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## **The Case Against the Use of Sewage Effluent for Wet-Cooling the Greenfield Incinerator**

### **Introduction:**

An essential component of the planned Pioneer Renewable Energy (PRE) incinerator proposed to be located adjacent to the Greenfield Industrial Park is the use of partially treated sewage liquid for wet-cooling during the generation of electricity by steam turbines. Operators of the incinerator plan to “buy” sewage effluent from the City of Greenfield in lieu of paying to discharge the wastes from the operations of the incinerator into the city sewer system. As explained below, the proposal to use inadequately treated sewage water in a manner that will release dangerous contaminants into the ground level air is ill-conceived, inadequately studied, and should not be approved without a thorough analysis and extensive public participation in the decision-making process. The approval process followed by the City has severely limited and disrespected the public at every turn, and as a result, opposition to the incinerator continues to build, lawsuits have been filed, and citizen outrage intensifies. This presentation endeavors to bring several legitimate concerns to the forefront of the discussion so that the Town Council will make an informed decision and properly execute their legal responsibility to protect the public from avoidable harm.

### **Background:**

The Greenfield Water Pollution Control Plant (WPCP) provides only secondary treatment for the wastewater generated by the residents, businesses, and industries that discharge to the sewers in town. Primary treatment consists of grit removal and settling. Secondary biological treatment removes just enough of the gross nutrients (measured as BOD & TSS<sup>1</sup>) from the wastewater to allow the sewage effluent to be discharged to a receiving stream.<sup>2</sup> The Deerfield River is relied upon to complete the treatment of Greenfield’s effluent, mainly through dilution and to a lesser extent by the additional biological processes that occur in a living aqueous ecosystem. Such treatment is often calculated as the Total Maximum Daily Load that the receiving stream or body of water can absorb without measurable impairment and degradation.

Recent scientific studies have shown that secondary sewage effluent is still a highly contaminated solution containing numerous classes of discarded and excreted biologically active chemicals such as active pharmaceutical ingredients & personal care products (PPCPs),

endocrine disrupting compounds (EDCs), mutagenic cytotoxins, etc.<sup>3</sup> The US EPA formed the [Endocrine Disruptor Screening and Testing Advisory Committee](#) in 1996 to design a screening and testing program to determine whether any unregulated contaminants behave as EDCs. The EDSTAC final report estimated that there are approximately 87,000 chemicals that should be considered for EDC screening. Many of these chemicals can pass through the traditional sewage treatment process with their concentrations and chemical structures unchanged, or possibly modified in ways that may actually increase their biological activity and subsequent impacts.<sup>4</sup> Relevant studies indicate that the type of treatment employed by the City of Greenfield has been shown to be incapable of removing many classes of Endocrine Disrupting chemicals. The presence of the Baystate Franklin Medical Center facility which discharges pharmaceuticals, medications, controlled substances, diagnostic aid residues, chemotherapy preparations including highly mutagenic cytotoxins, sanitizers, antibiotics, anti-microbials, synthetic hormones, and other classes of medical wastes, to the Greenfield sewer, makes the treated sewage effluent of special concern and highlights the risk of exposure to this complex mix of biologically active chemicals.<sup>5</sup>

Published studies have shown that modern, more advanced treatment of sewage, unlike that now used at the Greenfield WPCP, such as tertiary treatment using actively controlled processes such as ozone treatment, high-energy ultraviolet radiation, activated carbon adsorption, and reverse osmosis, may be capable of removing or destroying many of these contaminants and thereby reduce their concentrations to below detectable limits.<sup>6</sup> However, the simple physical and biological treatment system utilized by the Greenfield Water Pollution Control Facility does not have the ability to completely remove these contaminants of concern. In fact, the Operator of the treatment plant does not routinely monitor for any EDC inputs in the raw wastewater discharges to the sewer, or measure the removal rate efficiencies of the WPCP for any EDC indicator classes.

These so-called "emerging contaminants" have been showing up in drinking water supplies because the surface water intakes are downstream from sewage treatment plant outfalls. These contaminants are also being found in groundwater which is probably being contaminated by residential septic systems. Concentrations of PPCPs, EDCs, and other emerging contaminants are known to be much higher in secondary sewage effluent than in finished drinking water. Yet exposure to the levels being detected in drinking water is still of enough concern that policies are being formulated and additional research is being conducted, to better characterize these low levels of exposure. Many scientists and regulators are very concerned about the effects of long-term exposure to these low-level contaminants because of their known biological activity at extremely small concentrations. Scientific studies have documented measurable biological effects from exposures to some hormones and hormone-mimicking compounds at the low parts per trillion range. Numerous studies now indicate that many endocrine disrupting and hormonally active compounds have a non-monotonic dose response profile which means that the normal linear dose response models are not predictive. Toxicologists have found significant biological responses at extremely low doses, especially during critical time periods in fetal development.<sup>7</sup>

No one would propose that sewage effluent should be served as drinking water to the residents of Greenfield, Turners Falls, and Gill. This would be unacceptable from a public health perspective

and most people would not accept drinking direct sewage plant effluent. A much greater concern is raised by the potential for significantly higher levels of exposure to the contaminants known to occur in sewage effluent, especially due to the nature of the proposed aerosol exposure route.

### **Air-Stripping and Steam-Stripping of Environmental Contaminants**

The proposed cooling towers at the Greenfield incinerator are needed to cool and condense the steam that drives the generating turbine. The towers will dissipate heat by evaporating a large quantity of water (>500 gallons per minute) by spraying sewage effluent over columns of fill material, allowing the liquid to trickle down in the packed columns, while air is drawn up through the material by mechanical ventilation fans. The heat is dissipated by allowing the evaporated water to escape to the atmosphere.<sup>8</sup> This cooling process is very similar to Air-stripping and Steam-stripping, two common treatment methods which are employed to remove environmental pollutants found in contaminated groundwater. Air-stripping<sup>9</sup> is a process that is used to remove volatile compounds from contaminated water through the use of columns that typically consist of countercurrent flows where a low volume of contaminated water is sprayed over media with large surface area while a high volume of air is introduced from the bottom and flows up over the thin water film, transferring the volatile contaminants from the aqueous to the gaseous phase. Since these stripped compounds are often considered hazardous air pollutants, the exhaust from air-strippers may have to be treated to recover the vapors using activated carbon adsorption or some other form of treatment. Many of the highly-volatile compounds in the Greenfield sewage effluent would be reduced during the biological treatment process at the WPCP which uses large trickling filters that act in a manner similar to air-stripper columns, so volatile organic compounds (VOCs) would not be expected in Greenfield effluent.

Steam-stripping<sup>10</sup> is used to remove compounds that have a lower vapor pressure and a higher aqueous solubility. The higher temperature is more appropriate for compounds that can't be removed with air-stripping due to their lower volatility. Steam-stripping is essentially a form of steam distillation which removes or separates different fractions of steam based on the chemical properties of the components. The Greenfield incinerator, using the inadequately-treated sewage effluent, will function as a hybrid steam-stripper / air-stripper, except that all gaseous and volatilized emissions will be intentionally released directly to the ambient air at an elevation of approximately 35 feet above the ground. This contaminated vaporous mixture will be allowed to drift with the wind, or under still atmospheric conditions will be allowed to build up in the local air space. During daylight hours the emitted compounds may be subject to natural ultraviolet bombardment and photo-transformations (photo-chemical smog). During nighttime emissions the volatilized mixture will be subject to condensation as air temperatures decline and the dew-point is lowered. In both cases, many of the stripped compounds will either be deposited in a fall-out zone or will remain in the ambient air, where the concentrations can build up to higher levels. Unpredictable meteorological conditions could lead to the creation of chemical fogs and precipitates containing concentrated xenobiotic compounds. Human and wildlife exposure would be likely from the inhalation of these nebulized and volatilized contaminants from the sewage effluent, as explained below.<sup>11</sup>

## **Exposure- Ingestion versus Inhalation**

Many Toxicologists are now proposing that the long-term chronic exposure to hormone-mimicking and endocrine disrupting compounds, even at the extremely low concentrations found in drinking water, represents an unacceptable risk, especially for pregnant woman, fetuses, and other sensitive and vulnerable populations.<sup>12</sup> However, the inhalation exposure risk could be orders of magnitude or greater than ingestion, based on several factors. The relatively small amounts of water that can be ingested in a day (approximately two quarts), combined with the low starting levels of EDC contaminants in finished drinking water, result in a relatively limited exposure.

The inhalation route, through pulmonary absorption, can raise the exposure levels significantly. Many drugs, like asthma inhalers, can directly and rapidly enter the bloodstream when inhaled. The average normal human lung inhales about a half quart of air with each breath. This volume can vary, depending on the individual and activity levels, but the average is assumed for this example. Normal inhalation rates are about 14 breaths per minute. This equates to roughly 1  $\frac{3}{4}$  gallons per minute of inhaled air, or 2,520 gallons of air inhaled per day. Compared with the exposure from a  $\frac{1}{2}$  gallon of ingested water, the inhalation exposure route is potentially orders of magnitude greater.

Added to the inhalation exposure equation is the fact that between 690,000 to 900,000 gallons per day (gpd) of contaminated sewage effluent will be heated to high temperatures during the wet-cooling process at the Biomass Incinerator, with an estimated 86% of the sewage liquid volatilized into the low-level ambient air. Since this is an intentional or unavoidable exposure source that will be occurring 24 hours per day, 365 days per year, the cumulative exposure will be significant and on-going. This long-term, chronic exposure raises important questions about the risks associated with this constant barrage of contaminants on the residents of Greenfield and surrounding population centers.

## **Risks and Unanswered Questions**

The following questions concerning the chemical fog that will be produced by the wet-cooling process used at the PRE incinerator were submitted to the City of Greenfield during permit hearings and were entered into the public record, but were never addressed by the town. These same questions were sent to MA DEP, but no reply was ever received.<sup>13</sup>

1. What Pharmaceuticals, Personal Care Products, Endocrine Disrupting Compounds, or other Volatile Organic Compounds will be discharged into the air by the use of reclaimed sewage effluent for wet-cooling at this incinerator?
2. What is the effect on the above compounds from chlorination during the disinfection process?
3. What disinfection products will be produced and what compounds will be discharged to the air during the wet-cooling process employing reclaimed sewage effluent?

4. What is the effect of heating the above compounds (Personal Care Products, Endocrine Disrupting Compounds, other Volatile Organic Compounds, Chlorine disinfection byproducts) to the high temperatures encountered during the wet-cooling process?
5. What is the total amount of these compounds that will be emitted every day by the wet-cooling process, assuming that 555 gpm of reclaimed water will be volatilized or nebulized? What is the expected fall-out zone for these compounds?
6. What are the health impacts to citizens, wildlife, and the environment from the constant discharge of Personal Care Products, Endocrine Disrupting Compounds, other Volatile Organic Compounds, and Chlorine disinfection byproducts to the air from the use of reclaimed sewage effluent for wet-cooling of the biomass incinerator?
7. Are any of the above compounds known to cause or exacerbate any medical conditions such as asthma, chronic obstructive pulmonary disease, heart disease, lung diseases, or other commonly occurring disorders? What are the acute risks associated with inhalation of these compounds?
8. What are the long-term health and other impacts associated with inhalation and exposure to these compounds on vulnerable populations such as pregnant women, babies, the elderly, and persons with chronic diseases or compromised immune systems?
9. What are the synergistic effects that can be expected from exposure to multiple compounds?
10. What are the effects of sunlight and ultra-violet radiation on these compounds and are they subject to photo-reactive modification or synthesis?

Concerned citizens have repeatedly requested public officials to address these concerns at public hearings. Some members of the Town Council even stated in public that they were very concerned and some even claimed that they were scared by the potential for impacts to public health from the inhalation of contaminants in sewage effluent, but in the end, all approvals were given without addressing any of the issues raised by these questions.

### **Inadequately Treated and Tested Sewage Effluent**

At a Greenfield Zoning Board of Appeals (ZBA) hearing on 6/25/09, it was emphasized that the sewage effluent would be treated four times; once at the Greenfield WPCP, then at a new treatment plant adjacent to the incinerator, then again (possibly) before discharge to the sewer system, and finally a fourth time when it returns to the WPCP. Disregarding the fact that the treatment at the WPCP is being counted twice, none of the existing or proposed treatment processes being employed are designed to remove the chemicals and compounds that are of greatest concern, the whole range of toxic PPCPs, EDCs, and extremely dangerous cytotoxins that are dissolved in the sewage effluent and pass through these initial treatment processes. At a public hearing before the Town Council subcommittee on ordinances and regulations, it was explained that recycled sewage effluent has been used for cooling at UMass for the past two

years. It was implied that the use of contaminated sewage effluent for wet-cooling was safe, since it was being done at the UMass campus. However, the sewage effluent used at UMass is first purified by a Reverse-Osmosis filtration process and then the purified liquid is used as boiler make-up water in a Combined Heat and Power (CHP) facility.<sup>14</sup> Boiler make up water has to have a high level of purity. The reclaimed UMass effluent is used for a completely different purpose which has no similarity to the proposed use at the Greenfield incinerator, where inadequately-treated effluent would be boiled off into the ground-level air. At the same subcommittee meeting, the question was raised about testing the Greenfield sewage effluent for endocrine disrupting compounds, but the committee was told that such testing is difficult, expensive, time consuming, and is not done at the Greenfield WPCP. The committee was told that the Greenfield effluent is tested by a better method which employs a sensitive bioassay using Fathead Minnows (*Pimephales promelas*). It was claimed that since all of the minnows survive in the sewage effluent for 96 hours, this proves that the Greenfield effluent is safe for use by the incinerator. What was not explained was that the Fathead Minnow bioassay is a test used to measure gross acute toxicity for fish and is not designed to measure the presence of hormonally active chemicals in the wastewater or the effects of long-term exposure to these compounds. It is the constant exposure to these chemicals, even at extremely low concentrations, that is of concern. The Fathead Minnow test has no relevance to the issue of chronic exposure to PPCPs, EDCs, and other toxic compounds.

After the ZBA approval was given, Greenfield's Mayor convened a taskforce of fact-finding "experts" to review all facets of the proposed incinerator. This effort focused on collecting individual opinions from local "experts". These opinion letters and emails were combined into a 23-page taskforce report, broken down by subject: Traffic, Fuel Supply, Water and Wastewater Issues, Economic Impacts, Site Analysis, and Property Values.<sup>15</sup> The "Property Values" report submitted by William T. Finn (page 23), contained four sentences. Published professional studies provide examples of the types of analyses that can be done to estimate the effects that incinerators and other similar projects -toxic waste sites, environmental contamination (brownfields), and concentrated livestock facilities (CAFOs)- can have on local property values.<sup>16</sup> The "Economic Impacts" report consisted of an email from Henry Hardy containing a single sentence describing the economic upside of the project. A similar approach was taken for the other topics as well. The discussion of wastewater issues contains not a single mention of the PPCPs, EDCs, and other toxic contaminants in the sewage effluent.

Since no local air-quality "expert" could be found, the Mayor hired a consulting firm, GZA GeoEnvironmental, to review the information on air quality and sound impacts produced by Epsilon Associates and submitted by the applicant as part of the Environmental Notification Form (ENF). In consultation with the applicant, GZA produced an 8-page report titled "Independent Review of Air Quality Impact Analysis and Noise Study Performed in Support of Pioneer Renewable Energy Facility".<sup>17</sup> It should be noted that the applicant's ENF information stated that only "100% pure water vapor" will be released by the cooling towers, but this unsubstantiated statement was not addressed in the GZA review. Since Madera Energy submitted no analysis or information concerning the PPCPs, EDCs, and toxic chemicals that will be emitted by vaporizing contaminated sewage effluent, GZA didn't have anything to review regarding the use of recycled contaminated sewage effluent, and the topic wasn't addressed in their review, even though the issue had been continuously raised in public testimony.

The legitimate public concerns about the degraded air-quality, toxic exposures, and health impacts from volatilizing hundreds of gallons per minute of contaminated sewage effluent were not addressed by the Mayor's "expert's study" nor by the GZA "independent report". An honest analysis of the obvious risks to the public has yet to be conducted.

### **Known Risk Factors**

Pharmaceuticals and many classes of over-the-counter drugs and prescription medications are intentionally designed to have significant biological effects at extremely low doses. Modern anti-cancer or chemo-therapy drugs are so toxic that the Occupational Safety and Health Administration (OSHA) regulations allow a zero-tolerance for exposure during manufacturing and administration of the drugs. The National Institute for Occupational Safety and Health (NIOSH) gives the following caution in its publication [Preventing Occupational Exposures to Antineoplastic and Other Hazardous Drugs in Health Care Settings](#) :“Warning! Working with or near hazardous drugs in health care settings may cause skin rashes, infertility, miscarriage, birth defects, and possibly leukemia or other cancers.” What is the risk associated with the long-term, constant inhalation or inadvertent ingestion of these extremely toxic drugs and active pharmaceutical ingredients discharged from Franklin Medical Center, other medical offices, veterinary clinics, and similar sources which may be present in the inadequately treated sewage effluent? Therapeutic exposures to extremely toxic drugs are considered to be beneficial when used to treat a disease or its symptoms, even if the treatment for an existing cancer may result in an increased likelihood of genetic damage and the development of other unrelated cancers later in life. Such uses follow the informed-consent standard and all medications are required to be accompanied by extensive caution statements and descriptions of known or possible side-effects. Unintentional exposures are often felt to be an unwelcome intrusion and something which the exposed person would never voluntarily give consent for. Such exposures are often perceived as negative, can cause distress, and may result in harm without providing any direct positive benefit.<sup>18</sup>

Exposure to toxic contamination can be measured in numerous ways, such as acute, chronic, cumulative, and in other more complex and technical ways. The use of many toxic medications, such as the blood thinner Coumadin which is also the rat-poison Warfarin, must be monitored very carefully in order to prevent a toxic exposure that could injure or kill the patient. Unintentional exposures to toxins are not carefully controlled, although the recent development of “bio-monitoring” techniques has increased the knowledge of our widespread exposure and subsequent “Body Burden” of synthetic industrial chemicals.<sup>19</sup> While we now know that we are unwillingly being exposed to all manner of toxic compounds, the risks associated with these chemicals is not clear.

The key concept to understand about the risks associated with contaminant exposure can be summarized by the following equation:

$$\text{Risk} = \text{Toxicity} * \text{Exposure}$$

The harm done to the exposed organism further depends on the individual susceptibility which varies by species, age, sex, health level, genetic predisposition, and other factors.<sup>20</sup> It is well known that babies and children are most at risk from low levels of lead exposure which may cause permanent neurological impairment and life-long learning disabilities. Another example of this is the individual variability to bee stings or peanut allergies. Some individuals or entire classes of people may be more sensitive than others. This information has to be taken into consideration when attempting to characterize risks and assess potential impacts.

The above equation shows that even for things with very low toxicity, long-term exposure can eventually result in significant risk. Cigarette smoke is a good example, as smoking a single cigarette is not likely to kill someone, but long-term smoking is known to result in all sorts of increased risks for heart disease, lung disease, and various cancers. The best approach to take when the toxicity of compounds is suspected is to utilize methods of personal protection, such as that used by first responders when they show up at the scene of a chemical spill, or to use management techniques that greatly minimize or completely eliminate exposure. Common sense and numerous laws require that known exposures must be managed to reduce the risks to workers and the general public. No attempts were made by the applicant or the City of Greenfield to identify or characterize the toxic exposure that will occur due to the use of contaminated sewage, and no effort has been made to address the expected risk management issues.

### **Inappropriate Use of Sewage Effluent**

The City of Greenfield is now very aware of the serious concerns associated with the use of contaminated sewage effluent. Even after repeated requests, all levels of government have failed to address the issue. The decision makers have acted as if the problem does not exist, even after hearing hours of testimony from dozens of concerned citizens who repeatedly raised the issue of volatilizing large quantities of sewage effluent contaminated by dangerous pharmaceuticals, endocrine disrupting compounds and hormonally active chemicals. The use of contaminated Greenfield sewage effluent in the wet-cooling process can be classified as an inappropriate use. Based on the characteristics of the contaminated material, and the fact that it is being sold for an inappropriate purpose, the effluent could be legally classified as a defective product.

This means that the city of Greenfield could be selling an intentionally defective product, contaminated wastewater, for a use for which it is clearly unsuitable. Such use could be a contributing factor to an illness, death, or other manifestation such as birth defects or fetal impairment. This inappropriate use could subject several classes of vulnerable individuals to injurious exposure to known carcinogens, mutagens, suspected teratogens (a drug or other substance capable of interfering with the development of a fetus, causing birth defects), and other hormonally active and endocrine disrupting compounds.

The scientific literature on this subject is still expanding, but extensive published studies have already concluded that intentional exposures to these hormone-mimicking agents would constitute serious risk due to the constant nature of the inhalation route.<sup>21</sup> The classes of those potentially exposed would include, but not be limited to: pregnant women; all women of

childbearing age; women who develop breast cancer; children with learning disabilities and developmental delay; asthmatics; chemically-sensitive individuals; persons with compromised immune systems due to AIDS or auto-immune disease (IBD, GBS, Lupus, MS, etc.); chronic disease sufferers (cancer, copd, diabetes, liver disease, heart disease); overweight and obese individuals; patients taking psychoactive medications for treatment of chemical imbalances; men suffering from prostate cancer or enlarged prostate syndrome (BPH); organ transplant recipients taking immuno-suppressing drugs; and patients undergoing chemotherapy treatments.

## **Regulatory Perspective**

### **A. Local Sewer Use Regulations:**

Use of sewage effluent in a manner that intentionally degrades air quality and creates a public health nuisance is clearly in violation of the spirit and intent of Greenfield's sewer use regulations. Article I, Purpose and Policy, (b), states that "The objectives of these regulations are: To prevent the introduction of pollutants into the municipal wastewater system which will pass through the system, inadequately treated, into receiving water *or the atmosphere...*" (emphasis added).

### **B. State Regulations:**

The MA DEP has issued guidance for the reuse of wastewater in a document titled Revised Interim Guidance: Effective Date – 1/3/00.<sup>22</sup> It is the stated policy of DEP that:

"The water quality criteria for the treated wastewater is extremely rigorous, requiring that reclaimed water be virtually pathogen and contaminant free."  
"Best Management Practices aimed at minimizing direct human exposure will be required of all projects."

The guidance further states:

"...encourage the innovative reuse of treated wastewater while continuing to consider the public's health as the controlling factor...by: controlling chemical contaminants; limiting public exposure; maintaining levels of chemicals and pathogens so that they pose no appreciable risk of harm to health or the environment, considering both planned and occasional unplanned exposure or changes in site conditions and use; and implementation of site specific best management practices and public awareness programs that promote safe use."

The City of Greenfield has not addressed the above policy which requires consideration of the public's health, and instead intends to expose the public to large quantities of sewage effluent while doing nothing to address the appreciable risk of harm to health or the environment. The guidance also includes a section on the requirements for "Public Awareness" for any reclaimed water use project:

"Experience nationally demonstrates that an early, open, and thorough public awareness effort on the part of entities utilizing reclaimed water is very effective in diminishing

the fears and suspicions frequently encountered when considering the use of reclaimed water.

To promote consumer acceptance of reclaimed water, the DEP recommends that purveyors and end users continually inform the public, especially potential users, of project status as regulatory and infrastructure decisions are being formulated. This should aid in the public's understanding of the safeguards and rigorous consideration the project is being given and will provide a sense of involvement and inclusion."

The City of Greenfield has chosen to ignore the DEP requirements for public involvement and consumer acceptance. Instead the City has followed a process which seemed to ignore, belittle, disregard, misdirect, dismiss, and alienate the public.

The MA DEP has codified the reuse of sewage effluent in the regulations<sup>23</sup> found at 314 CMR 20.00 which specifically allow the reuse of reclaimed effluent at 20.17(1)(a) 2. Cooling Water:

Class A reclaimed water may be used for industrial or commercial cooling or air conditioning where aerosols or other mists are created, including, without limitation, cooling towers, evaporative condensers, or spray mechanisms. When a cooling system uses Class A reclaimed water in conjunction with an air conditioning facility that utilizes a cooling tower or otherwise creates a mist that may come into contact with employees or members of the public, the cooling system shall comply with the following:

- a. drift eliminator shall be used whenever the cooling system is in operation.
- b. Chlorine or other biocide shall be used to treat the cooling system recirculating water to minimize the growth of LEGIONELLA and other microorganisms.

However, this is the only section of the DEP regulations that mentions the reuse of sewage effluent in cooling towers and nowhere in the regulations are the terms "pharmaceuticals", "personal care products", endocrine disrupting compounds", hormonally active", or "emerging contaminants" found. Overall the DEP regulations predominantly envision the reuse of reclaimed sewage water for agricultural irrigation, landscaping use, car washing, toilet flushing, and groundwater recharge. The vaporization and volatilization of hundreds of gallons of sewage effluent per minute for wet-cooling of incinerators does not seem to have been envisioned when these regulations were written. The controversial topic of PPCPs and EDCs in sewage effluent is likewise not addressed by these regulations.

Still, the regulations give DEP the ability to apply the standards found at 20.17: Special Permit Conditions, (10) Other Special Conditions which allows that the "Department may also require the implementation of specific source control and pollution prevention measures and other best management practices aimed at protecting water quality, the public health and the environment." Even though the regulations were not written to address the specific type of sewage effluent reuse that is proposed in Greenfield, and the scale of exposure that would result from this use, there is sufficient language in the regulations to preclude this use based on unacceptable risk to public health and the environment.

### **C. Abatement of Public Nuisance laws:**

The Greenfield Board of Health has the authority to regulate the discharge of contaminants to the air under M.G.L. Chapter 111 Section 31C:<sup>24</sup>

“A board of health, or other legal authority constituted for such purpose by vote of the town or city council shall have jurisdiction to regulate and control atmospheric pollution, including, but not limited to, the emission of smoke, particulate matter, soot, cinders, ashes, toxic and radioactive substances, fumes, vapors, gases, industrial odors and dusts as may arise within its bounds and which constitutes a nuisance, a danger to the public health, or impair the public comfort and convenience.”

In addition, the proposed use of sewage effluent must be approved by the Greenfield Board of Health before it can be approved by the MA DEP. Pursuant to M.G.L. Chapter 111: Section 143, NOISOME TRADES:<sup>25</sup>

“Trade or employment attended with noisome and injurious odors; assignment of places; prohibition; appeal

Section 143. No trade or employment which may result in a nuisance or be harmful to the inhabitants, injurious to their estates, dangerous to the public health, or may be attended by noisome and injurious odors shall be established in a city or town except in such a location as may be assigned by the board of health thereof after a public hearing has been held thereon, subject to the provisions of chapter forty A and such board of health may prohibit the exercise thereof within the limits of the city or town or in places not so assigned, in any event. Such assignments shall be entered in the records of the city or town, and may be revoked when the board shall think proper.”

The Greenfield Board of Health can also find that the specific type of sewage effluent reuse that is proposed in by Pioneer Renewable Energy, and the scale of the exposure that would result from this use, represents an unacceptable risk to public health and the environment. The Board could either deny the discharge of the pollutants from the cooling towers by enacting regulations, or it could refuse to assign the proposed site as suitable for the intended use, based on the unacceptable inhalation exposure that will occur from the gaseous and aerosol discharges emitted during the wet-cooling process. The applicant must come before the Board of Health and request a site assignment and the Board must hold a Public Hearing to discuss the proposed use of contaminated sewage effluent for wet-cooling at the incinerator.

### **Summary**

In summary, while many communities and state and local governments are developing innovative ways to significantly reduce or eliminate toxic material use and exposure, the City of Greenfield is developing an industrial process that will expose thousands of people to uncontrolled toxic emissions of pharmaceuticals, drugs, medications, personal care products, endocrine disrupting compounds, persistent organic pollutants, and other dangerous chemicals.<sup>26</sup>

Extensive public comments about the dangers of using contaminated sewage effluent have been ignored, public officials have tried to downplay the risks, and permits have been approved without a clear understanding of the complex toxicology involved, because the City has not undertaken a truly independent expert review. Although overwhelming evidence and extensive scientific literature clearly indicates that our society needs to do everything it can to reduce our exposure to toxic materials, the proposed use of contaminated sewage effluent will result in constant and sustained toxic exposure for entire classes of vulnerable persons without the individual's awareness or consent.

The City of Greenfield decision makers have not addressed these legitimate concerns in any substantive manner, have issued approvals and permits without conducting any truly independent analyses, and have excluded the public from the decision making process. The public continues to express its concerns that widespread, serious, and negative impacts to public health and the environment may result from the use of inadequately treated sewage effluent.

The Precautionary Principle<sup>27</sup> states:

"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically." *from the January 1998 Wingspread Statement on the Precautionary Principle*

The Precautionary Principle is featured in the two major reference papers that the MA DEP has posted on its web site about PPCPs and EDCs.<sup>28</sup> The City of Greenfield and the DEP need to carefully consider the precautionary approach and apply this principle as they consider approval of the use of contaminated sewage effluent in a way that will result in widespread exposure, unquantified environmental contamination, and unmanaged risks.<sup>29</sup>

By far, the most sensible approach when dealing with the contaminants found in partially treated sewage effluent is to avoid exposing large numbers of the population to these unnecessary risks. If no other feasible alternative exists, then every practical effort should first be taken to reduce the levels of toxic contaminants entering the sewage flows, through source reduction, drug stewardship programs, and public education, then appropriate methods of advanced treatment should be studied and employed to ensure that the effluent is properly treated and filtered to remove all remaining toxic and hormonally active-compounds. This proposal to use inadequately treated sewage effluent in a manner that will release dangerous contaminants into the ground level air is ill-conceived, inadequately studied, and should not be approved without a thorough analysis and extensive public participation in the decision-making process.

## **Endnotes**

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<sup>1</sup> These measurements are used to characterize wastewater. BOD –biochemical oxygen demand, is a measure of the simple food value or strength of the wastewater; TSS –total suspended solids, is a gross measure of the cleanness of the water or thoroughness of particulate matter removal during the treatment process.

<sup>2</sup> See 02A-Greenfield WPCP overview, 02B-EPA fact sheet, and 02C-NPDES permit

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<sup>3</sup> See 03A-Down the Drain, <http://www.ewg.org/book/export/html/20919> ; 03B-Pharmaceuticals in Treated Wastewater Effluent, <http://ga.water.usgs.gov/nawqa/moll.pdf> ; 03C-Persistence of pharmaceutical compounds, <http://www.neiwpc.org/ppcpconference/ppcp-docs/PaulStackelberg/Stackelberg%20et%20a%202007.pdf> ; 03D-PipeLine\_PPCCP overview, [http://www.nesc.wvu.edu/old\\_website/nsfc/pdf/pipline/PL\\_wi07.pdf](http://www.nesc.wvu.edu/old_website/nsfc/pdf/pipline/PL_wi07.pdf) ; and 03E-Proceedings of the 2nd International Conference on Pharmaceuticals and Endocrine Disrupting Chemicals in Water October 9-11, 2001, Minneapolis, Minnesota

<sup>4</sup> See 04A-Testimony by Kyla Bennett, [www.peer.org/docs/ma/08\\_12\\_5\\_ppcp\\_testimony.pdf](http://www.peer.org/docs/ma/08_12_5_ppcp_testimony.pdf) , 04B-PEER position paper, and 04C-Peer Analysis: EPA Dropping the Ball, [http://www.peer.org/docs/epa/08\\_19\\_3\\_analysis\\_of\\_epa\\_ppcp\\_duties.pdf](http://www.peer.org/docs/epa/08_19_3_analysis_of_epa_ppcp_duties.pdf) ; 04C-04C-Minnesota EDC Report, [www.pca.state.mn.us/publications/reports/lrp-ei-1sy08.pdf](http://www.pca.state.mn.us/publications/reports/lrp-ei-1sy08.pdf)

<sup>5</sup> See 05A-info about a treatment process that is **not** used at Franklin Medical Center, <http://www.sciencedaily.com/releases/2007/12/071206231740.htm> ; 05B-Hazardous Chemicals in the Health Care Profession, <http://www.psr.org/assets/pdfs/hazardous-chemicals-in-health-care.pdf> ; 05C-Chemical & Engineering News-Contained Chemistry, <http://pubs.acs.org/cen/coverstory/86/8624cover.html> ; and 05D-Chemical & Engineering News- One Pill, Many Uses, <http://pubs.acs.org/cen/coverstory/85/8534cover.html>

<sup>6</sup> See 06A-Treatment to Remove Endocrine Disrupters, <http://www.springerlink.com/content/t706uq4j5r452152/> ; 06B-Removal of EDCs during water treatment, <http://www.epa.gov/nrmrl/pubs/625r00015/625r00015.pdf> ; 06C- - removal of Endocrine disruptors by membranes and activated carbon; 06D- TrojanUV Environmental Contaminant Treatment, [http://www.trojanuv.com/resources/trojanuv//Products/TrojanUVPhox/ECT\\_Brochure\\_NEW\\_LR.pdf](http://www.trojanuv.com/resources/trojanuv//Products/TrojanUVPhox/ECT_Brochure_NEW_LR.pdf) ; 06E-Removal of Natural Estrogens and Synthetic Compounds, <http://www.pjoes.com/pdf/15.1/35-40.pdf> ; and 06F-The Occurrence and Fate of Pharmaceuticals, Personal Care Products and Endocrine Disrupting Compounds in a Municipal Water Use Cycle: A Case Study in the City of Ann Arbor, [http://www.a2gov.org/government/publicservices/water\\_treatment/Documents/EndocrineDisruptors.pdf](http://www.a2gov.org/government/publicservices/water_treatment/Documents/EndocrineDisruptors.pdf)

<sup>7</sup> See 07A-Body Burden: The Pollution in Newborns <http://www.ewg.org/reports/bodyburden2/execsumm.php> ; 07B-There is No “Away”, [www.cielap.org/pdf/NoAway.pdf](http://www.cielap.org/pdf/NoAway.pdf) ; 07C-Pharmaceuticals as Environmental Pollutants-EoPH2008, <http://www.epa.gov/nerlesd1/bios/daughton/EoPH2008.pdf> ; and 07D-Analysis of Ecologically Relevant Pharmaceuticals in wastewater, <http://environmentalhealthcollaborative.org/images/batt-ecopharms.pdf>

<sup>8</sup> See 08-PRE ENF, Appendix F-Air Quality, <http://www.pioneerrenewableenergy.com/wp/wp-content/uploads/2009/03/appendixb-airquality.pdf>

<sup>9</sup> See 09A-EPA Guide to Air Stripping, <http://clu-in.org/download/citizens/airstripping.pdf>

<sup>10</sup> See 10-Steam Stripping brochure, [www.jaeger.com/Brochure/steamstripping.pdf](http://www.jaeger.com/Brochure/steamstripping.pdf)

<sup>11</sup> See 11-ENDOCRINE DISRUPTORS IN THE ENVIRONMENT, <http://www.iupac.org/publications/pac/2003/pdf/7505x0631.pdf>

<sup>12</sup> See 12-Good Genes Gone Bad, <http://www.prospect.org/cs/articles?articleId=11315>

<sup>13</sup> These questions were submitted to the Greenfield ZBA on 6/15/09 & 6/25/09, and to MA DEP on 6/11/09.

<sup>14</sup> See 14-UMass Sewage Reuse summary, <http://www.districtenergy.org/pdfs/08CampConference/Proceedings/5A3MathewsIDEACampus08.pdf>

<sup>15</sup> See 15-Mayor’s Task Reports except GZA

<sup>16</sup> See 16A- Brownfields and Property Values, [www.epa.gov/ncer/publications/workshop/pdf/EE-0428-01.pdf](http://www.epa.gov/ncer/publications/workshop/pdf/EE-0428-01.pdf) ; 16B- Hazardous waste sites and Housing Appreciation Rates, <http://www.ses.wsu.edu/PDFFiles/JournalArticle/McCluskey/Housing%20Appreciation%20Rates.pdf> ; 16C-The Impact of Livestock Facilities on Rural Residential Property Values, <http://www.card.iastate.edu/publications/DBS/PDFFiles/03wp342.pdf> ; 16D-Toxic Sites and Housing Appreciation Rates, [http://www.holycross.edu/departments/economics/RePEc/Kiel\\_Woburn.pdf](http://www.holycross.edu/departments/economics/RePEc/Kiel_Woburn.pdf) ; 16E-Kiel\_HouseValues,

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[http://www.holycross.edu/departments/economics/RePEc/Kiel\\_HouseValues.pdf](http://www.holycross.edu/departments/economics/RePEc/Kiel_HouseValues.pdf) ; and The Effect of an Incinerator Siting on Housing Appreciation Rates (available on-line by subscription only), <http://www.sciencedirect.com/science/article/B6WVG-45R8GBT-V/2/a30035a63147fcd517ca4d63e4c1dd8f>

<sup>17</sup> See 17A- GZA Scope of Work 8-24-09 email exchange, and 17B-GZA Air Pollution Report, [http://www.montaguema.net/Content/NetSite\\_720/ groups/208/files/GZA\\_air\\_pollution\\_report.pdf](http://www.montaguema.net/Content/NetSite_720/ groups/208/files/GZA_air_pollution_report.pdf)

<sup>18</sup> See 18A-Agents of Subtle Change, <http://www.ehponline.org/members/1999/suppl-6/907-938daughton/daughton-full.html> ; 18B-Preventing Occupation Exposure to Antineoplastic & Other Haz Drugs, <http://origin.cdc.gov/niosh/docs/2004-165/pdfs/2004-165.pdf> ; 18C-Preventing Occupational Exposures to Antineoplastic Drugs, <http://caonline.amcancersoc.org/cgi/reprint/56/6/354.pdf> ; 18D-Chemo Agents Mgt and Disposal , [http://www.medserve.com/ filelib/FileCabinet/Envirosolve/Chemo\\_Agents\\_Mgt\\_and\\_Disposal\\_5.3.07.pdf](http://www.medserve.com/ filelib/FileCabinet/Envirosolve/Chemo_Agents_Mgt_and_Disposal_5.3.07.pdf) ; and 18E-Safe Handling of Hazardous Drugs, <http://www.nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Vol9me92004/No3Sept04/HazardousDrugs.aspx> ; , [http://www.osha.gov/dts/osta/otm/otm\\_vi/otm\\_vi\\_2.html](http://www.osha.gov/dts/osta/otm/otm_vi/otm_vi_2.html) ;

<sup>19</sup> See 19-EWG Body Burden, [http://archive.ewg.org/reports/bodyburden1/pdf/BBreport\\_final.pdf](http://archive.ewg.org/reports/bodyburden1/pdf/BBreport_final.pdf)

<sup>20</sup> See 20A-Does the Dose Make the Poison? [http://www.endocrinedisruption.com/files/2007-04-30\\_does\\_the\\_dose\\_make\\_the\\_poison.pdf](http://www.endocrinedisruption.com/files/2007-04-30_does_the_dose_make_the_poison.pdf)

<sup>21</sup> See 21A-Endocrine disrupting chemicals in indoor and outdoor air, [http://s20428.gridserver.com/pdf/our\\_publications/Rudel\\_RA2009.pdf](http://s20428.gridserver.com/pdf/our_publications/Rudel_RA2009.pdf) ; 21B-Comments on Medical Waste Incinerator Regulations, (not available on-line); and 21C-The Significance of Factors beyond Direct Excretion to Sewers (available on-line by subscription only)

<sup>22</sup> See 22-DEP Policy #: BRP/DWM/PeP-P00-3, <http://www.mass.gov/dep/water/reuse.pdf>

<sup>23</sup> See 23-314 CMR 20.00: Reclaimed Water Permit Program and Standards - Promulgated March 2009, <http://www.mass.gov/dep/service/regulations/314cmr20.pdf>

<sup>24</sup> See 24A-Chapter 111- Section 31C -Atmospheric pollution, <http://www.mass.gov/legis/laws/mgl/111-31c.htm> , and 24B-DEP c.111 s. 31c Guidance, <http://www.mass.gov/dep/air/laws/31cguid.pdf>

<sup>25</sup> See 25-Chapter 111, Section 143 -Noisome Trades, <http://www.mass.gov/legis/laws/mgl/111-143.htm>

<sup>26</sup> See 26A-Beyond the Medicine Cabinet, <http://www.epa.gov/nerlesd1/bios/daughton/EnvInt2008.pdf>; 26B- Pharmaceuticals in the Environment-Sources and Their Management, [http://www.epa.gov/nerlesd1/bios/daughton/Chap1\\_Petrovic&Barcelo.pdf](http://www.epa.gov/nerlesd1/bios/daughton/Chap1_Petrovic&Barcelo.pdf) ; 26C-Drug Usage and Disposal-Daughton, [http://environmentalhealthcollaborative.org/images/Daughton\\_RT\\_Environmental\\_Health\\_Collaborative\\_-\\_presentation\\_%2820Oct08%29.pdf](http://environmentalhealthcollaborative.org/images/Daughton_RT_Environmental_Health_Collaborative_-_presentation_%2820Oct08%29.pdf)

<sup>27</sup> See 27-Precautionary Principle Handbook, <http://www.biotech-info.net/handbook.pdf>

<sup>28</sup> See 28-DEP Web Page, <http://www.mass.gov/dep/toxics/ppc.htm#research> ; 28A-Pharmaceuticals in the Water: A Look at an Emerging & Pressing Issue, Report by Executive Office of Energy & Environmental Affairs intern & Brandies University student Nina Savransky, <http://www.mass.gov/dep/toxics/stypes/pharmh2o.pdf> ; 28B- Investigating Emergent Contaminants: Pharmaceutical Impacts & Possible Solutions 2007, Prepared by Leah Bowe as part of a research project funded by the Rappaport Institute for Greater Boston, Kennedy School of Government, Harvard University, [http://www.mass.gov/dep/toxics/stypes/ec\\_bowe.pdf](http://www.mass.gov/dep/toxics/stypes/ec_bowe.pdf) .

<sup>29</sup> See 29-Water Reuse and Health Risks – Real vs Perceived, S. Toze, (available on-line by subscription only), [http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6TFX-4J444DP-8&\\_user=10&\\_rdoc=1&\\_fmt=&\\_orig=search&\\_sort=d&\\_docanchor=&\\_view=c&\\_searchStrId=1103880397&\\_rerunOrigin=google&\\_acct=C000050221&\\_version=1&\\_urlVersion=0&\\_userid=10&md5=7cef646cbedd1195f9efa936e9f6c81](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TFX-4J444DP-8&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&_view=c&_searchStrId=1103880397&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=7cef646cbedd1195f9efa936e9f6c81)

## MEDICINES RECOMMENDED FOR DISPOSAL BY FLUSHING

This list from FDA tells you what unused or expired medicines you should flush down the sink or toilet to help prevent danger to people and pets in the home. Flushing these medicines will get rid of them right away and help keep your family and pets safe. FDA continually evaluates medicines for safety risks and will update the list as needed.

<i>Medicine</i>	<i>Active Ingredient</i>
<b>Actiq</b> , oral transmucosal lozenge	Fentanyl Citrate
<b>Avinza</b> , capsules (extended release)	Morphine Sulfate
<b>Daytrana</b> , transdermal patch system	Methylphenidate
<b>Demerol</b> , tablets *	Meperidine Hydrochloride
<b>Demerol</b> , oral solution *	Meperidine Hydrochloride
<b>Diastat/Diastat AcuDial</b> , rectal gel	Diazepam
<b>Dilaudid</b> , tablets *	Hydromorphone Hydrochloride
<b>Dilaudid</b> , oral liquid *	Hydromorphone Hydrochloride
<b>Dolophine Hydrochloride</b> , tablets *	Methadone Hydrochloride
<b>Duragesic</b> , patch (extended release) *	Fentanyl
<b>Embeda</b> , capsules (extended release)	Morphine Sulfate; Naltrexone Hydrochloride
<b>Fentora</b> , tablets (buccal)	Fentanyl Citrate
<b>Kadian</b> , capsules (extended release)	Morphine Sulfate
<b>Methadone Hydrochloride</b> , oral solution *	Methadone Hydrochloride
<b>Methadose</b> , tablets *	Methadone Hydrochloride
<b>Morphine Sulfate</b> , tablets (immediate release) *	Morphine Sulfate
<b>Morphine Sulfate</b> , oral solution *	Morphine Sulfate
<b>MS Contin</b> , tablets (extended release) *	Morphine Sulfate
<b>Onsolis</b> , soluble film (buccal)	Fentanyl Citrate
<b>Opana</b> , tablets (immediate release)	Oxymorphone Hydrochloride
<b>Opana ER</b> , tablets (extended release)	Oxymorphone Hydrochloride
<b>Oramorph SR</b> , tablets (sustained release)	Morphine Sulfate
<b>Oxycontin</b> , tablets (extended release) *	Oxycodone Hydrochloride
<b>Percocet</b> , tablets *	Acetaminophen; Oxycodone Hydrochloride
<b>Percodan</b> , tablets *	Aspirin; Oxycodone Hydrochloride
<b>Xyrem</b> , oral solution	Sodium Oxybate

\*These medicines have generic versions available or are only available in generic formulations. List revised: August 2009 From:

<http://www.fda.gov/Drugs/ResourcesForYou/Consumers/BuyingUsingMedicineSafely/EnsuringSafeUseofMedicine/SafeDisposalofMedicines/ucm186187.htm>

**Antineoplastic Agents That are Classified as Known or Probable Human Carcinogens,**  
Adapted from the International Agency for Research on Cancer.

**Group 1 (Human Carcinogens)**

Arsenic trioxide  
Azathioprine  
Chlorambucil  
Chlornaphazine  
Cyclophosphamide  
Myleran  
Melphalan  
Semustine  
Tamoxifen  
Thiotepa  
Treosulfan  
Mustargen-Oncovin-Procarbazine-Prednisone (MOPP)  
Etoposide-Cisplatin-Bleomycin (ECB)

**Group 2A (Probable Human Carcinogens)**

Azacitidine  
BCNU  
CCNU  
Chlorozotocin  
Cisplatin  
Doxorubicin HCl  
N-Ethyl-N-nitrosourea  
Etoposide  
Mechlorethamine HCl  
N-Methyl-nitrosourea  
Procarbazine HCl  
Teniposide

**Antineoplastic Agents That are Classified as Pregnancy Category D\* or X†**

Drug	Drug	Drug	Drug
Arsenic trioxide D	Azathioprene D	Bleomycin D	Capecitabine D
Carboplatin D	Carmustine D	Chlorambucil D	Cisplatin D
Cladribine D	Cyclophosphamide D	Cytarabine D	Dactinomycin D
Daunorubicin HCl D	Docetaxel D	Doxorubicin HCl D	Epirubicin D
Etoposide D	Floxuridine D	Fludarabine D	Fluorouracil D
Gemcitabine D	Hydroxyurea D	Imatinib mesylate D	Interferon alfa-2b X
Irinotecan HCl D	Ibritumomab tiuxetan D	Idarubicin D	Ifosfamide D
Leflunomide X	Lomustine D	Mechlorethamine HCl D	
Melphalan D	Mercaptopurine D	Methotrexate X	Mitoxantrone HCl D
Oxaliplatin D	Paclitaxel D	Pipobroman D	Procarbazine D
Tositumomab X	Tamoxifen D	Temozolomide D	Teniposide D
Thalidomide X	Thioguanine D	Thiotepa D	Topotecan D
Vinblastine sulfate D	Vincristine sulfate D	Vinorelbine tartrate D	

-Adapted from the US Food and Drug Administration Center for Drug Evaluation and Research.

\*D = There is clear evidence of risk to the human fetus, but the benefits may outweigh the risk for pregnant women who have a serious condition that cannot be treated effectively with a safer drug.

†X = There is clear evidence that the medication causes abnormalities in the fetus. The risks outweigh any potential benefits for women who are (or may become) pregnant.

From: <http://caonline.amcancersoc.org/cgi/reprint/56/6/354.pdf>

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**APPENDIX VI: 2-1. SOME COMMON DRUGS THAT ARE CONSIDERED HAZARDOUS. –From OSHA TECHNICAL MANUAL - SEC VI Chap 2**

Appendix VI:2-1 is not all-inclusive, should not be construed as complete, and represents an assessment of some, but not all, marketed drugs at a fixed point in time. Appendix VI:2-1 was developed through consultation with institutions that have assembled teams of pharmacists and other health care personnel to determine which drugs should be handled with caution. These teams reviewed product literature and drug information when considering each product. Sources for this appendix are the "Physicians Desk Reference," Section 10:00 in the *American Hospital Formulary Service Drug Information*, IARC publications (particularly Volume 50), the Johns Hopkins Hospital, and the National Institutes of Health, Clinical Center Nursing Department. No attempt to include investigational drugs was made, but they should be prudently handled as hazardous drugs until adequate information becomes available to exclude them. Any determination of the hazard status of a drug should be periodically reviewed and updated as new information becomes available. Importantly, new drugs should routinely undergo a hazard assessment.

<b>CHEMICAL/GENERIC NAME</b>	<b>SOURCE*</b>
ALTRETAMINE	C
AMINOGLUTETHIMIDE	A
AZATHIOPRINE	ACE
L-ASPARAGINASE	ABC
BLEOMYCIN	ABC
BUSULFAN	ABC
CARBOPLATIN	ABC
CARMUSTINE	ABC
CHLORAMBUCIL	ABCE
CHLORAMPHENICOL	E
CHLOROTIANISENE	B
CHLOROZOTOCIN	E
CYCLOSPORIN	E
CISPLATIN	ABCE
CYCLOPHOSPHAMIDE	ABCE
CYTARRABINE	ABC
DACARBAZINE	ABC
DACTINOMYCIN	ABC
DAUNORUBICIN	ABC
DIETHYLSTILBESTROL	BE
DOXORUBICIN	ABCE
ESTRADIOL	B
ESTRAMUSTINE	AB
ETHINYL ESTRADIOL	B
ETOPOSIDE	ABC
FLOXURIDINE	AC
FLUOROURACIL	ABC
FLUTAMIDE	BC

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**SOME COMMON DRUGS THAT ARE CONSIDERED HAZARDOUS (con't).**

<b>CHEMICAL/GENERIC NAME</b>	<b>SOURCE*</b>
GANCICLOVIR	AD
HYDROXYUREA	ABC
IDARUBICIN	AC
IFOSFAMIDE	ABC
INTERFERON-A	BC
ISOTRETINOIN	D
LEUPROLIDE	BC
LEVAMISOLE	C
LOMUSTINE	ABCD
MECHLORETHAMINE	BC
MEDROXYPROGESTERONE	B
MEGESTROL	BC
MELPHALAN	ABCE
MERCAPTOPYRINE	ABC
METHOTREXATE	ABC
MITOMYCIN	ABC
MITOTANE	ABC
MITOXANTRONE	ABC
NAFARELIN	C
PIPOBROMAN	C
PLICAMYCIN	BC
PROCARBAZINE	ABCE
RIBAVIRIN	D
STREPTOZOCIN	AC
TAMOXIFEN	BC
TESTOLACTONE	BC
THIOGUANINE	ABC
THIOTEPA	ABC
URACIL MUSTARD	ACE
VIDARABINE	D
VINBLASTINE	ABC
VINCRISTINE	ABC
ZIDOVUDINE	D

**\* Sources**

A - The National Institutes of Health, Clinical Center Nursing Department

B - Antineoplastic drugs in the [italicize the following text name] Physicians' Desk Reference

C - American Hospital Formulary, Antineoplastics

D - Johns Hopkins Hospital E - International Agency for Research on Cancer

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## How to visualize One in a Trillion

Many Endocrine disrupting compounds have measured biological effects in the low parts per trillion range. Some endotoxins are so dangerous (cause cancer) at the genetic level that they are toxic in the parts per quadrillion range. How much is a part per trillion (ppt)?

Imagine stacking one dollar bills on top of each other. The present sized currency measures 2.61 inches wide by 6.14 inches long, and the thickness is .0043 inches.

1 trillion is 1,000,000,000,000.

So, a stack of dollar bills 1 trillion high would be:

$1,000,000,000,000 \times .0043 \text{ inches} = 4,300,000,000 \text{ inches}$ .

$4,300,000,000 \text{ inches} = 358,333,333.333333 \text{ feet}$

$358,333,333.333333 \text{ feet} = 67,866.1616 \text{ miles}$

At the equator, the earth is about 24,901.55 miles in circumference.

This means that at the equator the stacked bills would circle the earth about 2.73 times.

The biological activity of some Endocrine Disrupting Compounds would be equivalent to removing a few dollars from this 68,000 mile stack. As you can imagine, even removing thousands of dollars would not put a dent in a pile that wraps around the earth almost three times. This comparison, although hard to imagine, portrays the incredible sensitivity of certain biological processes, especially those involving developing embryos and chemical signaling during early fetal developmental stages.