[64]	23.5[65]	10.7[66]
Wheeler et al. 2006[67]	KY	4	56	22,500	2.9	0.87[68]	49.5[69]	16.8[70]
Siefert and Scudlark 2008[71]	Delmarva Peninsula	1	42	18,600	*not available*	0.12[72]	5.2[73]	*not available*
Miles et al. 2014[74]	MS	1	43	27,860	2.27	0.54	23.5	10.4[75]

The studies that monitored total, full-cycle emissions (Table 3) also segregated emissions between the grow-out and between-flock periods, which allows us to derive scaling factors between grow-out emissions and total emissions. For production-based emissions factors, the scaling factor will be a multiplier that increases the emissions factor, because each broiler is responsible for between-flock emissions that are always additive to grow-out emissions. For an inventory-based emissions factor, the scaling factor could theoretically result in an increase or a decrease in the amount of ammonia emitted per bird per day. Although peak emissions during the clean-out or decaking of a barn will often be higher than peak emissions during the grow-out period, the average daily emission rate over the entire between-flock period may be lower than the average daily emission rate during the grow-out period. Tables 5 and 6 compare grow-out and total emissions from studies with available data. These tables show that total emissions are roughly 21% higher than emissions from the grow-out period only, and that the total daily emissions rate over the entire flock cycle is roughly 7% lower than the daily emissions rate during the grow-out period.

Table 5: Total emissions compared to emissions for the grow-out period

Study	Grow-out emissions	Total emissions	Total emissions / grow-out emissions
Moore et al. (2011)[76]	28.37 g NH_3/bird	37.46 g NH_3/bird	1.32
EPA (2012), California barns[77]	4,049.48 kg NH_3	4,466.41 kg NH_3	1.10
EPA (2012), Kentucky barns[78]	3,619.62 kg NH_3	4,373.08 kg NH_3	1.21
Average ratio (scaling factor)			***1.21***

Table 6: Total emissions rates compared to emissions rates for the grow-out period

Study	Grow-out emissions rate, g/bird-day	Total emissions rate, g/bird-day	Total emissions rate / grow-out emissions rate
Moore et al. (2011)[79]	0.56[80]	0.51[81]	0.91
EPA (2012), California barns[82]	0.50[83]	0.46[84]	0.92
EPA (2012), Kentucky barns[85]	0.56[86]	0.52[87]	0.95
Average ratio (scaling factor)			***0.93***

Using the scaling factors shown in Tables 5 and 6, we combined the emissions estimates from Table 3 with adjusted emissions estimates from Table 4 to derive average emissions factors from all of the literature values. Table 7 shows this derivation.

Table 7: Combined emissions factors

Study	Grams of ammonia per bird, per day	Grams of ammonia per bird marketed	Grams of ammonia per kg of market weight
EPA (2012),[88] CA	0.46	29.0	11.0
EPA (2012), KY	0.52	35.4	12.5
Moore et al. (2011)[89]	0.51	37.5	14.5
Lacey et al. (2003)[90]	0.59	37.5	15.6
Siefert et al. (2004)[91]	0.84	45.7	*not available*
Wheeler et al. (2006),[92] PA	0.52	28.4	13.0
Wheeler et al. (2006), KY	0.81	59.9	20.3
Siefert and Scudlark (2008)[93]	0.11	6.3	*not available*
Miles et al. (2014)[94]	0.50	28.4	12.6
Average value	**0.54**	**34.3**	**14.2**

Note: Highlighted cells are based on values in Table 4, but adjusted with the scaling factors shown in Tables 5 and 6.

The studies shown in Table 7 are mutually consistent, which increases the reliability of the combined estimates. Most studies predict daily emissions of between 0.4 and 0.6 grams of ammonia per bird. The lowest (0.11 grams per bird per day) and highest (0.84 grams per bird per day) estimates were both generated by Siefert et al., and do not change the overall average value. Similarly, total emissions are generally in the range of 30-60 grams of ammonia per bird, or 10-20 grams of ammonia per kilogram of broiler weight. In short, the range of estimates is generally within a factor of two, which is comparable to (or better) than the data used to develop emissions factors for most other industries.[95]

Broiler Emissions in the Chesapeake Bay Watershed

Using the emissions factors derived in the preceding sections and the broiler statistics shown in Appendix A, we estimated the ammonia emissions from broiler confinements in the Chesapeake Bay states in 2002, 2007 and 2012 (all years for which broiler inventory data are available), and also 2016 (the most recent year with production statistics). Table 8

compares our estimates with emissions estimated using the most recent obtainable EPA method (the 2011 NEI method). It should be noted that the 2011 NEI method and our inventory-based emissions factor can be directly compared, as they both use broiler inventory statistics. The NEI method is equivalent to 0.27 grams of ammonia per bird, per day. Based on the monitoring data described above, EPA's NEI factor is much too low, and the true factor should be roughly twice as large, at 0.54 grams of ammonia per bird, per day. Total emissions estimates presented in Table 8 reflect this difference.

Table 8: Ammonia emissions (tons) from broiler confinements in the Chesapeake Bay states using different emissions factors

	2011 NEI method	Emissions factors derived from monitoring data, as described above		
Year	8.32E-03 kg NH_3/bird-month	0.54 g NH_3/bird-d	34.3 g NH_3/bird marketed	14.2 g NH_3/kg of market weight
2002	19,370	38,239	38,944	37,460
2007	22,088	43,605	38,981	40,314
2012	20,888	41,237	38,339	40,861
2016			41,628	47,009

Table 8 shows that broiler confinements in the Chesapeake Bay watershed emit roughly 40,000 tons of ammonia each year, and that the amount is increasing over time. The three emissions factors that we derived produce roughly comparable results, within 5 or 10 percent of each other, for any given year. Table 8 also shows that the NEI emissions factor for broiler operations is outdated and too low, estimating half as much ammonia as the three factors that we derived.

Discussion

We estimate that broiler confinements in the Chesapeake Bay watershed emit roughly 40,000 tons of ammonia each year. For comparison, the 2014 NEI estimated that ammonia emissions from all livestock waste totaled 96,000 tons,[96] and EPA's most recent estimate of ammonia *deposition* in the watershed is 81,000 tons.[97] Broilers are clearly a large part of the ammonia problem, and it is important that the Bay model get this part of the puzzle right. An outdated emissions factor based on European agricultural practices is not the right fit for today's Chesapeake Bay.

It helps to frame these estimates in terms of a typical broiler CAFO. We have previously reported on data found in "Annual Implementation Reports" for broiler CAFOs on Maryland's Eastern Shore.[98] Based on these reports, a typical Eastern Shore broiler CAFO

might have an inventory of 110,000 broilers and raise 4.8 flocks per year. If we assume 3% mortality,[99] this CAFO would produce 512,160 broilers per year, at an average weight of about 6 pounds (see Appendix A), thus producing just over 3 million pounds of broilers per year. According to the 2011 NEI emissions factor, this CAFO would emit 12 tons of ammonia per year. According to the emissions factors that we derived, this CAFO would actually emit between 19 and 24 tons of ammonia per year.

Our estimates are based on monitoring studies, but they agree well with mass-balance estimates of ammonia emissions. Coufal et al. (2006) measured all nitrogen inputs and outputs over eighteen flocks at a Texas broiler barn.[100] Overall, these authors determined that ammonia losses totaled 13.5 grams per kilogram of broiler weight,[101] very close to our estimated emissions factor of 14.2 grams per kilogram (Table 7).

The use of litter amendments can help to reduce ammonia emissions to some degree. For example, in a doctoral dissertation on this topic, Senyondo found that small experimental broiler flocks treated with a biodegradable litter amendment made from corn cobs had ammonia emission that were, on average, 27% lower than control flocks.[102] The effectiveness diminished over the course of five flocks as the litter was left in place, and by the fifth flock the treatment emissions were actually higher than the control emissions.[103] Another study evaluated the effectiveness of three alum treatments, and found that average weekly emissions were between 9 and 34% lower from alum-treated barns than from a control barn.[104]

Some of the studies that we included in this report did not use litter amendments (e.g., the EPA NAEMS study), others included a mix of barns that did or did not used litter amendments (e.g., Wheeler et al., 2006),[105] and others did not specify whether amendments were used. If the use of litter amendments is more widespread in the Chesapeake Bay watershed than it was in the studies we evaluated, then actual emissions may be slightly lower than we predict. However, this variable does not significantly affect our conclusions: We do not know the extent of litter amendment in the Bay watershed, but even if its use is widespread, the resulting reduction in emissions is presumably less than a third (since at least some of the data in this report was based on amended litter). This means that even in a best-case scenario, emissions are still significantly higher than EPA has traditionally assumed.

Given the possibility that EPA is underestimating a significant component of the Chesapeake Bay's nitrogen load, the Agency should more clearly explain how much ammonia it assumes to be escaping from broiler confinements. If EPA is still relying on outdated emissions factors based on European agricultural practices, it should revise its assumptions to reflect what we now know about ammonia emissions from American broiler operations.

Appendix A: Broiler statistics for the Chesapeake Bay Watershed

Data for inventory and birds sold through 2012 are from the USDA Census of Agriculture, which is compiled every five years.[106] Data for pounds of broilers produced, and for birds sold in 2016, are from USDA Poultry Production and Value summaries, which are produced each year.[107]

Table A1: Inventory and production of broiler chickens in Chesapeake Bay states

Inventory (millions of birds)	MD	VA	PA	DE	WV	TOTAL
2002	51.1	45.4	21.6	45.6	12.2	176.0
2007	65.5	43.7	27.5	51.1	12.8	200.7
2012	64.2	38.4	29.2	43.2	14.8	189.8
Production (millions of birds sold)	MD	VA	PA	DE	WV	TOTAL
2002	287.1	266.1	132.5	255.9	88.7	1,030
2007	296.4	249.2	150.1	246.1	88.8	1,031
2012	304.7	237.7	166.7	211.6	93.7	1,014
2016	303.5	269.1	185.7	252.5	90.3	1,101
Production (millions of pounds)	MD	VA	PA	DE	WV	TOTAL
2002	1,381.4	1,330.4	701.2	1,494.7	368.2	5,276
2007	1,591.9	1,301.0	831.6	1,597.7	355.6	5,678
2012	1,604.8	1,306.8	962.1	1,505.2	376.0	5,755
2016	1,851.4	1,533.9	1,039.9	1,843.3	352.2	6,621
Average bird size (lbs)	MD	VA	PA	DE	WV	AVERAGE
2002	4.8	5.0	5.3	5.8	4.2	5.1
2007	5.4	5.2	5.5	6.5	4.0	5.5
2012	5.3	5.5	5.8	7.1	4.0	5.7
2016	6.1	5.7	5.6	7.3	3.9	6.0

EXHIBIT G

Acres of Freshwater and Estuarine Wetlands and Waters on Maryland's Eastern Shore as Estimated by the Chesapeake Bay Model

(R. at 0485.)

This exhibit shows the number of acres of wetlands and surface waters on Maryland's Eastern Shore from the Chesapeake Bay Model, as discussed in the Administrative Record on page 0485 and referenced in the memorandum of law on page 10.

To access this information, see:
https://cast.chesapeakebay.net/.

Data Source Version	CAST-2019
File Creation Date	10/06/2020
Base Conditions Report	This report provides information on the base conditions utilized for the selected scenario, including load source acres, septic systems, animal counts, and nutrients applied. Definitions are available https://cast.chesapeakebay.net/Reports/RetrievePublicReport?reportType=1

Row Labels	**Headwater or Isolatec**	**Non-tidal Floodplain Wetland**	**Water**	**Acres**
Caroline, MD	21,185	6,111	3,098	**30,394**
Cecil, MD	1,096	2,348	4,642	**8,086**
Dorchester, MD	11,148	1,575	31,819	**44,541**
Kent, MD	5,311	4,325	5,660	**15,297**
Queen Annes, MD	16,281	10,249	5,012	**31,542**
Somerset, MD	26,757	1,761	11,650	**40,168**
Talbot, MD	5,545	1,911	5,138	**12,593**
Wicomico, MD	22,698	12,136	5,709	**40,543**
Worcester, MD	16,683	42,790	2,659	**62,132**
Grand Total	**126,703**	**83,206**	**75,388**	**285,297**

EXHIBIT H

Affidavit of Ms. Kathy Phillips.

This exhibit includes the affidavit of Ms. Kathy Phillips, the Executive Director of Petitioner, Assateague Coastal Trust. As discussed on page 13 and 14 of the memorandum of law, Ms. Phillips provided written comments during the comment period and testimony at the public hearing expressing her concerns regarding the reissuance of the Permit.

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AFFIDAVIT OF KATHY PHILLIPS

My name is Kathy Phillips. I reside at 12316 W. Torquay Road, Ocean City, Worcester County, Maryland. I have lived in Worcester County for over 40 years. I am also a frequent recreational water user who recreates on the Pocomoke River and in the adjacent parks, the Atlantic Coastal Bays, Indian River, Herring Creek, and elsewhere in the Chesapeake watershed. I typically recreate weekly in the northern Coastal Bays and Herring Creek, several times a year on the Pocomoke, and once or twice a year in the Indian River watershed or in Rehoboth Bay. These activities include swimming, boating, kayaking, canoeing, bird watching, and hiking. I regularly swim and kayak in the Maryland Coastal Bays and from time to time like to paddle on the Pocomoke River.

I have been the Executive Director and Assateague Coastkeeper (Coastkeeper) for the Assateague Coastal Trust (ACT) since 2007. ACT is a nonprofit corporation organized under the laws of the State of Maryland and is a charitable corporation under section 501(c)(3) of the Internal Revenue Code. ACT maintains an office at 9842 Main St., Suite 1, Berlin, Maryland, 21811. ACT works to protect and enhance the natural resources of Delmarva's Coastal Bays watershed through advocacy, conservation, litigation, and education. ACT's history of advocacy throughout the region includes advocacy focused on tributaries to these bays, such as the St. Martin River and Greys Creek, whose watersheds extend into Sussex County, as well as on Delaware's Inland Bays (Rehoboth Bay and Indian River Bay). ACT's advocacy also includes nearby waterways such as the Pocomoke River.

As Executive Director of ACT I am responsible for overseeing its day-to-day operations, including managing staff, fundraising, event planning, and interacting with members and the Board of Directors. As Coastkeeper, I patrol the bays, rivers, and streams in the region to monitor water quality and investigate sources of pollution. Some of this investigation leads to Clean Water Act (CWA) citizen suits. Because ACT is focused on improving water quality and holding polluters accountable, the CWA and citizen enforcement actions under the CWA are integral to my ability to further ACT's mission and goals. I also conduct water monitoring for ACT's Swim Guide app, which posts weekly information about the water quality in various waterways so citizens can make informed decisions about whether to swim in or otherwise come into contact with water that could contain pathogens.

I am aware that nutrient and pathogen pollution has impaired water quality in many portions of the Pocomoke River, St. Martin River, Delaware's Inland Bays, and other waterways in Delmarva. For example, I am aware that the St. Martin River has Total Maximum Daily Loads (TMDLs) for nutrients, and that the Pocomoke River has a TMDL for fecal coliform. I am also aware that the Chesapeake Bay is impaired by nutrient pollution and is now subject to a Bay-wide TMDL for nitrogen and phosphorus. I am further aware that the Delaware Inland Bays are impaired for nutrient pollution and that certain bayside beaches in Rehoboth Bay have swimming advisories for bacteria pollution.

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My knowledge and awareness of the various types of pollution in all of the area's waterways, including fecal coliform and nutrient pollution from poultry CAFOs, make it much less enjoyable for me when I have to paddle or patrol as Coastkeeper or when I personally recreate on rivers in the Coastal Bays watershed. I worry about the environmental damage caused by these pollutants and the decline in the health of the rivers and streams in the region. I also worry about the effects of increased pollution on my personal health and the health of ACT's members

My knowledge that CAFOs are a significant source of nutrient and pathogen loads to waterways on Delmarva, including the Pocomoke River, affects how I use and enjoy the Pocomoke and other waterways in the region. I regularly kayak and boat on the Pocomoke, but when I do, the pollution is constantly on my mind, and diminishes my enjoyment of boating and wildlife watching. I am also aware that Chincoteague Bay is fed in part by groundwater flow that in turn is impacted by pollution upstream. This pollution includes runoff and infiltration from agricultural fields, including some upstream fields spread with CAFO waste, as well as runoff from land development. I patrol this area for ACT due to its pollution problems, and also kayak around the edges of the Bay and in some creeks that feed it. But when I kayak here recreationally, I am careful not to capsize and to avoid making contact with polluted water out of concern for my health.

I am concerned that the Maryland Department of the Environment's reissuance of the State General Discharge Permit MDG01; 19-AF will negatively impact sensitive waterways and wetlands on Maryland's Eastern Shore, including in Worcester County, and will result in immediate, substantial and irreparable harm to myself as a resident of Worcester County and recreational user of waterways and wetlands in Worcester County and on Maryland's Eastern Shore.

I have submitted comments to the Maryland Department of the Environment regarding deficiencies in the above mentioned permit. I am concerned that MDE has not given these undisputed facts fair consideration in the new Permit issuance.

MDE has ignored substantive questions raised by Chesapeake Legal Alliance, Assateague Coastal Trust, Chesapeake Bay Foundation, and others regarding failures to control and/or reduce pollutants to local watersheds and the Chesapeake Bay watershed.
In its current form, the Permit as approved, will not be protective of Designated Uses of the Pocomoke River and its tributaries, the St. Martin River, Chincoteague Bay and the Chesapeake Bay, and will result in further degradation of these waters and impairment of their Designated Uses.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on: 10/22/20

CONFIDENTIAL

Kathy Phillips

Kathy Phillips

STATE OF MARYLAND, COUNTY OF

Wicomico, to wit:

I hereby certify that on the 22nd day of October, 2020, before me, the subscriber, a notary public of the State of Maryland, in and for Wicomico County for which notary is appointed, personally appeared Kathlyn Phillips and made oath in due form of law that the matters and facts set forth in the affidavit are true.

As witness, my hand and notarial seal.

L McCoy 1-2-2022

EXHIBIT I

Affidavit of Ms. Monica Brooks.

This exhibit includes the affidavit of Ms. Monica Brooks, a resident of Wicomico County who lives near several AFOs and is concerned about the health and environmental impacts of AFOs. As discussed on page 14 of the memorandum of law, Ms. Brooks provided written comments during the comment period regarding the reissuance of the Permit.

CONFIDENTIAL

AFFIDAVIT OF MONICA BROOKS

1. My name is Monica Brooks. I reside at 29022 Red Fox Drive, Salisbury, Wicomico County, Maryland. I regularly visit wetlands and waterways in Wicomico and Somerset counties, including Wicomico River and Wicomico Creek. I recreate in and around these waters and enjoy the aesthetic quality of the wetlands, waters and estuaries and their environs.
2. My home is located within approximately 2.8 miles from Rockawalkin Ridge CAFO, and 3 miles from Northwind CAFO.
3. Occupation: I am an entrepreneur and a Spanish teacher.
4. I have volunteered to lend support to area nonprofits in Maryland interested in water issues for 7 years. I have served as an Assateague Coastal Trust board member (over 1,000 members) where I monitor threats to waterways and wetlands on the Eastern Shore.
5. I am a member of the Concerned Citizens Against Industrial CAFOs (CCAIC), which is a community group based in Wicomico County, MD. CCAIC serves to protect our air and water quality from air pollution and run off of other pollutants from CAFOs.
6. I am concerned that the Maryland Department of the Environment's reissuance of the State General Discharge Permit MDG01; 19-AF will negatively impact sensitive waterways and wetlands on Maryland's Eastern Shore, including in Wicomico County, and will result in immediate, substantial and irreparable harm to myself as a resident of Wicomico County and recreational user of waterways and wetlands in Wicomico County and on Maryland's Eastern Shore.
7. I have submitted comments to the Maryland Department of the Environment regarding deficiencies in the above-mentioned permit.
8. I am aware that the Wicomico River and its tributaries, including the Tony Tank Pond, are impaired for fecal bacteria, nitrogen, phosphorus and sediment and subject to a EPA approved Total Maximum Daily Load (TMDL) pollution diet for those pollutants. I am concerned that MDE has not given these undisputed facts fair consideration in the new Permit issuance.
9. MDE has ignored substantive questions raised by Chesapeake Legal Alliance, Assateague Coastal Trust, Chesapeake Bay Foundation, and others regarding failures to control and/or reduce pollutants to local watersheds and the Chesapeake Bay watershed.
10. In its current form, the Permit as approved, will not be protective of Designated Uses of Wicomico River and its tributaries, and the Chesapeake Bay, and will result in further degradation of these waters and impairment of their Designated Uses.
11. As one of thousands of residents on well water, I am continually concerned about the health and well-being of families across Delmarva living under threat of water contamination.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on: October 25, 2020

Monica Brooks

CONFIDENTIAL

Monica Brooks

STATE OF MARYLAND, COUNTY OF

Worcester, to wit:

I hereby certify that on the 25 day of October, 2020, before me, the subscriber, a notary public of the State of Maryland, in and for Worcester County for which notary is appointed, personally appeared

Monica Brooks and made oath in due form of law that the matters and facts set forth in the affidavit are true.

As witness, my hand and notarial seal.

Debbie M Kellum

DEBBIE M KELLUM
NOTARY PUBLIC
MY COMMISSION EXPIRES
7/6/22
WORCHESTER COUNTY, MD