

# From Therapeutic Drugs to Toxic Contaminants: Pharmaceutical Pollution in the Water and Strategies to Regulate Its Impact

Guillermo Cuevas\*

## I. Introduction

Pollution from pharmaceutical end products is a widespread and under-regulated source of environmental contamination. United States Geological Survey researchers detected pharmaceutical contaminants in eighty percent of 139 streams sampled.<sup>1</sup> The contaminants found in the sampled aquatic environment included: antibiotics, hypertensive medication, antidepressants, analgesics, reproductive hormones, and other prescription drugs.<sup>2</sup> These chemical agents have also impacted municipal drinking water supplies.<sup>3</sup> There currently exists little, if any, health risk assessment data regarding the potential adverse effects from chronic exposure.<sup>4</sup>

There are several gaps in the current regulatory framework and little action from federal agencies to combat this pollution source. As pharmaceutical contaminants become increasingly endemic and more concentrated in both the environment and human drinking water, it will become necessary to abate their impacts. Fortunately, there are legal regimes currently in place that can respond to this contamination. This Field Report will examine the regulatory framework currently in place and its limitations as well as suggest that: (1) more detailed chemical analyses are required on pharmaceutical pollutants and can be achieved in a cooperative partnership with industry, (2) infrastructure improvements on wastewater treatment can prevent environmental and human health harms damage, and (3) short-term mitigation steps are possible through increased regulation of medical facilities.

\* Guillermo Cuevas is a student at Columbia Law School.

<sup>1</sup> NATURAL RES. DEF. COUNCIL, DOSED WITHOUT PRESCRIPTION: PREVENTING PHARMACEUTICAL CONTAMINATION OF OUR NATION'S DRINKING WATER 3 (2009) [hereinafter NRDC WHITE PAPER], available at [http://docs.nrdc.org/health/files/hea\\_10012001a.pdf](http://docs.nrdc.org/health/files/hea_10012001a.pdf).

<sup>2</sup> *Id.*

<sup>3</sup> *Id.*

<sup>4</sup> *Id.* at 3–4.

## II. Background

As a starting point it, is important to understand the source of this pollution. When a pharmaceutical is ingested by a person, a certain portion of the original active ingredient (parent compound) is excreted through human waste products without being absorbed, metabolized, or otherwise altered by physiological processes.<sup>5</sup> The percentage of the parent compound that passes through the human body is dependent upon the chemical properties of the substance.<sup>6</sup> These active compounds found in human waste are deposited into wastewater streams and eventually to a sewage treatment plant (“STP”).<sup>7</sup> Additional sources of this form of pollution come from discarded drugs and other hazardous medical waste materials from health care facilities which are flushed and eventually enter the waste water influent of a STP.<sup>8</sup> Unfortunately, STPs are not designed to specifically process these constituents, and the removal rates can vary from over ninety percent to as little as seven percent.<sup>9</sup> The STP effluent carrying the biologically effective parent compound is then discharged into aquatic systems.

The full impact of this form of pollution on the environment is unknown; however, studies have already observed impacts on aquatic species. Perhaps the most iconic are the reports of estrogen in waterways, most likely from birth control pills and hormone therapies, causing male fish to develop female reproductive characteristics.<sup>10</sup> Fish species are also suspected to be impacted by the presence of antidepressants, which may cause fish to lose their innate fear of predators and essentially become fatalistic.<sup>11</sup>

In addition to environmental harm, there is potential for negative human health outcomes. Pharmaceutical contaminants are being investigated for their potential role in the increasing trend of precocious puberty.<sup>12</sup> The ubiquitous usage of antimicrobial agents is also a source

<sup>5</sup> Christopher T. Nidel, *Regulating the Fate of Pharmaceutical Drugs: A New Prescription for the Environment*, 58 FOOD & DRUG L.J. 81, 83–84 (2003).

<sup>6</sup> See generally CASARETT AND DOULL’S ESSENTIALS OF TOXICOLOGY 99–107 (Curtis D. Klaasen & John B. Watkins III eds., 2003).

<sup>7</sup> Nidel, *supra* note 5, at 83–84.

<sup>8</sup> NRDC WHITE PAPER, *supra* note 1, at 30–31.

<sup>9</sup> *Id.*; Mira Petrovic et al., *Fate and Removal of Pharmaceuticals and Illicit Drugs in Conventional and Membrane Bioreactor Wastewater Treatment Plant and by Riverbank Filtration*, 367 PHIL. TRANSACTIONS ROYAL SOC’Y A 3979, 3994 (2009).

<sup>10</sup> George J. Mannina, Jr., *Medicines and the Environment: Legal and Regulatory Storms Ahead?* 21 LEGAL BACKGROUNDER, Mar. 24, 2006, at 1.

<sup>11</sup> *Id.*

<sup>12</sup> Teirney Christenson, *Fish on Morphine: Protecting Wisconsin’s Natural Resources Through a Comprehensive Plan for Proper Disposal of Pharmaceuticals*, 2008 WIS. L. REV. 141, 144; see also Nidel, *supra* note 5, at 89 (estrogen has been detected in drinking water sources).

of potential concern as these compounds tend to bioaccumulate in the environment and may foster the evolution of antibiotic resistance in pathogens.<sup>13</sup> Pharmaceutical contamination may also be impacting groundwater aquifers. Efforts to increase aquifer recharge rates have included the injection of treated sewage effluent.<sup>14</sup> However, a groundwater aquifer environment lacks many natural characteristics such as solar degradation and microorganisms that can decompose parent compounds.<sup>15</sup> Without any significant natural attenuation of pharmaceutical pollutants there is a potential for a rapid increase in concentration of these constituents.<sup>16</sup>

### **III. Current Regulatory Limitations and Strategies for Improvement**

#### **A. Food and Drug Administration (“FDA”)**

The FDA, tasked with ensuring that drugs are both safe and effective, is typically the first agency to interact with pharmaceutical manufacturers at the drug development stage.<sup>17</sup> As a federal agency the FDA is subject to the National Environmental Protection Act.<sup>18</sup> Thus, the FDA requires the submission of an Environmental Assessment (“EA”) by a pharmaceutical company prior to any drug approval.<sup>19</sup> However, the FDA has created a number of categorical exclusions to the EA requirement. For example, drugs which are anticipated to enter the aquatic environment at a concentration below one part per billion can receive a categorical exclusion.<sup>20</sup> This approach is inadequate as the biologically effective concentration or dosage of pharmaceutical agents varies dramatically. Certain parent compounds have been shown to exhibit toxicity in aquatic systems at a concentration of one part per trillion.<sup>21</sup> In addition, this categorical exclusion does not consider the effects of bioaccumulation of certain drugs, such as ethinylestradiol (a synthetic hormone), which can concentrate in aquatic species to a level

<sup>13</sup> NRDC WHITE PAPER, *supra* note 1, at 4–5.

<sup>14</sup> Christian G. Daughton, *Cradle-to-Cradle Stewardship of Drugs for Minimizing Their Environmental Disposition While Promoting Human Health*, 111 ENVTL. HEALTH PERSP. 775, 779 (2003).

<sup>15</sup> *Id.*; Petrovic, *supra* note 9, at 3994.

<sup>16</sup> Petrovic, *supra* note 9, at 3994.

<sup>17</sup> Nidel, *supra* note 5, at 92.

<sup>18</sup> NEPA requires federal agencies to investigate the impact of their actions on the environment. 42 U.S.C. § 4372 (2006).

<sup>19</sup> NRDC WHITE PAPER, *supra* note 1, at 12.

<sup>20</sup> 21 C.F.R. § 25.31(b) (2010).

<sup>21</sup> Mannina, *supra* note 10, at 2.

one million times greater than observed in the water medium.<sup>22</sup> This categorical exclusion thereby effectively prevents an EA from being produced for extremely potent drugs.

There is potential for additional environmental considerations during the initial stages of interaction with the FDA. Emphasis on chemical toxicity and pharmacokinetic profile,<sup>23</sup> specifically aquatic toxicity and expected chemical behavior in the ambient environment, could shed light on the parent compound's potential to persist and bioaccumulate.<sup>24</sup> This is an important first step given both the lack of environmental toxicity data<sup>25</sup> and the fact that some of these constituents in waterways are already affecting ecosystems at current concentration levels.<sup>26</sup> Pharmaceutical manufacturers are in the best position to evaluate and study potential environmental effects given that they have intimate knowledge on a drug's pharmacokinetic profile. There is also FDA precedent for providing incentives for pharmaceutical manufacturers to provide additional information beyond the scope required for a drug approval.<sup>27</sup> This information could be invaluable to policy makers and regulatory agencies.

### **B. Environmental Protection Agency ("EPA")**

EPA administers three separate environmental statutes that are particularly pertinent to the issue of pharmaceutical pollution in waterways. These statutes are the Clean Water Act ("CWA"), the Resource Conservation and Recovery Act ("RCRA"), and the Safe Drinking Water Act ("SDWA").

The CWA regulates the discharge of toxic pollutants into the nation's waterways through the National Pollution Discharge Elimination System ("NPDES") permitting regime.<sup>28</sup> The CWA requires technology-based standards for all toxic pollutants, with an additional economic consideration for pre-existing sources.<sup>29</sup> This regulatory

<sup>22</sup> NRDC WHITE PAPER, *supra* note 1, at 5.

<sup>23</sup> A pharmacokinetic profile describes the manner in which a chemical constituent is absorbed, distributed, metabolized, and excreted by an organism. *See generally* CASARETT AND DOULL'S ESSENTIALS OF TOXICOLOGY, *supra* note 6, at 60–69.

<sup>24</sup> NRDC White Paper, *supra* note 1, at 10.

<sup>25</sup> Daughton, *supra* note 14, at 778.

<sup>26</sup> Nidel, *supra* note 5, at 88–89.

<sup>27</sup> *See* Daughton, *supra* note 14, at 776 (pharmaceutical manufacturers have been provided patent extensions in exchange for research regarding a drug's effects on a different target population).

<sup>28</sup> NRDC WHITE PAPER, *supra* note 1, at 12–13.

<sup>29</sup> William Wombacher, *There's Cologne in the Water: The Inadequacy of U.S. Environmental Statutes to Address Emerging Environmental Contaminants*, 21 COLO. J. INT'L ENVTL. L. & POL'Y 521, 542 (2010); 33 U.S.C. § 1317(a)(2) (requiring application of the "best available technology economically achievable").

authority extends to public-owned treatment works or STPs.<sup>30</sup> EPA could regulate the pollution from parent compounds by mandating certain effluent limitations on the STPs. This would have the benefit of not only reducing pollution discharges to aquatic environments, but also preventing contaminants from penetrating human drinking water supplies.<sup>31</sup> Unfortunately, no pharmaceutical compounds have been listed by EPA as toxic pollutants, and future listing seems unlikely.<sup>32</sup>

Efforts should be made by EPA to evaluate potentially dangerous parent compounds and their impact on the environment and human health. There are a plethora of pharmaceutical constituents in wastewater streams;<sup>33</sup> however, an accurate characterization of toxicity, persistence, and ability to bioaccumulate could help identify the most pernicious substances. For example, the non-steroidal anti-inflammatory ibuprofen, a common over-the-counter pain medication, has been shown to rapidly degrade in the environment.<sup>34</sup> On the other hand, carbamazepine, an anti-epileptic drug, is highly persistent in the environment.<sup>35</sup>

Infrastructure improvements on STPs are a potential source for environmental impact mitigation. Technology and waste treatment practices have been developed on an economically feasible basis to help alleviate the burden of pharmaceutical pollution.<sup>36</sup> In particular, microorganisms can be generated that have the ability to efficiently degrade specific active parent compounds.<sup>37</sup> EPA could initiate the process of mandating these types of technological upgrades on STPs in an incremental fashion for the most dangerous compounds.

EPA also regulates certain pharmaceutical waste under RCRA, the federal law that governs the management of solid waste.<sup>38</sup> Many drug products, however, are not covered by RCRA—including very toxic chemotherapy agents—resulting in a significant regulatory gap.<sup>39</sup> In addition, all household waste generated by residential users of pharmaceutical products is exempt from RCRA regulations.<sup>40</sup> However, pharmaceutical waste that is listed as hazardous and generated in

<sup>30</sup> NRDC WHITE PAPER, *supra* note 1, at 13.

<sup>31</sup> Tee L. Guidotti, Editorial, *Emerging Contaminants in Drinking Water: What to Do?*, 64 ARCHIVES ENVTL. & OCCUPATIONAL HEALTH 91, 92 (2009).

<sup>32</sup> Wombacher, *supra* note 29, at 543.

<sup>33</sup> Petrovic, *supra* note 9, at 3979–80.

<sup>34</sup> *Id.* at 3989.

<sup>35</sup> *Id.* at 3990.

<sup>36</sup> *Id.* at 3992.

<sup>37</sup> *Id.*

<sup>38</sup> NRDC WHITE PAPER, *supra* note 1, at 13.

<sup>39</sup> *Id.*

<sup>40</sup> 40 C.F.R. § 261.4(b)(1) (2010).

sufficient quantities at hospitals or medical facilities is governed under RCRA.<sup>41</sup> Unfortunately, these facilities' compliance with RCRA is generally poor.<sup>42</sup> Part of the problem is that RCRA regulations are not well suited to the healthcare industry.<sup>43</sup> In addition, medical providers receive contradictory instructions or guidance from federal agencies. For example, medical providers are subject to regulation by the Drug Enforcement Agency ("DEA"), an agency that has advised disposal of unwanted pharmaceuticals through flushing.<sup>44</sup>

Medical care facilities' waste streams are an important target for regulatory action, as they tend to contain particularly toxic and environmentally persistent pharmaceutical pollution.<sup>45</sup> Health care facilities often already have a pharmaceutical classification and waste removal system in place.<sup>46</sup> These facilities can serve as an important role in mitigation efforts as they have the ability to appropriately segregate and dispose of pharmaceutical waste.<sup>47</sup> If RCRA regulations were created that specifically addressed the medical care facility context, a substantial amount of highly toxic drug compounds might be prevented from entering the environment: about thirty percent of pharmaceutical disposal is generated by health care facilities.<sup>48</sup> Medical care providers would be incentivized to improve efficiency in obtaining RCRA compliance, were it more rigorously enforced.<sup>49</sup> In addition to protecting the environment, such regulations could, therefore, potentially reduce costs to providers by decreasing the amount of wasted or unused drug products. There is precedent for this approach on the state level. Illinois law currently prohibits medical facilities from flushing of medications.<sup>50</sup>

Under the SDWA, EPA regulates the containment concentration in drinking water.<sup>51</sup> In 2009, EPA for the first time included eleven pharmaceutical chemical constituents that could be potentially regulated under the SDWA in response to public attention on pharmaceutical contamination.<sup>52</sup> However, no pharmaceuticals are regulated under this

<sup>41</sup> NRDC WHITE PAPER, *supra* note 1, at 13.

<sup>42</sup> Christenson, *supra* note 12, at 150.

<sup>43</sup> Ron Seely, *Flushed Drugs Polluting Water: Complicated Rules for Disposal Result in Most Hospitals Taking Easy Way Out*, WIS. ST. J., Dec. 10, 2006, available at [http://m.host.madison.com/news/article\\_acdb4a7b-6a05-5c6f-aeae-2e2431e515d7.html](http://m.host.madison.com/news/article_acdb4a7b-6a05-5c6f-aeae-2e2431e515d7.html) (observing that hospitals have not received much guidance from agencies regarding proper waste disposal).

<sup>44</sup> NRDC WHITE PAPER, *supra* note 1, at 15.

<sup>45</sup> Petrovic, *supra* note 9, at 3995; Daughton, *supra* note 14, at 778.

<sup>46</sup> Christenson, *supra* note 12, at 163.

<sup>47</sup> *Id.*

<sup>48</sup> NRDC WHITE PAPER, *supra* note 1, at 31.

<sup>49</sup> *Id.* at 33.

<sup>50</sup> *Id.* at 35.

<sup>51</sup> *Id.* at 13.

<sup>52</sup> *Id.* at 14.

statue.<sup>53</sup> In fact, no pharmaceuticals are proposed to be monitored under the Act's endocrine disruptor screening program despite the fact that many parent compounds are potential hormone disruptors.<sup>54</sup>

Although regulation of pharmaceutical pollution in drinking water may be protective of human health, it would not address issues relating to environmental contamination from waste water.<sup>55</sup> Regulation at this point of the cycle is also of limited value because the source of pollution—human and medical facility waste—would remain unabated. Were drinking water standards for pharmaceutical agents issued, they could become increasingly burdensome due to the inherent disconnect of a regulatory system that does not address the pollution source.

#### **IV. Conclusion**

Protection from the adverse environmental and human health effects of pharmaceutical pollution will require regulatory action both to obtain more toxicity information and to control environmental releases. The FDA is in the best position to solicit more data from pharmaceutical manufacturers in exchange for patent extension.<sup>56</sup> This information can then be used by EPA and other agencies to formulate regulations and policies. EPA has existing authority under its governing statutes to address this issue. In the more immediate-term, progress can be made by using RCRA to focus on medical care providers' waste management practices. Once a greater scientific understanding of these compounds is determined, longer-term solutions can be developed through CWA regulation of STP effluent streams.

A commonly repeated adage among toxicologists is that “the dose makes the poison.” If sufficient action is not taken in controlling these pharmaceuticals, then these products—often of tremendous therapeutic value—may indeed poison humans and their environment.

<sup>53</sup> *Id.*

<sup>54</sup> *Id.*

<sup>55</sup> Guidotti, *supra* note 31, at 92.

<sup>56</sup> *See supra* note 27 and accompanying text.