Exhibit 1

# BEFORE THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
# OFFICE OF WATER
# OFFICE OF WASTEWATER MANAGEMENT

**Petition for Rulemaking** )
**Under the Clean Water Act** )
)
**Secondary Treatment Standards for** )
**Nutrient Removal** )
_________________________________)

For the reasons discussed in detail below, the Natural Resources Defense Council, the Environmental Law and Policy Center of the Midwest, the Sierra Club, the Waterkeeper Alliance, the Missouri Coalition for the Environment, Midwest Environmental Advocates, the Prairie Rivers Network, the Iowa Environmental Council, the Minnesota Center for Environmental Advocacy, American Rivers, and the Gulf Restoration Network ("Petitioners") hereby petition the Environmental Protection Agency ("EPA" or "the agency") to promptly fulfill its obligation under the Clean Water Act to publish information on the state of effluent treatment technology for publicly owned treatment works ("POTWs"). In particular, Petitioners seek a statement from the agency that specifies the "degree of effluent reduction attainable" at the present time "through the application of secondary treatment" for nutrient pollution. 33 U.S.C. § 1314(d)(1). Separately, Petitioners request that EPA issue generally-applicable nitrogen and phosphorous removal requirements for wastewater treatment plants. Petitioners contend that limits of 0.3 mg/l total phosphorus ("TP") and 3 mg/l total nitrogen (TN) are consistently attainable using current technology. In addition, limits of 1.0 milligrams per liter (mg/L) TP and 8.0 mg/L TN averaged yearly can be met with existing technology that uses only improved conventional biological treatment processes. Moreover, biological processes capable of meeting these limits have been implemented at many existing facilities at a reasonable cost or even a net savings in treatment costs.

Many of Petitioners' organizations have members that use waters that are or may be affected by nutrient pollution. In particular, Petitioners have members who drink water, fish, swim, canoe, study nature and otherwise use waters that may be affected by the unnecessary discharge of nitrogen and phosphorus.

This petition contains four principal parts. First, we summarize problems nutrient pollution can cause. Second, we discuss EPA's statutory duties regarding secondary treatment, and show that EPA has become long overdue in fulfilling its responsibilities under the law. Third, we explain how biological treatment processes already in use can effectively remove nutrients from effluent, and to what extent. Fourth, we explain how it would be unreasonable to further delay in publishing information about the nutrient removal capacity of secondary treatment and show how the present petition differs from prior citizen pleas to address nutrient pollution, or how EPA erred in its previous responses to such requests.

## I. Nutrient Pollution Causes Multiple Environmental Harms and Must Be Controlled Under the Clean Water Act.

Excess quantities of the macronutrients, nitrogen and phosphorus, have caused well documented damage to freshwater and marine aquatic wildlife communities as well as damage to the aesthetic quality of many waters. As EPA itself has described:

> Human health problems can be attributed to nutrient enrichment. One serious human health problem associated with nutrient enrichment is the formation of trihalomethanes (THMs). Trihalomethanes are carcinogenic compounds that are produced when certain organic compounds are chlorinated and brominated as part of this disinfection process in a drinking water facility. Trihalomethanes and associated compounds can be formed from a variety of organic compounds including humic substances, algal metabolites and algal decomposition products. The density of algae and the level of eutrophication in the raw water supply has been correlated with the production of THMs.
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> Nutrient impairment can cause problems other than those related to human health. One of the most expensive problems caused by nutrient enrichment is the increased treatment required for drinking water.
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> Adverse ecological effects associated with nutrient enrichment include reductions in dissolved oxygen (DO) and the occurrence of HABs (harmful algal blooms). High algal and macrophyte biomass may be associated with severe diurnal swings in DO and pH in some water bodies. Low DO can release toxic metals from sediments contaminating habitats of local aquatic organisms. In addition, low DO can cause increased availability of toxic substances like ammonia and hydrogen sulfide, reducing acceptable habitat for most aquatic organisms, including valuable game fish. Decreased water clarity (increased turbidity) can cause loss of macrophytes and creation of dense algal mats. Loss of macrophytes and enrichment may alter the native composition and species diversity of aquatic communities.[1]

In addition, "[h]igh pH associated with algal blooms can also cause fish kills."[2] Phosphorous can also contribute to blue-green algae growth that can create several toxins.[3]

One of the primary adverse effects of excess nutrients in aquatic systems is the creation of anoxic conditions, including so-called "dead" zones. According to the National Science and Technology Council, "[h]ypoxia occurs when dissolved oxygen concentrations are below those necessary to sustain most animal life. Since 1993, mid-summer bottomwater hypoxia in the northern Gulf of Mexico has been larger than 4,000 square miles. In 1999, it was 8,000 square miles, which is about the size of the state of New Jersey."[4] This year, according to a report by Dr. Nancy Rabalais, the "Dead Zone" ranks as one of the three largest areas of Gulf hypoxia measured to date, with an area of 20,500 square kilometers.[5] Nutrients are a key part of that problem. "Scientific investigations over the last several decades indicate overwhelmingly that

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[1] U.S. EPA, Nutrient Criteria, Technical Guidance Manual, Rivers and Streams, EPA-822-B-00-002, at pp. 4-5 (July 2000) (citations omitted).

[2] Walter K. Dodds, Freshwater Ecology 341-42 (Academic Press, 2002) (citation omitted), viewed online at http://books.google.com/books (search terms walter dodds "freshwater ecology").

[3] Indiana Dept. of Envtl. Mgmt., Water Column, Vol. 13, No. 4 (Fall 2001), available at http://www.spea.indiana.edu/clp/fall%2001%20water%20col.pdf [Exhibit 1].

[4] National Science and Technology Council, Committee on Environment and Natural Resources, Integrated Assessment of Hypoxia in the Northern Gulf of Mexico, at 2 (May 2000) (hereinafter "Integrated Assessment").

[5] Louisiana Universities Marine Consortium, Press Release: Dead Zone Size Near Top End (July 28, 2007), available at http://gulfhypoxia.net/shelfwide07/PressRelease07.pdf [Exhibit 2].

oxygen stress in the northern Gulf of Mexico is caused primarily by excess nutrients delivered to Gulf waters from the Mississippi–Atchafalaya River drainage basin, in combination with the stratification of Gulf waters."[6]

Excess nitrogen in a water body can cause additional problems. At elevated levels, nitrates can cause blue-baby syndrome -- a condition in infants in which the blood has diminished ability to take up oxygen, causing asphyxia and, in extreme cases, even death.[7] Furthermore, nitrogen can be converted in aquatic systems to nitrous oxide, a potent greenhouse gas.[8]

Because of these myriad harms, EPA has long worried whether sufficient Clean Water Act safeguards are in place to guard against excessive nutrient pollution. As it has addressed nitrogen and phosphorus pollution, however, EPA has not applied the principles that led Congress to pass the Clean Water Act in 1972 and has instead relied entirely on a water quality-based approach that was found by Congress to be inadequate. As the Supreme Court stated many years ago:

> Before it was amended in 1972, the Federal Water Pollution Control Act employed ambient water quality standards specifying the acceptable levels of pollution in a State's interstate navigable waters as the primary mechanism in its program for the control of water pollution. This program based on water quality standards, which were to serve both to guide performance by polluters and to trigger legal action to abate pollution, proved ineffective. The problems stemmed from the character of the standards themselves, which focused on the tolerable effects rather than the preventable causes of water pollution, from the awkwardly shared federal and state responsibility for promulgating such standards, and from the cumbrous enforcement procedures. These combined to make it very difficult to develop and enforce standards to govern the conduct of individual polluters …

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[6] Integrated Assessment at 13.

[7] EPA, "National Primary Drinking Water Regulations, Final Rule," 56 Fed. Reg. 3526, at 3537-38 (January 30, 1991); Environmental Working Group, Pouring it On: Nitrate Contamination of Drinking Water (1996) [Exhibit 3]; National Research Council, Nitrate and Nitrite in Drinking Water (1995); EPA, Integrated Risk Information System: Nitrate, available online at http://www.epa.gov/iris/subst/0076.htm (visited Nov. 17, 2006).

[8] EPA, Nitrous Oxide: Sources and Emissions, available online at http://www.epa.gov/nitrousoxide/sources.html (visited Oct. 1, 2007).

> In 1972, prompted by the conclusion of the Senate Committee on Public Works that "the Federal water pollution control program...has been inadequate in every vital aspect," Congress enacted the Amendments, declaring "the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985."[9]

As discussed below, EPA has not reconsidered or modernized the definition of "secondary treatment." Instead, EPA has embraced an approach to phosphorus and nitrogen pollution that is inconsistent with Congress's decision to incorporate technology-based standards into the Act to supplement water quality standards.

Over time, EPA has taken some steps towards a more effective approach to nutrient pollution, but only halting steps. In 1998, the agency published its National Strategy for the Development of Regional Nutrient Criteria ("1998 Strategy"), a roadmap for designing guidance – on a water body-specific and ecoregion-specific basis – for States to use in the development of numeric water quality criteria for nutrients. Such criteria are one of the two linchpins of the Act, with numerous programs designed to drive pollution levels down to the point at which criteria can be met. The 1998 Strategy laid out EPA's plan to develop ranges for numeric nutrient criteria, which would provide guidance to the States and would inform the agency's review of State criteria (and promulgation of criteria itself, if need be). Specifically, EPA said:

> EPA expects States and Tribes to use the waterbody type guidance documents and nutrient target ranges as a guide in developing and adopting numeric levels for nutrients that support the designated uses of the waterbody as part of State water quality standards. EPA will work with States to support and assist in this process. States should have adopted nutrient criteria that support State designated uses by the end of 2003.[10]

A few years later, in 2001, EPA slightly revised its target, saying:

> By the end of 2001, each State and authorized Tribe should complete a plan for developing and adopting nutrient criteria. . . . By the end of 2004, States and authorized Tribes should adopt nutrient criteria . . . . *** EPA intends to propose to promulgate nutrient water quality criteria. . . by the end of 2004, where States and authorized tribes

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[9] *Environmental Protection Agency v. California ex rel. State Water Resources Control Board*, 426 U.S. 200, 202-03 (1976) (citations omitted).

[10] 1998 Nutrient Criteria Strategy at iv.

> have not substantially completed their adoption . . . if the Administrator determines that such new or revised standards are necessary to meet the requirements of the Clean Water Act.[11]

To date, however, these efforts have failed, or as EPA too generously says, "overall progress has been uneven over the past nine years."[12] The vast majority (well over 90%) of States do not have numeric nutrient criteria for all relevant parameters and water bodies.[13] Furthermore, a significant majority – 34 States and territories – are presently only at the stage of gathering data to support criteria development.[14] In the numerous places where these standards are absent, the water bodies are deprived of the effective use of multiple tools for cleaning up the resource.[15] In other words, the States have not adequately protected their waters from nutrients. And despite previously warning States that the agency would step in to establish standards where they were needed and lacking, EPA has failed to do so and indeed has recently suggested – by not even mentioning the possibility of federal intervention in its latest statement of policy concerning nutrient standards – that it may be abandoning its prior commitment.[16]

In the past, EPA has suggested that until numeric criteria are adopted, states can address the nutrient pollution problem by using their narrative standards. But most states are not even trying to apply narrative standards to set necessary effluent limits for phosphorus or nitrogen. For example, in a recent guidance document put out by the Wisconsin Department of Natural

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[11] 66 Fed. Reg. 1671, 1673-74 (Jan. 9, 2001).

[12] Memorandum from Benjamin H. Grumbles, EPA Assistant Administrator for Water, to State Water Program Directors et al., "Nutrient Pollution and Numeric Water Quality Standards," at 1 (May 25, 2007) [Exhibit 4].

[13] *Id.* at 8.

[14] *Id.*

[15] *Id.* at 2 (noting that numeric criteria support "easier and faster development of TMDLs"; "quantitative targets to support trading programs"; "easier to write protective NPDES permits"; "increased effectiveness in evaluating success of nutrient runoff minimization programs"; and "measurable, objective water quality baselines against which to measure environmental progress").

[16] National Research Council, Committee on the Mississippi River and the Clean Water Act, Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities, at 111 (Oct. 16, 2007) (prepublication copy) ("None of the 10 Mississippi River mainstem states currently have numeric criteria for nitrogen or phosphorus applicable to the river . . . . Without such standards, whether they are adopted by individual states or the EPA, there is little prospect of significantly reducing or eliminating hypoxia in the Gulf of Mexico.").

Resources, the state bluntly admitted that it does not and will not use its narrative standards to set effluent limits on nutrients.[17] Petitioners, which have followed permit issuance in many states, are aware that other states differ from Wisconsin only in that Wisconsin has openly stated in a guidance document what others do and fail to do.

Numeric nutrient criteria could certainly be adopted and used to set water quality based limits on nutrient pollution, and they should be. However, such criteria are not being adopted and narrative standards are not being used to fill the gap.[18] In fact, there is no reason to believe that water quality-based limits will ever be able to address adequately nitrogen and phosphorus pollution.

Protection of the nation's rivers, lakes, streams and estuaries depends on technology-based requirements to minimize releases from known nutrient sources. One such category of sources – POTWs – is the subject of the instant petition.

## II. Statutory and Regulatory Background Concerning Secondary Treatment

Section 301(b)(1)(B) of the Clean Water Act (CWA) obligates POTWs "in existence on July 1, 1977" to achieve "effluent limitations based upon secondary treatment as defined by the Administrator pursuant to section [304(d)(1).]"[19] Section 304(d)(1) accordingly requires EPA to "publish within sixty days after October 18, 1972 (and from time to time thereafter) information, in terms of amounts of constituents and chemical, physical, and biological characteristics of

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[17] Memorandum from Russ Rasmussen, State of Wisconsin, to WPDES Staff, at 3 (Dec. 14, 2006) [Exhibit 5] ("Until there is guidance or a rule that establishes a general or site-specific methodology for determining reasonable potential to attain narrative water quality standards as applied to nutrients, WPDES permits should not be issued with nutrient limits based on narrative water quality standards.").

[18] *See* 40 C.F.R. § 122.44(d) (water quality-based effluent limitations must be included in permits where they would be "in addition to or more stringent than promulgated effluent limitations guidelines or standards").

[19] 33 U.S.C. § 1311(b)(1)(B). The language about sources in existence in 1977 is not a limitation on the applicability of secondary treatment to other sources; EPA's regulations make clear that secondary treatment must be met by all POTWs. *See* 40 C.F.R. § 125.3(a)(1)(i) (permits must require POTWs to contain "effluent limitations based upon . . . [s]econdary treatment . . . from [the] date of permit issuance").

pollutants, on the degree of effluent reduction attainable through the application of secondary treatment."[20]

As discussed below, EPA has refused to update its secondary treatment standards on the basis of faulty legal principles and antiquated information regarding the effluent standards that are attainable using biological treatment processes. Further, EPA has not published secondary treatment information at all for over 20 years.

## A. Regulatory History of EPA's Definition of Secondary Treatment

To put the instant petition in context, it is first important to review what EPA has done to regulate POTW discharges under the "secondary treatment" provisions of the CWA. It is also necessary to review how the agency has previously responded to citizen requests to upgrade nutrient control requirements for POTWs, in order to understand why granting the instant petition is appropriate notwithstanding EPA's prior refusals.

EPA first promulgated effluent limitations based on secondary treatment standards in 1973, then revised its regulations several times in the dozen years thereafter. In 1973, immediately after the passage of the Clean Water Act, EPA set limits for biochemical oxygen demand, suspended solids, fecal coliform bacteria, and pH.[21] Later, EPA deleted the limitations on fecal coliform bacteria and narrowed but did not eliminate the pH limitation.[22] Other changes occurred in 1977, 1984 and 1985.[23] The Secondary Treatment Regulation is codified at 40 C.F.R. §§ 133.100-133.105, and has not been materially updated since 1985.

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[20] 33 U.S.C. § 1314(d)(1).

[21] 38 Fed. Reg. 22,298 (Aug. 17, 1973).

[22] 41 Fed. Reg. 30,786 (July 26, 1976).

[23] 42 Fed. Reg. 54,664 (Oct. 7, 1977) (easing suspended solids requirements for certain POTWs); 49 Fed. Reg. 36,986 (Sept. 20, 1984) (sanctioning alternative treatments "equivalent to secondary treatment" and allowing use of carbonaceous BOD in place of general BOD parameter); 50 Fed. Reg. 23,382 (June 3, 1985) (adjusting percent removal requirements). A 1989 amendment adding a special provision for "[l]ess concentrated influent wastewater for combined sewers during dry weather" does not alter the basic effluent limitations of "secondary treatment." *See* 54 Fed. Reg. 4228 (Jan. 27, 1989); 40 C.F.R. § 133.103(e).

EPA has been aware of demands to include nutrients in the secondary treatment rules for decades. In 1983, the agency stated that "'nutrients (*i.e.*, phosphorus and $NH_3$) were not specified for inclusion, because secondary treatment, under normal conditions, does not effectively or consistently remove them.'"[24] In 1984, during a rulemaking to allow measurement of oxygen demand as carbonaceous BOD (CBOD) rather than aggregate BOD, the agency received comments suggesting that it place limits on nitrogenous biochemical oxygen demand (NOD) as well as CBOD. EPA declined to add NOD, arguing that NOD should not be regulated because it may vary based on temperature, flow, and other factors particular to individual water bodies:

> [W]e do not concur with the notion that a $CBOD_5$ standard ignores the major NOD exerted by ammonia . . . . NOD in the receiving waters depends on the characteristics of those waters as well as the ammonia concentration of the effluent. *** Therefore, the determination of whether NOD reduction is required should be a case-by-case decision for each receiving water segment, and should not be applied across-the-board.[25]

The agency did not provide any data supporting this finding in the Federal Register notice. EPA also did not explain exactly how it believed CBOD, which also has varying effects in different receiving waters, differed from NOD in that respect.

## B. The Petition to Require Nitrogenous Biochemical Oxygen Demand Limits

In 1993, several environmental groups and individual petitioners ("Maier") petitioned EPA to revise the secondary treatment regulations to include a nitrogenous biochemical oxygen demand (NOD) parameter. EPA denied the petition. The agency decided that "the determination that NOD reduction is required should be determined on a case-by-case basis for

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[24] 48 Fed. Reg. 52,272, 52,273 (Nov. 16, 1983) (citation omitted) (citing support document for 1973 regulations titled "Effluent Limitations by the Application of Secondary Treatment," Contract No. 69-01-9346, November 1972, pp. 3, 10, 11); *see also* 49 Fed. Reg. 36,986, 36,988 (Sept. 20, 1984) ("Secondary treatment requirements are based on controlling the oxygen demand due to the carbonaceous component of the organic material in the effluent because secondary treatment facilities can effectively remove carbonaceous organic material but may not consistently remove ammonia.").

[25] 49 Fed. Reg. 36,986, 36,999 (Sept. 20, 1984).

each receiving water segment and should not be applied across-the-board."[26] While allowing that "[a]mendments to the regulations might be warranted if NOD from POTWs posed a significant threat to waters of the United States," the agency noted that POTWs had to comply with state water quality standards and said that "[t]he Petition does not offer any indication of the inadequacy of water quality-based permitting to address NOD concerns."[27] Maier appealed this denial to the Tenth Circuit, which ruled in favor of EPA.[28]

The majority held that EPA had the discretion under the law to determine that NOD would be better dealt with through case-by-case treatment during the permit process than a generally-applicable regulation.[29] The majority read section 301 to permit effluent limitations that are "based upon," but not necessarily identical to, the pollution reductions achievable by "secondary treatment" as defined by EPA. Because the majority found that section 301 was ambiguous, it allowed EPA to handle NOD (which varies significantly "with the conditions of the receiving body of water") on a case-by-case basis.[30] EPA had not ignored the NBOD problem altogether, according to the court, but rather dealt with it through alternative mechanism of individual permit limitations, leading the majority to find that the agency had not been arbitrary or "manifestly contrary to the statute."[31] A strong dissent noted that EPA had historically viewed its obligation to develop information on "secondary treatment" and its obligation to issue effluent limitations as coextensive.[32] The dissent also found that EPA's approach was inconsistent with one of the central motivations animating the adoption of the

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[26] Letter to Matthew Kenna, attorney for Peter Maier et al., from Robert Perciasepe, Assistant Administrator for Water, U.S. EPA, attachment titled "Decision on Petition for Rulemaking re: Secondary Treatment," at 8 (Feb. 6, 1995) (hereinafter "Response to Maier et al. petition") [Exhibit 6].

[27] *Id.*

[28] *Maier v. U.S. EPA*, 114 F.3d 1032 (10th Cir. 1997), *cert. denied*, 118 S. Ct. 599.

[29] *Id.* at 1042-43.

[30] *Id.* at 1042-43 & 1045.

[31] *Id.*

[32] *Id.* at 1047 (Lucero, J., dissenting).

CWA: to institute a program of technology-based, generally-applicable effluent limitations rather than relying only on ambient water quality standards.[33]

## C. Chesapeake Bay Foundation Petition to Require Nitrogen Limits

In 2003 the Chesapeake Bay Foundation (CBF) petitioned EPA to update its secondary treatment requirements in the Chesapeake Bay watershed. The agency denied CBF's request, insisting that it was implementing a plan to reduce nutrient levels in the Bay by adjusting water quality criteria and deriving load allocations and effluent limitations from those criteria.[34] EPA said: "EPA and its partner States are rapidly developing updated tools necessary to establish and defend adequate and enforceable limits for nutrients in the Bay. Thus EPA has determined in general that there is no need for new or revised regulations."[35] EPA admitted that the CWA regulatory scheme calls for both technology-based standards applicable to all POTWs and water quality standards that serve as a supplement to technology-based requirements.[36] However, citing *Maier*, the agency asserted its authority to choose a water quality-based, case-by-case approach rather than generally applicable effluent limitations because of the highly variable impact of nutrients on various water bodies, the alleged efficacy of establishing case-by-case limits in individual permits, and the high cost of imposing the particular numeric limitation proposed by CBF.[37]

## III. Nutrient Removal can be Accomplished with Technology that Clearly Qualifies as Secondary Treatment

Historically, EPA has omitted nutrient removal from its published information concerning secondary treatment. In explaining its actions, EPA has suggested that secondary

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[33] *Id.* at 1048-49.
[34] U.S. EPA, Decision on Petition for Rulemaking To Address Nutrient Pollution From Significant Point Sources in the Chesapeake Bay Watershed, at 21-30 (June 13, 2005) [Exhibit 7].
[35] *Id.* at 4.
[36] *Id.* at 24.
[37] *Id.* at 26-30.

treatment only extends to physical and biological treatment methods, and that such methods do not significantly reduce nutrient pollution. EPA has stated that "secondary treatment, under normal conditions, does not effectively or consistently remove" nutrients.[38] EPA's conclusions, however, appear to be based on incomplete or seriously dated science. Scientific advances since the agency reached this conclusion show that secondary treatment technologies can be used to consistently remove nutrients. In particular, updated biological processes can be used to reduce greatly the amount of nitrogen and phosphorus discharged from POTWs. The discussion that follows illustrates how much has changed since the 1970s.[39]

## A. The Limits of Technology for Nutrient Removal

Wastewater treatment plants today are capable of a high degree of nutrient removal. According to EPA itself, "[u]pgrading municipal wastewater treatment plants to achieve total nitrogen concentrations of 3 mg/l and total Phosphorus concentrations of 0.3 mg/l is currently achievable in most cases."[40] The agency has also recognized that "[t]he current limit of technology is considered 3 mg/l total nitrogen . . . and 0.1 mg/l total phosphorus. . . ."[41] This estimate is in line with other recent assessments of the limits of technology. According to a 2006 article by James Barnard – of the Kansas City engineering, consulting, and construction firm Black & Veatch – the present limits of technology are between 2 and 3 mg/l for nitrogen and 0.1 mg/l for phosphorus. Barnard states that "[p]resently only suspended growth and attached growth biological processes or a combination of the two are used to reduce nitrogen

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[38] *See id.* at 25 (citing 48 Fed. Reg. at 52,273); 48 Fed. Reg. 52,272, 52,273 (Nov. 16, 1983) (citing "Effluent Limitations by the Application of Secondary Treatment," Contract No. 69-01-9346, November 1972, pp. 3, 10, 11).

[39] As discussed below, EPA's interpretation also is arbitrary. "Secondary treatment" is not statutorily limited to biological and physical removal of total suspended solids and carbonaceous organic material, especially where nutrients can be reduced using cost-effective methods in addition to physical and biological processes.

[40] Memorandum from Darrell Brown, Chief, Coastal Management Branch, Office of Wetlands, Oceans & Watersheds, to Holly Stallworth, Designated Federal Officer, Hypoxia Advisory Panel, Comments on the May, 2007 EPA Science Advisory Board's Hypoxia Advisory Panel Draft Report, at 4 (June 29, 2007) [Exhibit 8].

[41] *Id.*

concentration to around 3 mg/L" and that "biological treatment can remove phosphorus to between 0.1 and 0.15 mg/L" after filtration.[42]

These removal rates are within the same range of controls that are now being, or are soon to be, implemented at several POTWs. For instance, Maryland has adopted a program that, among other things, promotes "enhanced nutrient removal" by creating a Bay Restoration Fund supported by a fee on wastewater treatment plant users.[43] The program defines "enhanced nutrient removal" generally to mean technology "capable of reducing the nitrogen and phosphorus concentrations in wastewater effluent to concentrations of not more than 3 milligrams per liter total nitrogen and not more than 0.3 milligrams per liter total phosphorus, as calculated on an annually averaged basis. . . ."[44] The June 2007 issue of *Water Environment and Technology* similarly states, "in Europe, several consent decrees limit effluent to 2 mg/L total nitrogen and 0.15 total phosphorus levels."[45]

## B. Biological Nutrient Removal

As discussed above, excess quantities of nitrogen and phosphorus have caused well-documented damage to freshwater and marine aquatic wildlife communities as well as damage to the aesthetic quality of many waters. In response to concerns regarding these harmful effects of eutrophication, researchers have focused resources on identifying means of reducing anthropogenic sources of nitrogen and phosphorus entering waters. These studies have included development and testing of technologies for removing phosphorus and nitrogen from domestic

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[42] James L. Barnard, *Biological Nutrient Removal: Where We Have Been, Where We Are Going?*, WEFTEC®.06, at 1 (2006) [Exhibit 9]; *see also id.* at 8 ("Suspended growth biological systems can remove phosphorus to as low as 0.1 mg/L after filtration."); *id.* at 17 (describing "the present limits of technology" for nitrogen as "between 2 and 3 mg/L").

[43] *See* Annotated Code of Md., Environment, § 9-1605.2(a) (describing Fund and its intended purposes).

[44] *Id.* § 9-1601(*l*).

[45] Miguel Gutierrez, *Water Tables Turn: U.S. Follows Europe's Lead In Nutrient Removal*, Water Environment & Technology, at 89 (June 2007) [Exhibit 10].

sewage. As a result of this research, tremendous advancements have been made in the past two decades in the development and understanding of biological processes that enhance nutrient removal.[46]

The biological nutrient removal (BNR) processes that have been developed involve biological processes such as those that have been employed across the United States to remove oxygen demanding organic matter. Biological processes that have been updated to remove nutrients simply use types of microorganisms that are cultivated to perform the task of cleaning the wastewater. Therefore, in most cases, minor retrofits to existing wastewater treatment facilities enable facilities to cost-effectively reduce nutrient levels in their discharges.

That the benefits of nutrient removal outweigh the costs is becoming increasingly evident in the widespread application of simple nutrient removal technologies. Since the early 1970's all significant dischargers in the Great Lakes watershed have been required to remove total phosphorus to a level of 1 mg/L. In recent years, combined phosphorus and nitrogen removal has been incorporated into many facilities in the Chesapeake Bay watershed and many places in Florida. In 2005, the state of Virginia adopted regulations establishing wasteload allocations for approximately 125 facilities. In several instances, demonstrations of incorporating nutrient removal revealed that retrofits could be "relatively inexpensive to implement," despite initial projections of high costs. (Randall et al., 1999)

This section of the petition summarizes the mechanisms through which nitrogen and phosphorus are biologically removed from wastewater, the most common wastewater treatment plant designs that employ those processes, and their relative effectiveness. This section will also identify where such systems have been used. Information is also provided regarding the costs

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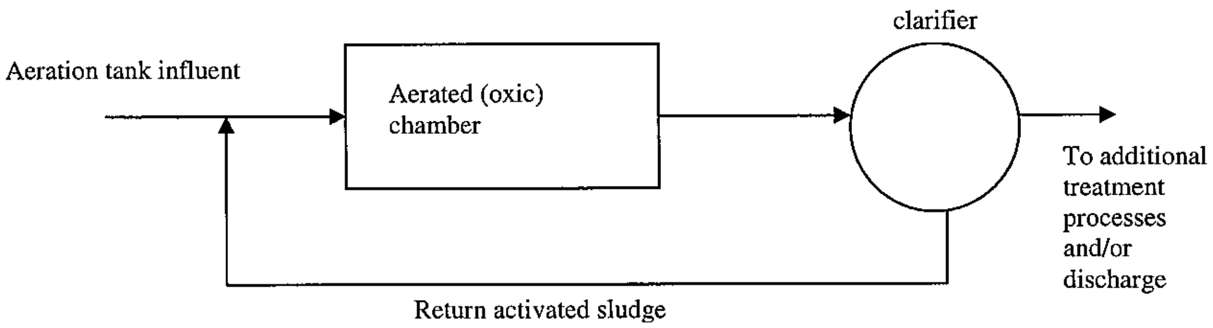
[46] Except where included in footnotes in this section, the materials cited in this section are listed in a bibliography attached as an appendix to this petition.

incurred in constructing and operating such systems, and potential effluent limits that would be consistent with the technology and economics of nutrient removal. This section is not intended to offer exhaustive coverage of every possible process, but rather to demonstrate that there are several well established process options for removing moderate quantities of nutrients. The processes discussed here (as well as other processes) should be considered by EPA in determining the "degree of effluent reduction attainable" through the application of secondary treatment.

## 1. Basic Wastewater Treatment

Existing regulations in the United States require substantial reduction of BOD and total suspended solids (TSS). Additionally, where large discharges are placed into relatively small receiving streams, regulations often require removal of ammonia because it is quite toxic to aquatic organisms. To comply with these regulations, wastewater treatment plants in the U.S. typically have at least some type of screens and often primary settling tanks to remove larger solids followed by a system that encourages the growth of microorganisms that consume the smaller particulate and dissolved organic matter. A common example of such a biological system is an activated sludge system, in which wastewater enters an aerated chamber with a concentration of recycled microorganisms. After aeration, the wastewater is then passed into a second settling tank, or clarifier. A portion of the solids from this second settling tank, the "activated sludge," is returned to the aerated chamber to maintain the desired concentration of microorganisms. A diagram of this process is shown in Figure 1.

Figure 1 – Activated Sludge System



While the activated sludge system and similar suspended growth systems are very common systems used to satisfy existing effluent requirements, there are numerous other systems -- including those that encourage the growth of microorganisms on surfaces, such as filter media or disks, within a reactor. In such attached growth systems, the microorganisms are grown on the media, and there is no need to return a portion of the solids from the secondary clarifier.

*Characteristics of wastewater*

The activated sludge process can be quite effective at removing BOD, TSS, and ammonia from wastewater. This process is not particularly good, however, at removing nutrients. (Ammonia is a nutrient form of nitrogen, but much of it is converted to nitrate, which is also available as a nutrient and is not removed in significant quantities in a typical activated sludge process.) The only nutrients totally removed through this basic treatment process are those that are part of the large solids removed during primary settling and those that are assimilated into the microorganism cells and disposed as part of the waste activated sludge. As discussed below, however, minor modifications to the traditional suspended growth or attached growth processes can result in significant reductions in these nutrients.

## 2. Creating Conditions that Favor Biological Nutrient Removal

As mentioned above, the primary difference between a biological system that achieves primarily BOD and TSS removal and a modern biological system that also reduces nutrient loads is the type of microorganisms that are cultivated to perform the task of cleaning the wastewater. Nutrient reduction is attainable by modifying the biological process to create environments that give some microorganisms competitive advantages over others or provide environments that alter the metabolism of organisms already present. In many cases, it is possible to create these environmental changes within the existing wastewater treatment plants with relatively simple modifications, such as those discussed below.

### *Promoting biological phosphorus removal*

Biological phosphorus removal is achieved by creating conditions that favor a group of organisms referred to as phosphate accumulating organisms (PAOs). These organisms are capable of taking up more phosphorus than is required for cell growth. This phosphorus is stored within the organisms. Therefore, overall phosphorus reduction is achieved by creating conditions that give PAOs a competitive advantage over other organisms such that a relatively larger population of these organisms is active in the system. PAOs release phosphorus under anaerobic conditions and then accumulate significant excess phosphorus when exposed to aerobic conditions. Such conditions can be produced by incorporating an anaerobic zone, in which neither oxygen nor nitrate/nitrite is present, prior to the aerated zone in the biological reactor. Numerous arrangements are possible, but all have this same feature. Some retrofits for biological phosphorus are as simple as placing a baffle in the activated sludge tank, turning off the aerators in that portion of the tank, and providing mixing by methods other than the normal aeration used in aerobic (or oxic) portions of the tank.

### *Promoting biological nitrogen removal*

Biological nitrogen removal is typically achieved by creating conditions that allow for growth of nitrifying organisms and creating conditions that promote the use of nitrate by organisms generally present in conventional secondary treatment systems. The first group of organisms, known as nitrifiers, use ammonia as an energy source and -- in an aerated environment -- convert ammonia to nitrate, in a process referred to as nitrification. Because nitrifiers are slower-growing than the organisms that use carbon as an energy source in secondary treatment systems, all the organisms must be maintained in aerobic zones for longer times than those required for conventional activated sludge. The second group of organisms use nitrate in place of oxygen to consume organic energy sources. The nitrate is converted to nitrogen gas in a process referred to as denitrification.[47]

Because ammonia is very toxic to aquatic life, nitrification is already employed at many wastewater treatment plants across the country. It is generally achieved in conjunction with BOD removal, though some additional factors must be considered. For instance, nitrifiers generally grow slowly at low temperatures. Therefore, a longer solids retention time is required to establish an effective population, particularly during cooler months. Nitrifiers are also more sensitive to pH and toxics, so pH must be regulated and upsets may occur at the plant if a toxic pollutant is introduced into the system. In addition, sufficient alkalinity must be present or added to allow for nitrification.

Denitrification is attained by establishing an anoxic zone, where nitrate and an organic carbon energy source are present but oxygen is not present. It must follow nitrification in the treatment process, but as shown below this is often achieved by placing the anoxic zone in front of the aerobic zone and incorporating a wastewater recycle line. If the denitrification zone is

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[47] More recent research has identified other organisms that are capable of removing nitrogen through other pathways. These organisms will likely prove to be very useful following additional research and testing, but because they are a relatively new discovery, they will not be addressed fully in this paper.

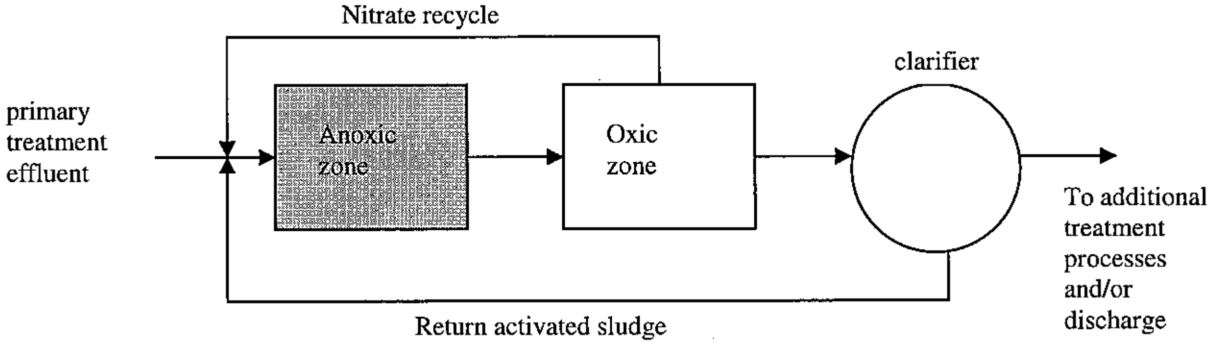
placed after the aerobic zone, there is typically insufficient organic matter remaining in the wastewater, and a carbon source, such as methanol, must be added. For facilities employing nitrification, adding denitrification is a logical cost-effective step. The biological denitrification process provides alkalinity required for nitrification, thus reducing potential supplemental alkalinity costs. Energy requirements for air are reduced as denitrification consumes carbon in the influent which would normally be consumed aerobically. In addition, an anoxic zone ahead of the aerobic zone can be, and often is, designed as a biological selector, which provides the additional benefit of improving the settling characteristics of the biomass in the secondary clarifiers. As with phosphorus removal, there are many configurations by which this anoxic zone is incorporated into the process.

## 3. Design and Performance of Biological Nitrogen Removal Systems

### *Modified Ludzak Ettinger*

Perhaps the simplest effective system for achieving both nitrification and denitrification is the Modified Ludzak Ettinger (MLE) system. This system can be retrofitted to existing activated sludge facilities with adequate volume (EPA, 1993). As shown in Figure 2, this process requires creating an anoxic zone in an existing tank or adding an anoxic tank before the aerated tank. Mixed liquor (water plus biomass) from the aerated tank, along with return activated sludge, is recycled back to the anoxic tank. Nitrification occurs in the aerated chamber, while denitrification of the nitrate in the recycled mixed liquor and return activated sludge is achieved in the anoxic chamber. By placing the anoxic zone before the oxic zone, the denitrifiers use organic matter naturally present in the wastewater. This has the added benefit of removing a portion of the BOD in the wastewater without aeration, so energy savings are possible. The effectiveness of the system at removing nitrogen is dependent on the quantity of water that is recycled back to the anoxic zone, which is typically 100-200% of the flow capacity of the plant. Effluent TN of 5 – 8 mg/L is achievable (Metcalf and Eddy, 2003). USEPA (1993) stated that an annual average of 8 mg/L is consistently attainable with sufficient recycle flow rates.

Figure 2. Modified Ludzak Ettinger system

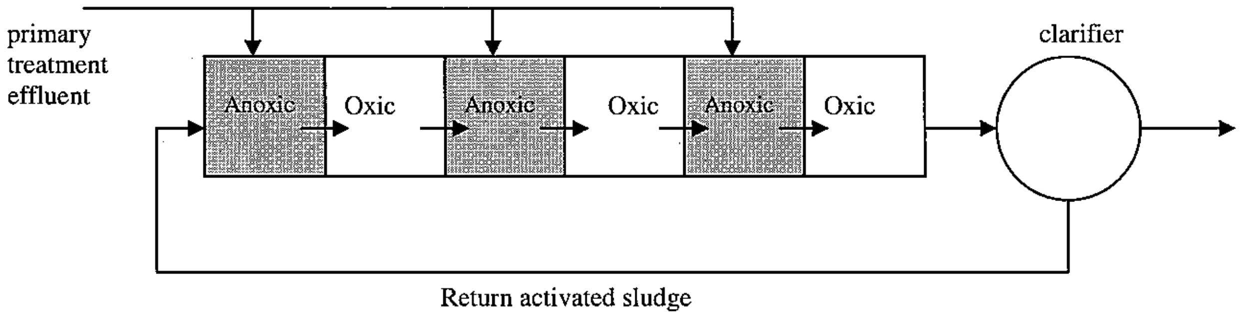


The MLE system has been one of the most utilized processes for achieving nitrogen removal in Maryland. When the state began implementing nitrogen removal requirements in 1983, the MLE system was the most common system used. MLE was in place at the Cambridge, Seneca, Freedom District, Conococheague, Cox Creek, Back River and Aberdeen POTWs. (MDE). In Florida, beginning in 1988, the South Water Reclamation Facility operated by Orange County Utilities used an MLE system at its North Plant. (Hurley, et al., 2003) The Landis Sewerage Authority WWTP in Vineland, New Jersey has used the MLE system and has easily met its discharge limit of 10 mg/L nitrate; in a 1990 test, effluent averaged 4.4 mg/L nitrate (Sedlak, 1991).

*Step-feed Process*

The step-feed process employs several alternating anoxic/aerobic chambers with a portion of the influent fed to each anoxic zone (Figure 3). Like the MLE system, feeding the wastewater to the anoxic zone allows the denitrifiers to use organic matter in the wastewater rather than requiring methanol addition. Effluent concentrations of 5-8 mg/L TN are achievable using this method (Metcalf and Eddy, 2003)

Figure 3. Step-feed Nitrification/Denitrification



The step-feed process is also well established. It was used in Maryland at the Piscataway and Cumberland POTWs (MDE), and in Edmonton, Alberta (Barnard, 1998). At the South Water Reclamation Facility's South West Plant in Orange County, Florida, the step-feed system achieved an average effluent TN concentration of 6.7 mg/L within the first 10 months of operation (Hurley et al., 2003). The New York City's Department of Environmental Protection (NYCDEP) has predicted performance obtainable for four of its 14 wastewater treatment plants based upon years of pilot scale and demonstration scale work.[48] Modifications to existing plants termed "High Level Step Feed BNR" by the City is predicted to discharge 5 – 9 mg-N/L on an

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[48] Jamaica Bay Watershed Protection Plan, Volume 2, City of New York Department of Environmental Protection, at 22 (Oct. 1, 2007), available at http://home2.nyc.gov/html/dep/pdf/jamaica_bay/vol-2-chapter-3.pdf [Exhibit 11].

annual average without expansion of the secondary treatment systems that were designed decades ago and that currently operate at low solids retention times.

*Sequencing Batch Reactor*

Sequencing Batch Reactor (SBR) is a system in which one tank is cycled through each desired environmental condition to promote control of different constituents. It can be operated simply for BOD and TSS removal, or by adding an anoxic stage in the cycle, nitrification and denitrification can be achieved. For nitrogen removal, the tank starts with a portion of the tank full with solids and water from the previous batch. The tank is then filled without aeration, allowing it to become anoxic. During this phase, the nitrate remaining in the water from the previous batch is converted to nitrogen gas by denitrifiers. The full tank is then aerated to achieve nitrification and degrade the remaining BOD. The tank is allowed to settle and the treated water is decanted off the top, leaving the solids and a portion of the water in the tank (Figure 4). Effluent concentrations of 5-8 mg/L are achievable (Metcalf and Eddy, 2003). USEPA (1993) indicated that an annual average of 8 mg/L is achievable with close attention to operating conditions.[49]

Figure 4. Sequencing Batch Reactor

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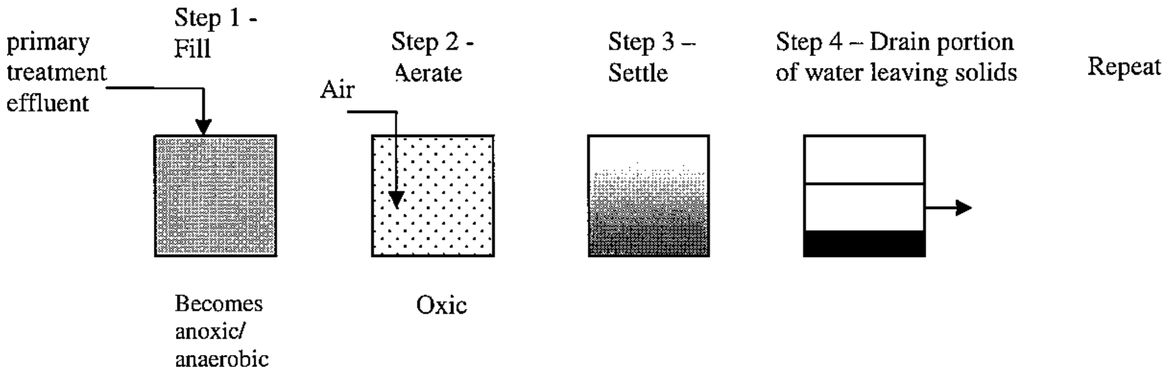
[49] *See also* U.S. EPA, Office of Water, *Wastewater Technology Fact Sheet: Sequencing Batch Reactors*, at 6 (Sept. 1999) [Exhibit 12] ("SBR manufacturers will typically provide a process guarantee to produce an effluent of less than . . . 5-8 mg/L TN . . . [and] 1-2 mg/L TP").

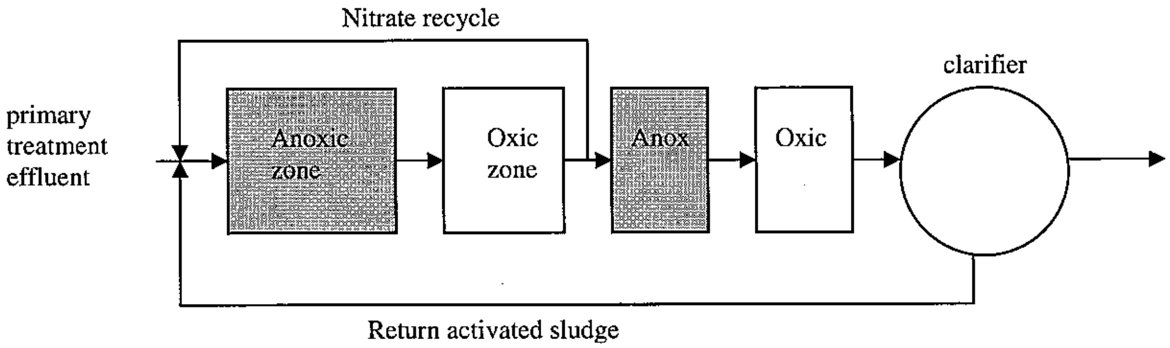


The SBR process has been operated successfully for nitrogen removal in several places, including the Del City, Oklahoma POTW, where effluent total nitrogen of 5.4 mg/L was routinely obtained. Notably, this facility did not have total nitrogen or nitrate effluent limits. The city decided to incorporate a nitrogen removal step "for energy conservation purposes and to improve sludge settleability." (Sedlak, 1991)

*4-Stage Bardenpho*

The 4-stage Bardenpho is similar to the MLE process but it has an additional anoxic and oxic zone following the first zones (Figure 5). Due to the extra anoxic zone, this process is capable of removing more nitrate for lower total nitrogen effluent, in some cases lower than 3 mg/L (Metcalf and Eddy, 2003). USEPA (1993) indicated that an annual average of 3 – 6 mg/L is achievable with sufficient recycle flow rates.

Figure 5. 4-Stage Bardenpho Process



Because fewer facilities have been required to achieve very low TN effluent levels, this system is not quite as common as some others. It has been effectively demonstrated in a few places including Parkway, Annapolis, and Hurlock, Maryland (MDE).

*Oxidation Ditch Systems*

An oxidation ditch is a type of activated sludge process in which the biological activity takes place in one or a series of concentric oval channels over a relatively long hydraulic retention time. There are several configurations possible for achieving nitrification and denitrification within an oxidation ditch, including Bio-denitro™, Nitrox™, Carrousel™, and VT2. Together, these systems have been installed at numerous facilities and have demonstrated capability of achieving effluent TN concentrations of less than 8 mg/L (Metcalf and Eddy, 2003; Hurley et al., 2003; Randall and Cokgor, 2000).[50] Some other oxidation ditch systems, including Orbal™, and Sym-Bio™, achieve "simultaneous" nitrification and denitrification in one area of the tank. This is accomplished by maintaining low dissolved oxygen in the chamber such that some micro-environments within the chamber, such as within floc particles, are anoxic while others are oxic. These simultaneous systems require a much larger tank because nitrification is very slow in these conditions. However, TN as low as 3 mg/L is possible in the effluent (Metcalf

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[50] Metcalf and Eddy (2003) indicate that TN of 5-10 mg/L is achievable. Hurley et al. (2003) note that an Orange County, Florida facility had 4.0 mg/L TN. Randall and Cokgor (2000) identified a facility in the Chesapeake Bay region using an oxidation ditch that averaged 4.9 mg/L annually.

and Eddy, 2003). USEPA (1993) indicated that an annual average of 6 – 8 mg/L was achievable in oxidation ditch systems at the time of that publication. Rockaway Valley Regional Sewerage Authority is discharging less than 1 mg- ammonia N/L and 3.6 mg- nitrate+nitrite-N/L. In addition TP effluent averages approximately 1.5 mg/L despite operating its oxidation ditches at 30 percent over capacity.[51]

*Attached Growth Systems*

For attached growth systems, the microorganisms responsible for carrying out these processes are attached to a surface, such as filter media or disks, rather than suspended in a mixture. Some attached growth systems that are designed to support denitrifying organisms are referred to as denitrifying filters. An attached growth denitrifier can be added to a suspended or attached growth system that achieves BOD removal and nitrification. As with suspended growth systems, the denitrifying system can be placed before the nitrification/BOD removal system, with nitrate recycled back to the denitrification system (preanoxic), or it can be placed after the nitrifying/BOD removal system, with addition of an organic carbon source (postanoxic).

A preanoxic attached growth denitrification system was shown to produce effluent TN concentration of less than 8 mg/L in Salisbury, Maryland, "at temperatures as low as 13° C" (Metcalf and Eddy, 2003). Postanoxic systems have been used where very low TN concentrations are desired. The Tetra® postanoxic attached growth denitrifying process by TETRA Tech has been shown to achieve effluent TN of 1 – 3 mg/L "with proper control of the methanol dose" (Metcalf and Eddy, 2003). Other systems including Biocarbone®, Biostyr®, and Biofor®, have shown capabilities of meeting TN effluent concentration of less than 8 mg/L (Metcalf and Eddy, 2003). The Reno-Sparks wastewater treatment plant employed nitrifying

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[51] Tamburini, et. al.,Improving Energy Efficiency and Effluent Quality, and Reducing Operating Costs By Controlling Nitrification and Denitrification Through Operational Modifications (2007) [Exhibit 13].

trickling filters and a postanoxic denitrifying attached growth system to achieve annual average TN 2.45 mg/L between 1989 and 1990 (Sedlak, 1991).[52]

*Summary – Nitrogen Removal is Consistently Achievable Using Established Biological Processes*

As the foregoing discussion reveals, well-developed biological approaches can reliably remove nitrogen from wastewater influent. Table 2 below summarizes the range of effluent TN concentrations that these technologies can achieve.

Table 2. Summary of Performance Capabilities of Selected Nitrogen Removal Processes

| Process | Range of Reported Effluent Total Nitrogen Concentration, mg/L |
|---|---|
| Modified Ludzak Ettinger | 5 – 8 [B] |
| Step Feed | 5 – 8 [B] |
| Sequencing Batch Reactor | < 8 [A] |
| 4-Stage Bardenpho | 3 – 6 [A] |
| Oxidation Ditch | 6 – 8 [A] |
| Attached Growth | < 8 [B] |

References:

[A] EPA, 1993
[B] Metcalf and Eddy, 2003

However, nitrogen is not the only aspect of nutrient pollution that pollution control professionals have discovered how to remove using biological methods. As discussed below, there are biological systems that remove phosphorus well, and ones that address both nitrogen and phosphorus.

## 4. Design and Performance of Phosphorus Removal Systems

Biological treatment to remove phosphorus is also well-established. According to a report by EPA Region 10 in April, wastewater treatment plants "which utilize enhanced

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[52] This facility also achieved 0.21 mg/L TP effluent over this period using the Phostrip™ System.

biological nutrient removal (EBNR) in the secondary treatment process can often reduce total phosphorus concentrations to 0.3 mg/l or less prior to tertiary filtration."[53] The report goes on to say:

> An EBNR treatment system promotes the production of phosphorus accumulating organisms which utilize more phosphorus in their metabolic processes than a conventional secondary biological treatment process. The average total phosphorus concentrations in raw domestic wastewater is usually between 6 to 8 mg/l and the total phosphorus concentration in municipal wastewater after conventional secondary treatment is routinely reduced to 3 or 4 mg/l. Whereas, EBNR incorporated into the secondary treatment system can often reduce total phosphorus concentrations to 0.3 mg/l and less. Facilities using EBNR significantly reduced the amount of phosphorus to be removed through the subsequent chemical addition and tertiary filtration process. This improves the efficiency of the tertiary process and can significantly reduce the costs of chemicals used to remove phosphorus.[54]

The agency also acknowledges that such treatment is cost-effective. According to Region 10, "[a]pplying advanced water treatment to remove phosphorus is affordable for most municipalities as demonstrated by the monthly residential sewer fees charged by the WWTPs included in this evaluation. These fees are listed in the Summary of Observations Table and are typically less than $30."[55]

## 5. Design and Performance of Combined Biological Nitrogen and Phosphorus Removal Systems

Biological phosphorus removal performance is site-specific. Generally, where wastewater has a higher rapidly biodegradable organic carbon concentration, effluent soluble P concentrations below 0.5 mg/L are possible. However, with lower strength wastewater, effluent

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[53] U.S. EPA Region 10, Office of Water and Watersheds, Advanced Wastewater Treatment to Achieve Low Concentration of Phosphorus, at 3 (Apr. 2007) [Exhibit 14].

[54] *Id.* at 9

[55] *Id.* at 10. Note that the monthly fees are not all associated with phosphorus control. *See id.* ("EPA intended to identify in more detail the costs incurred by these WWTPs to install and operate tertiary treatment for phosphorus removal. However, it was soon determined that separating the costs of the tertiary treatment from overall facility operating costs was beyond the resources and time available to complete this project. EPA instead presents the monthly residential sewer fees charged by each of these WWTPs as an indicator of the costs to construct, maintain and operate these facilities, including the tertiary treatment for phosphorus removal.").

concentrations after biological treatment may exceed 1.0 mg/L (Metcalf and Eddy, 2003). For these lower strength wastewaters, biological phosphorus removal performance may be improved by adding volatile fatty acids obtained from primary sludge fermentation or by reducing nitrate entering the anaerobic zone as discussed below. Kang, et al. (2001) showed that wastewater treatment plants with phosphorus limits of 1 mg/L could achieve their limits using only a biological process. Additionally, chemical precipitation equipment is installed as a backup at many facilities.

Removing both phosphorus and nitrogen biologically within the same system has some advantages as well as some challenges. Generally, biological phosphorus removal processes with short solids retention time (SRT) are more efficient than those with longer SRT. Nitrification, however, is more complete when longer SRT is achieved, particularly in cold climates. While these processes have competing optimum conditions, in practice, nitrification and phosphorus removal have been achieved throughout the Great Lakes watershed.

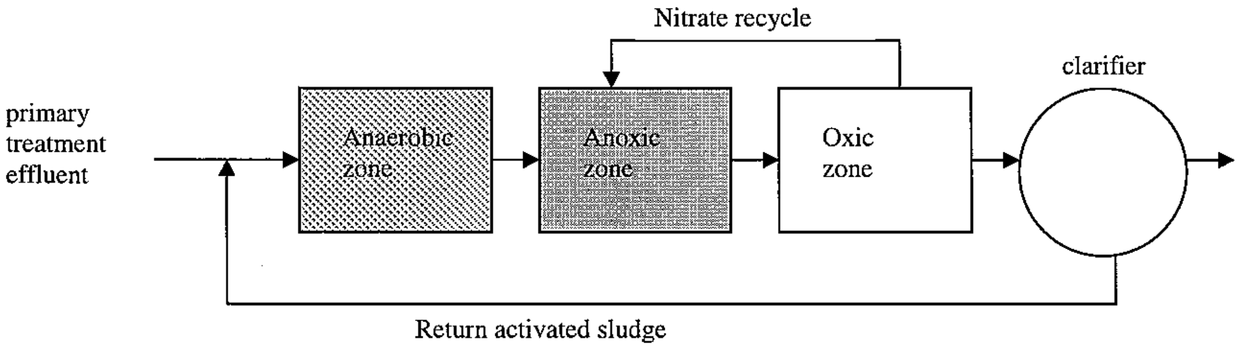
Where nitrification and phosphorus removal is required, there is an advantage to adding capacity to remove nitrogen through denitrification. The anaerobic selector tank for biological phosphorus removal is much more efficient if nitrate is not present in that tank. If there is no denitrification in the treatment process, nitrate is significant in the return activated sludge. Adding denitrification removes some of this nitrate and improves the effectiveness of the phosphorus removal process.

Overall, the advantages of achieving biological nitrogen removal and biological phosphorus removal together, rather than independently, outweigh the challenges. According to Randall et al. (1999), "the processes are more efficient, stable, and economical when implemented together, for most municipal wastewaters."

### *$A^2$/O Process*

The $A^2$/O process is the simplest process for biologically enhancing both nitrogen and phosphorus removal. It is similar to the MLE process with the addition of an anaerobic zone before the anoxic zone (Figure 6). It is also similar to one of the most common systems for removing phosphorus, the AO process, which is simply an anaerobic zone followed by an aerobic one. As mentioned above, presence of nitrate reduces the effectiveness of PAOs. Accordingly, the presence of nitrate in the return activated sludge imposes some limits on the performance of the AO process. However, because there is an anoxic zone for denitrification in the $A^2$/O process, there is less nitrate, and therefore, less nitrate interference in the PAO selector zone. Indeed, if nitrification is already required, as it is in many locations throughout the country, the $A^2$/O process is expected to perform much better than the AO process. USEPA (1993) indicated that an annual TN average of 6 - 8 mg/L is achievable.

Figure 6. The $A^2$/O Process



The $A^2$/O process is one of the most common systems employed where moderate levels of nitrogen and phosphorus removal are required or desired. It has been used in several places in

Maryland; the Ballenger, Westminster, Frederick,[56] and Sod Run POTWs use this process (MDE). In Largo, Florida, an $A^2/O$ process had a monthly average TN effluent of 7.7 mg/L (Sedlak, 1991). Fayetteville, Arkansas, had a plant that was operated in an AO process, but they found that, because they were required to nitrify, it was desirable to also remove a portion of the nitrate. Therefore, they modified it to allow operation as an $A^2/O$ system at times, achieving TN effluent concentrations as low as 3.7 mg/L. The same facility was subject to a monthly TP limit of 1 mg/L (Sedlak, 1991).

The $A^2/O$ process has also been combined with denitrification filters and methanol addition in Dunedin and Largo, Florida,[57] to achieve very low TN effluent concentrations ranging from 0.6 mg/L to 2.3 mg/L. TP concentrations have been below 0.3 mg/L with supplemental alum addition (Mines 1996). Likewise, in Atlanta, Georgia, $A^2/O$ systems have been supplemented with filtration and alum addition to achieve very low effluent levels of TP and TN (Mines et al., 2004). Thus, moderate levels of nutrient removal can be consistently and economically attained with a basic design, but the $A^2/O$ process is also capable of being adapted to achieve superior nutrient removal rates. According to EPA's recent report on biological nutrient removal, the $A^2/O$ process gets "good" removal of both nitrogen and phosphorus.[58]

*5-Stage Bardenpho*

The 5-stage Bardenpho process is similar to the 4-stage Bardenpho process (described above), except that it has an anaerobic selector zone before the system (Figure 7). As with the other phosphorus removal processes, this anaerobic zone provides conditions that encourage growth of phosphorus accumulating organisms. Because more nitrate is removed through this

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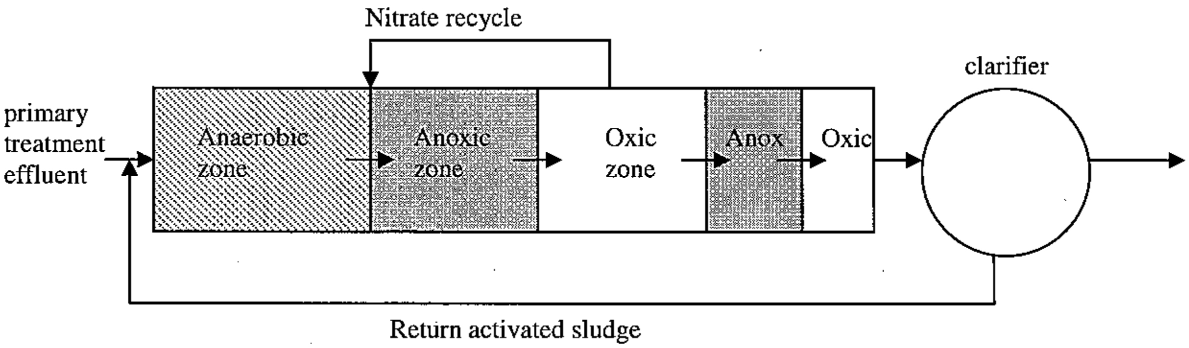
[56] According to EPA's report this year, this facility had average monthly effluent concentrations of 7.2 mg/L TN and 1.0 mg/L TP. U.S. EPA, *Biological Nutrient Removal Processes and Costs*, at 5 (June 2007) [Exhibit 15].

[57] EPA's recent report indicates that the average monthly effluent concentrations at this facility were 2.3 mg/L TN and non-detectable TP. U.S. EPA, *Biological Nutrient Removal Processes and Costs*, at 5.

[58] U.S. EPA, *Biological Nutrient Removal Processes and Costs*, at 5.

process than through the $A^2/O$ process,(due to the dual anoxic zones) even less nitrate is present in the return activated sludge, causing less interference with PAO selection in the anaerobic zone The 5-stage Bardenpho process is capable of achieving TN concentrations of 3 – 5 mg/L without filtration (Metcalf and Eddy, 2003). USEPA (1993) indicated that an annual average TN level of 3 - 6 mg/L is achievable.

Figure 7. 5-Stage Bardenpho Process



The 5-stage Bardenpho process has been employed at Palmetto, Florida, achieving a long-term average TN effluent concentration from January 1984 through November 1987 of 2.5 mg/L. The facility also achieved a monthly average discharge limit of 3 mg/L for 93.8% of the months (Morales, 1991). This process was also used at Eastern Service Area, Florida, where the long term average TN concentration between January 1986 through December 1987 was 1.8 mg/L , and the monthly average discharge limit of 5 mg/L was achieved for 100% of the months (Morales, 1991). In Clearwater, Florida, this process, followed by sand filtration, was used at three facilities, where TN effluent concentrations ranged from 1.0 – 3.1 and TP concentrations ranged from 0.4 – 4.6 mg/L without chemical additional and 0.4 mg/L or less with chemical addition (Mines, 1996). The process was also used in Pinery, Colorado, where the 5-stage Bardenpho is followed by chemical addition and multimedia filtration to meet effluent phosphorus permit limit concentrations of less than 100 μg/L as a daily maximum and 50 μg/L as a monthly average (Reynolds and Clark, 2005). Finally, EPA's recent report identifies one facility as using the 5-Stage Bardenpho process exclusively (Medford Lakes, NJ), and indicates that the plant achieved monthly average concentrations of 2.6 mg/L TN and 0.09 mg/L TP. The agency also states that the process gets "excellent" nitrogen removal and "good" phosphorus removal.[59]

*Virginia Initiative Plant*

The Virginia Initiative Plant (VIP) process is similar to the $A^2/O$ process but differs in its recycle configuration (Figure 8). Additionally, the VIP process has several separated zones in the anoxic and aerobic zones that are arranged in a series. The return activated sludge is added at the anoxic stage to avoid introducing nitrate into the anaerobic zone. An additional recycle line is run from the last anoxic zone to the anaerobic zone. This line carries microorganisms, including the PAOs, back to the anaerobic zone, but minimizes nitrate in the PAO selector by drawing this solution from the last stage in the anoxic zone. Because nitrate is minimal in the anaerobic zone, phosphorus removal capability is increased. USEPA (1993) indicated that an annual average of 6 - 8 mg/L TN is achievable with the VIP process.

Figure 8. VIP Process

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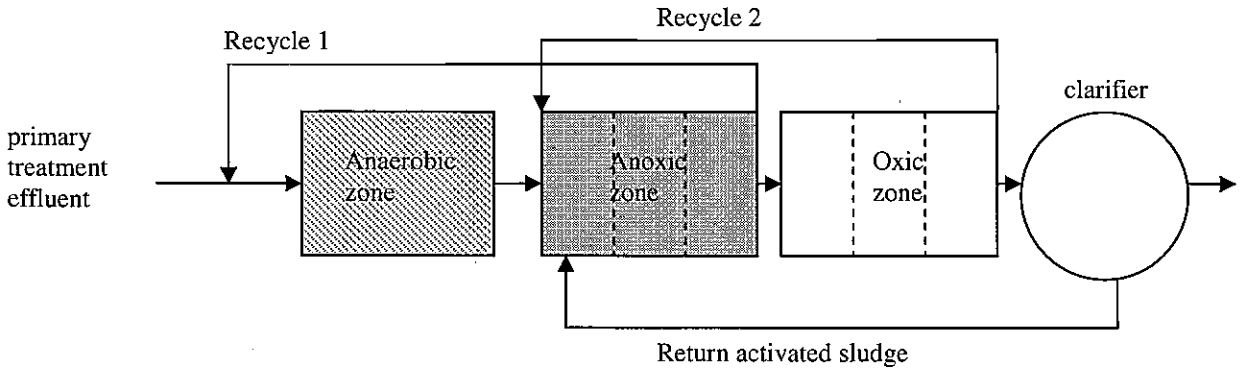
[59] U.S. EPA,, *Biological Nutrient Removal Processes and Costs*, at 5. The report also indicates that the Cape Coral, Florida, plant uses a "Modified Bardenpho" process to achieve average effluent concentrations of 1.0 mg/L TN and 0.2 mg/L TP. *Id.*

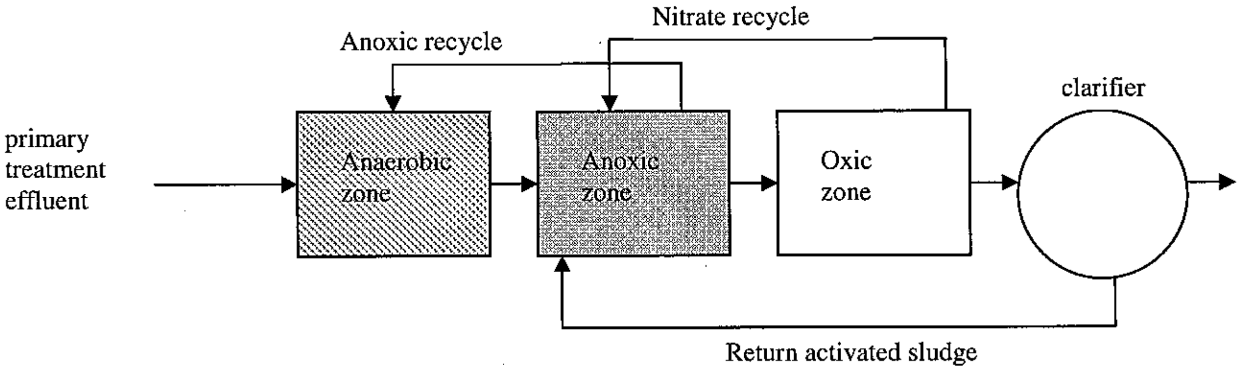


The VIP process was first demonstrated at the VIP pilot plant at Hampton Roads Sanitary District in Virginia, where it achieved a long term average TN of 7.7 mg/L between June 1986 and August 1987 (Morales, 1991). This plant has been online full-time since 1993. Randall and Cokgor (2000) reported that during a 1997 study, the average TN based on at least a year of data was 8.1 mg/L, but the plant could reliably achieve 6 mg/L if operated with a higher recycle rate.

### *University of Capetown (UCT) and Modified UCT*

The standard University of Capetown (UCT) process is quite similar to the VIP process. The only major difference is that the anoxic and aerobic zones are not divided into several separate zones. (Figure 9). Like the VIP process, nitrate is minimized in the anaerobic zone to improve phosphorus removal. The Modified UCT process merely separates the anoxic zone into two separate stages, which further reduces nitrate in the anaerobic zone. USEPA (1993) indicated that an annual average of 6 - 8 mg/L is achievable at a UCT facility, and an annual average of 3 – 6 mg/L is achievable at a MUCT facility.

Figure 9. UCT Process



The UCT process has been implemented in Henrico County Water Reclamation Facility in Virginia. The facility was relatively new in 1997 and had not yet reached optimum performance. In that year, the average TP was 1.4 mg/L and TN was 12.6 mg/L. (Randall and Cokgor, 2000) EPA's recent report on biological nutrient removal states that the modified UCT process gets "good" nitrogen removal and "excellent" phosphorus removal.[60]

*Oxidation Ditches*

The oxidation ditch processes described for nitrogen removal are also capable of removing phosphorus if an anaerobic selector tank or zone is incorporated into the design. This type of system has been employed at 3 plants in Hillsborough County, Florida. Denitrification filters have been added to the process to achieve TN effluent concentrations ranging from 0.5 mg/L to 2.9 mg/L and TP concentrations less than 0.5 mg/L in all but one month at a single plant (Mines, 1996). EPA's 2007 report identifies one facility (Bowie, MD) that used an oxidation ditch and achieved a monthly average effluent concentration of 6.6 mg/L TN and 0.20 mg/L TP.

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[60] U.S. EPA, *Biological Nutrient Removal Processes and Costs*, at 5.

The agency also says that oxidation ditches get "excellent" nitrogen removal and "good" phosphorus removal.[61]

*Improvements to Reduce Nutrients Can Have Added Benefits*

The Fourche Creek Wastewater Treatment Plant in Little Rock Arkansas identified that converting from step feed ultra-low (1 – 2 day) solids retention time (SRT) treatment system to plug flow nitrification and denitrification treatment system, many benefits can be realized.[62] The facility is not required to remove ammonia or phosphorous, however, the plant increased its SRT (by 4 – 5 days) to promote nitrification and added an anoxic selector for denitrification to stabilize some operational difficulties associated with the short SRT. Adding nitrification/denitrification to the process did not only result in overcoming operational difficulties, but:

- sludge bulking problems became controllable
- the plant was able to better withstand influent slug loadings
- final settling (clarifier) performance improved
- wasted solids reduced (reducing treatment and disposal)
- no increase in power requirements were needed

## 6. Biological Nutrient Removal is Cost-Effective

*The Chesapeake Bay Program Studies*

Recently published studies and other readily available information indicate that modifying existing wastewater treatment facilities to incorporate biological nutrient removal is affordable. Some of the most extensive recent studies of costs associated with retrofitting wastewater treatment systems to achieve nutrient removal were conducted as part of an initiative to reduce nutrient loadings to Chesapeake Bay.

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[61] U.S. EPA,, *Biological Nutrient Removal Processes and Costs*, at 5.

[62] Burnett, et. al., Conversion to Long Sludge Age Process After 17 Years at Ultra-Low SRT: Cost and Operational Benefits (WEFTEC, Oct. 2007) [Exhibit 16].

One such study (Randall et al., 1999) was conducted by the Virginia Tech BNR research group at the request of the Point Source Work Group of the Chesapeake Bay Program Nutrient Removal Subcommittee. The study was requested because full-scale pilot projects by the Virginia Tech researchers suggested that BNR retrofits can be relatively inexpensive. Fifty-one wastewater treatment facilities, including 48 municipal wastewater facilities, were evaluated, assuming a target effluent concentration of 8 mg/L TN. For several facilities – those for which it would be most economical -- a target effluent concentration of 2 mg/L TP was assumed. A few of the facilities reportedly had some capacity to reduce nutrient levels when the study was conducted. These costs, which had already been incurred, were not incorporated into the analysis.

The study found that over one-third of the facilities would reduce operation and maintenance costs with the upgrades, and several of those would realize net savings because the operation and maintenance savings exceeded the capital costs. The study also found that there was a wide range of costs. Generally, the retrofits at smaller facilities and those with attached growth systems would be less economical, while larger activated sludge and oxidation ditch systems would be cheapest. Although the study only reported total costs and cost/pound of nitrogen removed, one can easily estimate the annual cost per person by using the estimated population served,[63] a 20 year facility life and an interest rate of three percent (which reflects a blend between a five percent interest loan and a zero percent loan from the revolving fund). For 40 of the 48 municipal facilities in the study that had population data available, the estimated capital cost per person would be $8.15 ($ year)[64] per year.

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[63] In general, we obtained such figures from http://cfpub.epa.gov/cwns/populationP.cfm.

[64] Dollar year not specified in the report. The report is dated May 1999.

A study by the Nutrient Reduction Technology Cost Task Force (NRTCTF) of the Chesapeake Bay Program (2002), also found reasonable costs for nutrient removal. In this study, actual costs of nitrogen and phosphorus removal technology were obtained directly from 67 facilities at which nutrient technology had been incorporated. These data were used to estimate costs for all municipal facilities in the watershed. The study considered costs for four tiers of performance, each tier having incrementally more stringent nutrient removal requirements. One tier ("Tier 2") NRTCTF examined would achieve moderate nitrogen and phosphorus removal at all "significant" municipal facilities (defined in the study as those for which flow is greater than or equal to 0.5 MGD). At this tier, the analysis presumed an annual average effluent total phosphorus limit of 1.0 mg/L and an annual average effluent total nitrogen limit of 8.0 mg/L. At the time of the analysis, approximately half of the significant municipal facilities had been upgraded to meet the 8.0 mg/L TN effluent target. The cost analysis calculated costs for phosphorus removal based on costs of using chemical precipitation. This was done to simplify the analysis, but the authors note that biological phosphorus removal would be preferable in many cases.

The report of the NRTCTF study summarizes the incremental total capital costs and operation and maintenance costs for each tier. By adding the incremental costs up to the tier at which all significant municipal facilities are achieving average annual TN limits of 8 mg/L and TP limits of 1.0 mg/L (Tier 2), total costs for achieving these limits within the watershed can be obtained. These total costs can then be annualized assuming a 20 year life of the facility and an interest rate for the loan necessary to cover the capital costs. Performing this analysis using an interest rate of three percent and the estimated population served yields an estimated annual capital cost per person of $13.28 for 260 of the 304 facilities in the watershed that had population data available.[65] For all of the facilities in the watershed, the estimated additional operation and maintenance costs average approximately $6.00 per person per year (2000$).

*Other published cost studies*

EPA published a synopsis of biological nutrient removal systems and their costs this June.[66] In general, the agency found that costs were relatively low for larger treatment facilities, and more expensive for smaller systems, as one would expect for any treatment technology. In particular, EPA reviewed cost information for plants in Maryland and Connecticut, estimating that the average unit capital costs in those states were: $588,000/MGD for plants with greater than 10 MGD flow; $1,742,000/MGD for facilities greater than 1 MGD and up to 10 MGD; and $6,972,000 for plants between 0.1 and 1 MGD.[67] On average, the capital cost per person using available population estimates, a three percent interest rate and a 20 year facility life indicates that upgrading 10 MGD plants and under would cost approximately $15.40/person (2006$).[68]

Rosso and Stenstrom (2005) analyzed the operational costs of adding denitrification by examining aeration systems in conventional activated sludge systems designed to remove only BOD and in systems that nitrify in addition to removing BOD. They found that systems that both nitrify and denitrify "always have lower aeration costs, and generally have the lowest combined operating costs" compared to conventional activated sludge processes and systems that only nitrify. In addition to lower costs than expected, there are other benefits to upgrading for nitrogen removal; the authors mentioned improved oxygen transfer efficiency and more efficient

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[65] This estimate does not include costs already incurred by the facilities at which TN effluent concentrations of 8 mg/L were already being achieved.
[66] U.S. EPA, *Biological Nutrient Removal Processes and Costs* (June 2007).
[67] *Id.* at 10.
[68] EPA calculated capital BNR upgrade costs by taking account of financing (e.g., projects eligible for the Maryland Department of the Environment 50% cost share and projects eligible for the Connecticut Clean Water Fund), and by updating the estimated costs to 2006 dollars using the ENR construction cost index and assuming that the completion date (for MD plants) or the year in service date (for CT plants) represents the original year dollars.

BOD removal due to higher solids retention time, potential increased efficiency at removing anthropogenic compounds such as pharmaceuticals, lower oxygen requirements due to anoxic removal of BOD, and reduction in sludge production. The tremendous benefits that denitrification adds led the authors to state:

> NDN [nitrification/denitrification] operation should always be evaluated as an alternative to conventional treatment. *** The commonly accepted assumption that NDN is a more expensive type of operation should be abandoned. (Rosso and Stenstrom, 2005)

The concept that denitrification may have economic benefits has been noted by other researchers, as well. Randall and Sen (1996) found that while a study suggested that upgrading a system for year round nitrification without removal of total nitrogen would cost $24M, an enhanced design that had a total nitrogen goal of 8 – 10 mg/L would cost only $9.2M.

Solley and Barr (1999) found that substantial reductions in TP and TN could be realized without incurring substantial capital costs by optimizing operation, in an examination of two existing facilities in Brisbane, Australia. Solley and Armstrong (2003) later examined one of these plants and found that by retrofitting existing tankage at a facility to create a 5-stage Bardenpho design, they were able to achieve a long term median TN effluent concentration of less than 8 mg/L. The capital costs were expected to be approximately 28 Australian dollars (~$21US) per person. The annual cost per person would depend on the expected life of the upgrade. Even if the upgrade only satisfied needs for 10 years, the annual cost would be approximately $3.60 per person.

Rockaway Valley Regional Sewerage Authority in New Jersey, required only to nitrify, estimated that adding denitrification resulted in a savings of $230,000 annually and improved overall process performance by its oxidation ditches that were operating 30% over rated capacity.[69]

A report developed for the Maryland Department of the Environment in 2003 examined twenty plants' likely control costs based on a detailed analysis of each plant's options for upgrading its nitrogen removal technology. The analysis examined plants' ability to undertake two phases of nitrogen control improvements; Phase I would reduce effluent levels from 8.0 mg/L (the then-current target for sources in the study) to 6.0 mg/L, and Phase II would reduce nitrogen from 6.0 mg/L to 3.0 mg/L.[70] The study also examined whether it made more sense to upgrade to Phase II level controls in a single step. The report found:

- "[T]he cost per pound of TN removed for Phase I improvements ranges from $0.28 to $7.54, with an average of $2.42. The cost per gallon treated for Phase I improvements ranges from $0.03 to $2.42, with an average of $0.61."[71]
- "The cost per pound of TN removed for Phase II improvements ranges from $0.32 to $11.45, with an average of $5.25. The cost per gallon treated for Phase II improvements ranges from $0.04 to $1.46, with an average of $0.75."[72]
- "The cost per pound of TN removed for single step improvements ranges from $0.83 to $8.31, with an average of $4.26. The cost per gallon treated for single step improvements ranges from $0.17 to $3.42, with an average of $1.05."[73]

Based on the population estimates for each facility, a 20 year facility life, and a three percent interest rate, the following are the estimated capital costs per person, per level ($Year):[74]

- Phase I: $3.34/person
- Phase II: $17.68/person
- Single Step Improvements: $19.26/person

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[69] Improving Energy Efficiency and Effluent Quality, and Reducing Operating Costs by Controlling Nitrification and Denitrification Through Operational Modifications, Tamburini, et. al, Rockaway Valley Regional Sewerage Authority, October 2007, WEFTEC.

[70] Gannett Fleming, Inc. & George Miles & Buhr, LLC, for the Maryland Department of the Environment, *Refinement of Nitrogen Removal From Municipal Wastewater Treatment Plants: Report*, at ES1 (Aug. 2003) [Exhibit 17].

[71] *Id.* at ES2.

[72] *Id.*

[73] *Id.* at ES3.

[74] Dollar Year not given in the report. The date of the report is August 2003.

Perhaps most interestingly and importantly, the analysis showed that these projected upgrade costs were actually lower than the cost of making initial improvements to achieve only 8 mg/L TN:

> According to information provided by MDE regarding the first phase of nitrogen removal in Maryland, the average cost per pound of nitrogen removed was $6.83 for reduction from uncontrolled conditions to the target concentration of 8 mg/l. The results of this study show that the estimated cost per pound of nitrogen removed is less for either a phased approach or proceeding directly to the final goal of 3 mg/l. Taking into consideration that the initial phase of BNR accounted for a much larger total reduction than the proposed phases, it would not have been surprising to observe diminishing returns in these further reduction efforts. Therefore the value of further decreases in nitrogen discharge seem exceptional and continuation of the BNR program in Maryland should be given high priority.[75]

Finally, in a text describing systems for nutrient removal, a Water Environment Federation (1998) task force for nutrient removal draws the following conclusions regarding biological nutrient removal (BNR):

> It can be seen that the construction costs for BNR WWTPs are not significantly different from those of WWTPs designed and constructed during the U.S. Environmental Protection Agency construction grants program of the 1970's.
>
> ***
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> Actual capital costs for WWTPs using BNR technology are comparable to historical capital costs for secondary treatment. It appears that the advances in BNR technology indeed allow municipal utilities to do more for a similar amount of capital invested in wastewater reclamation facilities.
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> ***
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> Construction costs for WWTPs, from an overall perspective, appear to be more significantly influenced by other site-specific criteria than the need for nutrient control.

## 7. Attainable Limits for Phosphorus and Nitrogen

It is clear that traditional biological systems designed for BOD and TSS removal can be modernized to remove both phosphorus and nitrogen reliably. The published literature suggests that there are many such processes which can achieve total phosphorus levels of 1.0 mg/L as a

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[75] *Id.*

monthly average, and total nitrogen of 6 – 8 mg/L as an annual average.[76] Indeed, in a recent survey of common biological processes, EPA identified six different systems with either "good" or "excellent" nitrogen removal, four of which also had "excellent" or "good" phosphorus removal.[77]

As is evident from this discussion, there are numerous means of meeting TN and TP limits, and these processes offer considerable flexibility for plant managers to choose appropriate retrofits for each facility. Emerging technologies will undoubtedly increase the menu of options in this regard and further reduce costs.

## IV. EPA Must Protect the Public by Establishing Nitrogen and Phosphorus Limits for Publicly Owned Treatment Works

EPA has a present duty first to publish its view of what level of nutrient control secondary treatment is capable of achieving and also to specify – consistent with the science outlined above – that specific levels of nitrogen and phosphorous removal are achievable and, therefore, required to be implemented at POTWs.[78]

### A. EPA Has Unreasonably Delayed in Publishing Information on the Capacity of Secondary Treatment to Remove Excess Nutrients

EPA has a clear statutory duty to keep abreast of developments in the ability of secondary treatment technology to remove pollutants from effluent. This obligation arises under section 304(d)(1) of the Clean Water Act, which provides:

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[76] The sensitivity of nitrogen removal processes to temperature does result in variable performance during the course of a year. USEPA (1993) quantified this variability, stating that "typically the maximum month effluent TN will be 1.4 times the average annual value." So, for instance, many of the processes described would be capable of meeting monthly average limits of 8.4 – 11.2 mg/L TN.

[77] EPA, *Biological Nutrient Removal Processes and Costs*, at 5.

[78] The petitioners stress that we have two independent concerns here. First, EPA has failed to publish secondary treatment information at all since 1985. *Cf. Maier*, 114 F.3d at 1041 ("Mr. Maier has not advanced a duty-to-publish claim in the instant case"). Second, the agency has unreasonably refused to update its standards in response to new information about the capability of secondary treatment to remove nutrients.

> The Administrator, after consultation with appropriate Federal and State agencies and other interested persons, shall publish within sixty days after enactment of this title (and from time to time thereafter) information, in terms of amounts of constituents and chemical, physical, and biological characteristics of pollutants, on the degree of effluent reduction attainable through the application of secondary treatment.[79]

By its plain terms, the law requires EPA periodically to assess the state of the science concerning the ability of "secondary treatment" to remove pollutants and to publish its assessment. Disseminating information on secondary treatment is not merely an academic exercise. Once the agency publishes the information, it needs to use that information to define secondary treatment. The law specifies that "publicly owned treatment works in existence on July 1, 1977, or approved pursuant to section 203 of [the] Act prior to June 30, 1974 (for which construction must be completed within four years of approval)" must meet "effluent limitations based upon secondary treatment as defined by the Administrator pursuant to section 304(d)(1) of this Act. . . ."[80]

Although EPA has a legal duty to publish information on the state of secondary treatment "from time to time," EPA's last assessment of the state of "secondary treatment" appears to have been made in 1985.[81] The current, published EPA information on the "minimum level of effluent quality attainable by secondary treatment" addresses only three pollutants – biochemical oxygen demand (five-day), total suspended solids, and pH.[82] Petitioners have reviewed available materials, such as EPA Federal Register notices and other agency materials, and have identified no instance in which EPA has claimed to have published information about the capacity of

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[79] 33 U.S.C. § 1314(d)(1).

[80] *Id.* § 1311(b)(1)(B).

[81] *See* U.S. EPA, Decision on Petition for Rulemaking to Address Nutrient Pollution from Significant Point Sources in the Chesapeake Bay Watershed, at 24 ("EPA first promulgated secondary treatment regulations in 1973, and later revised those regulations in 1976, 1977, 1984, and 1985.").

[82] 40 C.F.R. § 133.102

"secondary treatment" to control pollutants apart from its issuance of these longstanding "secondary treatment" rules.

Whatever "from time to time" may mean, it means more often than twenty year intervals. The Administrative Procedure Act gives the district courts the authority to compel unreasonably delayed agency action, 5 U.S.C. § 706(1), and a 20-year failure to follow the secondary treatment publication requirement is clearly unreasonable. *See American Lung Ass'n v. Reilly*, 962 F.2d 258, 263 (2d Cir. 1992) (indicating "unreasonable delay" suit would be appropriate with regard to a statutory provision requiring action "from time to time"). As the U.S. Court of Appeals for the D.C. Circuit has stated:

> There is "no per se rule as to how long is too long" to wait for agency action, *In re Int'l Chem. Workers Union*, 958 F.2d at 1149, but a reasonable time for agency action is typically counted in weeks or months, not years. *See Midwest Gas Users Ass'n v. FERC*, 833 F.2d 341, 359 (D.C.Cir.1987) ("[T]his court has stated generally that a reasonable time for an agency decision could encompass 'months, occasionally a year or two, but not several years or a decade.' " (quoting *MCI Telecomms. Corp. v. FCC*, 627 F.2d 322, 340 (D.C.Cir.1980))). FERC's six-year-plus delay is nothing less than egregious.

*In re American Rivers and Idaho Rivers United*, 372 F.3d 413, 419 (D.C. Cir. 2004); *see also Public Citizen Health Research Group v. Brock*, 823 F.2d 626, 629 (D.C.Cir.1987) (six-year delay of OSHA workplace exposure rulemaking "treads at the very lip of the abyss of unreasonable delay"); *Air Line Pilots Ass'n, Intern. v. C.A.B.*, 750 F.2d 81, 86 (D.C. Cir. 1984) (holding that five-year delay was unreasonable and concluding that unreasonableness of delay depends on context, and is more easily found in cases involving public health and welfare).

It is well past time for an update of secondary treatment. EPA has simply violated its obligation under section 304(d)(1) of the CWA.

## B. EPA Must Revise Its Secondary Treatment Standards to Account for the Advances that Have Occurred

The delay in publishing secondary treatment information is made still worse by the fact that new information has arisen in the years since 1985 to demonstrate that nutrient removal by secondary treatment is achievable. As shown above (see section III), there are several available treatment options. The fact that those options exist gives rise to a legal obligation to revise the "secondary treatment" standards immediately to establish generally-applicable limits for nutrients, and to require publicly owned treatment works to comply with them.

The CWA requires EPA to address the variety of pollutants discharged by POTWs and establish limits achievable by "secondary treatment." The CWA does not define "secondary treatment" and, to that end, "the CWA does not further delimit 'secondary treatment,' or specifically constrain the Administrator in promulgating generally-applicable effluent limitations for POTWs."[83] In particular, although EPA's examination of "secondary treatment," has historically focused on "a process of physical and biological treatment of wastewater to remove pollutants which deplete the water's oxygen content and increase its acidity,"[84] neither the agency's authority nor its responsibility is at all limited to the pollutants upon which it has historically focused. Moreover, the history and language of the provision strongly indicates that "secondary treatment" should not be a static concept, but should evolve with pollution control capabilities. In its report on the House version of the 1972 legislation that established the secondary treatment requirement, the Public Works Committee explicitly stated that "[t]he Committee intends that the term 'secondary treatment' shall be utilized for the purposes of this

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[83] *Maier v. U.S. EPA*, 114 F.3d 1032, 1041 (10th Cir. 1997).
[84] *Id.* at 1035.

section in its broadest context. The Committee does not mean secondary treatment to include only the treatment of suspended solids and BOB [sic]."[85]

Beyond this specific statement, the history of the CWA's regulation of wastewater treatment plants – in which the "secondary treatment" requirement was originally conceived of as the first phase in plants' improvement, with more stringent follow-up requirements to come thereafter – makes it more arbitrary for the agency today to treat the obligation as static. The requirement for POTWs to attain effluent limitations based on secondary treatment was originally intended as an interim standard giving way several years after the CWA's passage in 1972 to more stringent limitations derived from the "best practicable waste treatment technology."[86] That the second phase of this planned program was later deleted (due in large part to funding problems),[87] only reinforces the need for EPA to take seriously its obligation to revisit its "secondary treatment" standards periodically.

EPA previously – and circularly – suggested that it did not include nitrogen and phosphorus controls in "secondary treatment" because secondary treatment did not control nutrients.[88] Subsequently, EPA has also referred to nutrient controls as "beyond secondary"

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[85] H.R. Rep. No. 92-911, at 108 (1972), *reprinted in* Committee Print, A Legislative History of the Water Pollution Control Act Amendments of 1972, Vo. 1, 93d Cong., 1st Sess., at 793 (Jan. 1973) (hereinafter "1972 Legislative History").

[86] S. Rep. No. 92-414, at 43 (1972), 1972 Legislative History at 1461 ("Publicly-owned treatment systems must meet the secondary treatment requirement of Phase I and, in Phase II, the mandate requires the best practicable treatment, including recycling and reclamation of wastes confined and contained disposal as set forth in section 201.").

[87] Pub. L. No. 97-117, § 21(b), 95 Stat. 1623, 1632 (1981) (repealing § 301(b)(2)(B)); *see also* Response to Maier et al. petition, attachment at 2-3 (indicating that decision to put off the deadline for achieving secondary treatment standards and delete altogether the provision requiring a later shift to "best practicable waste treatment technology" was because of repeated shortfalls in funding supporting the construction of secondary treatment facilities in POTWs).

[88] 49 Fed. Reg. 36,986, 36,988 (1984) ("Secondary treatment requirements are based on controlling the oxygen demand due to the carbonaceous component of the organic material in the effluent because secondary treatment facilities can effectively remove carbonaceous organic material but may not consistently remove ammonia."); 48 Fed. Reg. 52,272, 52,273 (1983) ("'[N]utrients . . . were not specified for inclusion, because secondary treatment, under normal conditions, does not effectively or consistently remove them.'") (citation omitted).

treatment or "advanced" treatment.[89] But these labels and arguments are simply wrong. The fact is that EPA has historically understood its obligation to establish limitations based on "secondary treatment" as encompassing, at a minimum, biological control mechanisms that help avoid the introduction of pollution that causes oxygen depletion. It is undisputed that nutrients in water bodies cause oxygen-robbing algal blooms, so the control of nutrients (especially where, as demonstrated above, biological treatment options are available) quite properly can be considered "secondary treatment," and EPA must establish limitations for these pollutants. Indeed, all of the judges who previously reviewed EPA's denial of a similar petition found that nutrients could properly be addressed by "secondary treatment."[90]

## C. Improved Technology and Proper Application of the Law Require EPA to Grant the Instant Petition

This is now at least the third petition to EPA requesting an upgrade in the agency's control of nutrients from POTWs. As described above, EPA twice previously refused to act. The agency rejected these prior petitions for a number of reasons; EPA argued that: (1) nutrients have varying effects in different waters; (2) individual permits were already being issued to address the impact of the subject pollutants on applicable water quality standards; (3) the particular requested levels of control were not technologically achievable by all BNR processes; and (4) costs could be high at individual facilities. For the reasons discussed below, these reasons do not justify rejecting the instant petition.

### 1. Nutrient Control Is Properly Included Within "Secondary Treatment"

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[89] *See, e.g.*, 48 Fed. Reg. 52,272, 52,275 (1983) (proposed Nov. 16, 1983); U.S. EPA, Primer for Municipal Wastewater Treatment Systems, at 17 (Sept. 2004) [Exhibit 18] ("Treatment levels beyond secondary are called advanced treatment.").

[90] *Maier*, 114 F.3d at 1042 (after describing various treatment techniques, majority opinion states, "[a]lthough *these descriptions suggest that NOD and nutrients fall within a general understanding of secondary treatment*, they also demonstrate 'secondary treatment' has a broad connotation."); *id.* at 1048 (Lucero, J., dissenting) ("having included the control of oxygen-depleting compounds within the general definition of secondary treatment, it is incumbent upon the EPA to explain its refusal to promulgate NOD and nutrient limitations. ")

Before addressing the arguments that EPA has made in the past, we highlight a claim that the agency has not made. EPA has not argued that "secondary treatment" cannot lawfully encompass nutrient controls. Although EPA has said that it has a "long-standing interpretation of the term 'secondary treatment' [as] refer[ring] to processes to remove carbonaceous biological oxygen demanding materials,"[91] EPA cannot reasonably justify limiting its view so narrowly. To the contrary, the agency's 1983 rulemaking specifically considered whether nutrient limitations should be included in the "secondary treatment" regulations.[92] EPA's secondary treatment regulation also has long required that POTWs control the pH and total suspended solids in their effluent, which are not carbonaceous biological oxygen demanding materials. This fact demonstrates that "secondary treatment" can reach pollution beyond CBOD. And even if EPA were to change its legal interpretation today, the fact of the matter is that biological nutrient removal is substantially similar to (indeed, it can be accomplished with slight modifications to) existing secondary treatment processes.

The primary argument EPA has made in support of its denial of prior petitions is that nutrients have varying effects in different receiving waters. This is an arbitrary and illogical reason for refusing to establish generally-applicable standards or for including a pollutant in the definition of "secondary treatment," for one simple reason – virtually all pollutants have different effects depending on the characteristics of the receiving water, yet there is no limitation on the

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[91] Response to Maier et al. petition, attachment at 6; *see also* U.S. EPA, Decision on Petition for Rulemaking to Address Nutrient Pollution from Significant Point Sources in the Chesapeake Bay Watershed, at 25 ("Secondary treatment . . . biologically removes degradable organic materials from wastewater and became synonymous with the biological treatment of wastewater for the removal of carbonaceous organic material."); H. Rep. No. 92-911, at 101, 1972 Legislative History at788 ("Secondary treatment as considered in the context of a publicly owned treatment works is generally concerned with suspended solids and biologically degradable, oxygen demanding materials (BOD).").

[92] 48 Fed. Reg. 52,272, 52,273 (Nov. 16, 1983) ("nutrients (i.e., phosphorus and NH3) were not specified for inclusion, because secondary treatment, under normal conditions, does not effectively or consistently remove them.")

inclusion of such pollutants in the CWA definition of "secondary treatment." Indeed, the very pollutant with which EPA has said "secondary treatment" is centrally concerned – biochemical oxygen demand – is a prime example of receiving water variability. As EPA has stated, "[t]he amount of oxygen dissolved in the water changes as a function of temperature, salinity, atmospheric pressure and biological and chemical processes."[93] BOD has a recognized role in this variability; as the government argued in a recent Supreme Court pleading, "BOD affects water quality indirectly by fueling a variety of biological and chemical reactions that reduce dissolved oxygen in the water. These reactions are dependent on such factors as temperature, biological activity, sunlight, tides, and the volume and speed of flow of water in the river."[94] In light of the fact that EPA has historically – and appropriately – imposed generally-applicable limitations for BOD as part of its definition of "secondary treatment" notwithstanding the differential impact such pollution has on receiving waters reveals the irrationality of relying on the water quality impacts of a pollutant to determine whether it is properly included as part of "secondary treatment."

The agency's subsidiary arguments also are irrational. EPA has previously indicated that establishing generally-applicable effluent limitations for a given pollutant within "secondary treatment" is inappropriate if water quality-based limitations were being implemented as needed, and where general regulation could lead to control where it was not needed. For example, in denying the CBF petition, EPA stated, "a categorical rulemaking as requested by CBF might result in additional controls and expenses being imposed on some POTWs that are not needed to

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[93] U.S. EPA, Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries, at 8 (Apr. 2003).

[94] Brief for the Federal Respondents in Opposition to Petition for Certiorari, *District of Columbia Water & Sewer Auth. v. Friends of the Earth, Inc.*, No. 06-119, at 8-9 (Nov. 2006), available online at http://www.usdoj.gov/osg/briefs/2006/0responses/2006-0119.resp.pdf (visited Jul. 16, 2007).

ensure that applicable water quality standards are achieved."[95] This argument proves too much; virtually any standard applicable to an entire industry will by necessity be disconnected from local water quality considerations and thus may lead to "over-control" (as well as under-control).

In this respect, the agency's argument that generally-applicable standards might not be sufficiently tailored to local conditions contradicts the basic principle of the Clean Water Act that "secondary treatment" is technology-based, not water quality-based. EPA has acknowledged that "the definition of secondary treatment is to be technology-based rather than water quality based."[96] This admission reflects the legislative history of the "secondary treatment" provision. As the Senate report on the bill states, "'[t]he application of Phase I technology to industrial point sources is based on the control technologies for those sources and to [POTWs] is based on secondary treatment. It is not based upon ambient water quality considerations.'"[97] And when EPA received public comments on its proposed "secondary treatment" regulations almost immediately following the adoption of the CWA, EPA rejected the suggestion that water quality considerations should guide pollution control requirements:

> Comments were received which recommended that the regulation be written to allow effluent limitations to be based on the treatment necessary to meet water quality standards. No change has been made in the regulations because the Act and its legislative history *clearly show* that the regulation is to be based on the capabilities of secondary treatment technology and not ambient water quality effects.[98]

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[95] *See also, e.g.*, Response to Maier et al. petition, attachment at 8 ("The Petition does not offer any indication of e inadequacy of water-quality based permitting to address NOD concerns. *** Any . . . revised secondary treatment requirements would be universally applicable to all POTWs pursuant to section 301(b)(1)B), regardless of local variability").

[96] Response to Maier et al. Petition, attachment at 2.

[97] *Id.* at 2, n.3 (quoting S. Rep. 92-414, 92d Cong., 1st Sess. 43, 2 Legis. Hist. 1461).

[98] 38 Fed. Reg. 22,298 (Aug. 17, 1973) (emphasis added); *see also Maier*, 114 F.3d at 1049 (Lucero, J., dissenting) (discussing 1977 enactment of 33 U.S.C. § 1311(h) – which allows EPA to modify secondary treatment requirements for POTWs that discharge to marine waters based on water quality considerations – as evidence that the standards otherwise should not depend on water quality).

As a consequence, it is arbitrary and capricious to interpret the provision in a way that renders it dependent on considerations of how the pollutant in question relates to site-specific local water quality conditions.[99]

Critically, the agency's reliance on site-specific standards is also unreasonable when one considers the current factual situation. EPA cannot credibly claim that relying on a water quality-based approach for nutrient pollution is working at present, or that the problem is not widespread enough to justify generally-applicable standards. Rather, as discussed above, the lack of numeric nutrient standards is a real problem today, one which is seriously hindering permitting authorities' ability to design appropriate water quality-based effluent limitations. EPA's own evidence supports the need for nationwide standards, as the problem of nutrient pollution is pervasive:

> Nutrient pollution is widespread. The most widely known examples of significant nutrient impacts include the Gulf of Mexico and the Chesapeake Bay. For these two areas alone, there are 35 States that contribute the nutrient loadings. There are also known impacts in over 80 estuaries/bays, and thousands of rivers, streams, and lakes. * * * Virtually every State and Territory is impacted by nutrient-related degradation of our waterways . All but one State and two Territories have Clean Water Act Section 303(d) listed impairments for nutrient pollution. States have listed over 10,000 nutrient and nutrient-related impairments. Fifteen States have more than 200 nutrient-related listings each.[100]

In light of EPA's own findings, it is simply untenable for the agency to argue that it would be a more reasonable public policy approach to establish needed standards on a POTW-by-POTW basis purely based on compliance with local water quality standards than to adopt generally-

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[99] *Cf. Kraft, Inc. v. U.S.*, 30 Fed.Cl. 739, 825 (Fed. Cl. 1994) ("Legislative regulations . . . are to be afforded considerable deference, and should be upheld unless they are so arbitrary and capricious as to be plainly inconsistent with the authorizing statute's language and purpose."). *See generally FDA v. Brown & Williamson Tobacco Corp.*, 529 U.S. 120, 133 (2000) ("It is also 'a fundamental canon that the words of a statute must be read in their context and with a view to their place in the overall statutory scheme.'") (citation omitted); *K Mart Corp. v. Cartier, Inc.*, 486 U.S. 281, 291 (1988) ("In ascertaining the plain meaning of [a] statute, the court must look to the particular statutory language at issue, as well as the language and design of the statute as a whole.").

[100] Memorandum from Benjamin H. Grumbles, EPA Assistant Administrator for Water, to State Water Program Directors et al., at 1-2.

applicable standards that could significantly reduce the nationwide levels of nutrient pollution. This is especially true with respect to nutrients, which in many cases have their effect in a location far distant from the water body into which they are discharged; the problem of hypoxia in the Gulf of Mexico and elsewhere is a prime example. In such circumstances, it is unrealistic at best to believe that permitting authorities will have the wherewithal and the inclination to establish effluent limitations that account for individual sources' impact on water quality in faraway waters. Petitioners submit that the current state of affairs is precisely the kind of situation that EPA previously suggested would warrant generally-applicable nutrient controls, when it said that "[a]mendments to the regulations might be warranted if NOD from POTWs posed a significant threat to waters of the United States. . . ."[101]

## 2. Nutrient Reductions Are Achievable As "Secondary Treatment"

In denying the Chesapeake Bay Foundation petition in 2005, EPA placed considerable emphasis on the particular level of nitrogen removal that CBF's petition demanded, and concluded that there was insufficient evidence that POTWs generally could meet this standard technologically and affordably.[102] In this petition, we have provided significant information (including EPA's own acknowledgements) that supports our conclusion that control levels of 0.3 mg/l TP and 3 mg/l TN are currently achievable. Accordingly, EPA must assess whether such effluent rates constitute "secondary treatment." Moreover, even though Petitioners contend that the Clean Water Act does not limit "secondary treatment" to biological controls and that it is unreasonable to interpret the statute in that way, if EPA were to look no further than purely biological processes, this petition shows that limits of 1.0 mg/L TP and 8.0 mg/L TN averaged

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[101] Response to Maier et al. petition, attachment at 8.

[102] U.S. EPA, Decision on Petition for Rulemaking to Address Nutrient Pollution from Significant Point Sources in the Chesapeake Bay Watershed, at 27-30; *see also* Response to Maier et al. petition, attachment at 11 (discussing EPA's beliefs about cost-effectiveness of technologies identified by Maier petition).

yearly can be met with existing, affordable and cost-effective technology that uses only minor modifications of conventional biological treatment processes.[103]

In the event that EPA concludes that even these basic control levels would be inappropriate as generally-applicable standards due to technological achievability concerns or cost, we emphasize that this petition requests the agency to consider the levels of controls for nutrients that can be reliably and cost-effectively achieved by wastewater treatment plants using "secondary treatment," and include those control levels in the agency's secondary treatment regulations as generally-applicable effluent limitations. For instance, if EPA believes that either TN or TP, but not both, can be controlled with current processes and at justifiable costs, it must identify what degree of control is achievable for the relevant pollutant and promulgate effluent limitations accordingly. Or, if the agency claims that effluent limitations weaker than 1.0 mg/L TP and 8.0 mg/L TN are all that can be reasonably accomplished, it must say so and establish the relevant limits as effluent limitations for all wastewater treatment plants. Petitioners reserve the right to object to such conclusions, but stress that the law does not permit EPA to indefinitely refuse to express its view on what "secondary treatment" can in fact do to control nutrient pollution.

## V. Conclusion

As in 1972, it cannot be reasonably contended that the water quality standards based approach to pollution control can by itself solve the nation's critical water pollution problems. Nitrogen and phosphorus pollution now causes innumerable rivers, lakes and streams to be

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[103] *See generally* MDE Refinement of Nitrogen Removal Report, at ES1 ("Under the current BNR program, the goal for most of the participating WWTPs has been set at 8 mg/l of total nitrogen on a seasonal basis. Many of the BNR plants that have been built and are in operation have successfully demonstrated the capability to achieve much better than the goal of 8 mg/l of total nitrogen. With this practical evidence of past and current plant performance, MDE and a number of local jurisdictions believe that further nitrogen reductions in the range of 6 mg/l or even down to 3 mg/l could be achieved in a cost-effective manner.").

choked by algae and cyano-bacteria and creates vast "dead zones" every year in the Gulf of Mexico and other coastal waters. Yet, few states have any numeric standards for nitrogen and phosphorus and states are not using their narrative standards to control nitrogen or phosphorus pollution from sewage treatment plants.

In compliance with 33 U.S.C. § 1314(d)(1), EPA should grant this petition and act on its overdue obligation to publish updated information on the pollution reductions that secondary treatment can achieve. As part of that analysis, EPA should specify the degree of nitrogen and phosphorous reduction attainable through the application of secondary treatment. The facts cited in the petition show that effluent levels of .3 mg/L TP and 3 mg/L TN are attainable through current technology, and that effluent levels of 1.0 mg/L TP and 8.0 mg/L TN are attainable even if only technologies using biological processes are considered.

If EPA rejects these particular control levels, the agency should establish technology-based nitrogen and phosphorus effluent limits based on its conclusions regarding what is attainable through the application of secondary treatment.

## Appendix 1: References Cited in Section III of the Petition

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