Nicoletta Dinelli
ART 120: Vassar Campus
Professor Elet
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The Past & Potential of Wastewater Treatment at Vassar College

Whether intentionally or not, most of us don't think about the journey the water we use begins after it swirls down the toilet. The management of wastewater, however, is not only essential to our health and well-being, but involves impressive feats of science and engineering. In Poughkeepsie, New York resides Vassar College, a place with a surprising history of innovation in the field of wastewater management.

This topic was first introduced to me by Karen Van Lengen, a professor of architecture who has written extensively about Vassar (her alma mater), including fascinating descriptions of Vassar's past wastewater initiatives (in "Pedagogy and Place" and *Vassar College: An Architectural Tour*). She touched on this topic in the lecture she delivered to my class as well, providing inspiration and direction for me to delve into the matter deeper.

I. The beginnings of Vassar's sewage disposal system

Founded in 1861, Vassar College was by the early 1970s already a leading innovator in sewage/wastewater treatment. Below is a description of Vassar's first real wastewater treatment system[1], designed by James Renwick Jr., that was quite advanced for the time.

[1] It is unclear what was done with the sewage for the first decade or so of the college's founding, but it can be assumed that it must have been extremely simple and probably just involved the transfer of sewage to a dump site of sorts.

> *"An improved and, as nearly as may be, perfect system of sewerage and drainage has been adopted within the last three years… and will be substantially completed in the course of another year. The sewage from the College is carried through pipes to the ravine, four hundred feet east of the building, and there discharged into a large covered brick tank, from which, after the settling of the more solid portions, the comparatively clear liquid is conveyed through sewer-pipes underground nearly two thousand feet, before it is discharged into the united Casper Kill and Mill-Cove Brook. The portion retained in the tank, rich in phosphates and other fertilizing elements, being then drawn off into the muck-heaps prepared to receive it, is at once deodorized and converted into a valuable manure" (Historical Sketch of Vassar College).*

Here we see that the original sewage system involved minimal filtration, with the wastewater quickly flowing through gravel or peat before being funneled directly into the Casperkill. There is also mention of the utilization of sewage as fertilizer, however, a positive and important practice that is clearly present from the beginning. Since the site of Vassar College was previously used as a horse race track as well as a farm, the soil was in desperate need of nutrient replenishment (*The Historical Sketch*). By 1876, sewage had been successfully used as a fertilizer so that the soil on the farm began to bear higher yield ("The Vassar Farm").

II. The dilemma of 1894

In the early 1890s, however, this "perfect" system proved to have some issues as reports started flooding in from landowners downstream of Vassar, claiming that the college's disposal of wastewater into the Casperkill was negatively impacting their lands and livelihoods. The outcry was overwhelming; Vassar had to change what it was doing with its wastewater. In the 1893/94 meeting, the trustees delegated the question of sewage disposal directly to the Executive Committee, with the request to do whatever was "most expedient and economical" as long as it cost under $20,000 (Vassar College Board of Trustee Minutes 93/94).

In 1894, the board of trustees met again to discuss this situation. The city of Poughkeepsie suggested that, to cease the contamination of the tributaries, the college build a six-mile pipeline to transport sewage from the campus directly into the Hudson River[2]. This option was expected to be fairly costly, legally challenging, and time consuming, as it required the permission of many individuals to construct a pipeline through their private property. Still, most of the trustees believed this to be the solution. Vassar graduate (class of 1870) and newly minted trustee Ellen Swallow Richards, however, was vehemently opposed to this proposal.

III. Ellen Swallow Richards & Euthenics

A pioneer in many ways, Ellen Swallow Richards attended Massachusetts Institute of Technology (MIT) for graduate school as the first woman admitted. Richards went on to become the first American woman to earn a BA degree in chemistry, the first woman faculty member at MIT, and the first to study the quality of American water through water surveying, prompting the creation of federal water quality standards and the municipal sewage treatment plant that we have today ("The Vassar Farm").

[2] At the time, polluting streams and smaller waterways such as the Casperkill Creek with sewage was seen as problematic because the impacts of such contamination was visible in the health of those who used such waterways as a water source. It was considered acceptable, however, that sewage be directed into larger bodies of water like the Hudson River because of its size and assumed fortitude as a force of nature that was harder to harm.

Richards also coined the term "euthenics," defining it in her 1910 book, *Euthenics, the Science of Controllable Environment*, as the "betterment of living conditions, through conscious endeavor, for the purpose of securing efficient human beings" and something that "depends upon two primary conditions -- heredity and hygiene -- or conditions preceding birth and conditions during life."

Helen Lefkowitz Horowitz, author of *Alma Mater*, succinctly frames the ambiguous nature of euthenics in her analogy that, "To ask, what was Euthenics? is to ask how the blind man saw the elephant. Perspective depends upon where one stood in the struggle." To some, such as the president of Vassar at the time, Henry MacCracken, euthenics represented progress and "the socialization of the curriculum," whereas others saw it as a way of "driving women back into the home" (Horowitz 297). Euthenics is also controversial in its troublingly unclear connection to eugenics, with Richards herself stating that "Euthenics precedes eugenics, developing better men now, and thus inevitably creating a better race of men in the future," and that "Euthenics is the term proposed for the preliminary science on which Eugenics must be based" (*Euthenics*). Overall, it can be said that euthenics served as a broad kind of umbrella term covering any type of applied science, including sanitation and sewage treatment.

Richards' suggestion of filtration beds, therefore, was likely an example of what she viewed as the practice of euthenics, because she was applying her scientific expertise in sanitation to address an issue that impacted the well-being of the community. The solution proposed by Richards saved Vassar College a significant amount of money, minimized the negative health impacts experienced by Vassar's downstream neighbors, and increased the productivity of the soil and the land itself. Richards commented that this was indeed "a valuable record of the possibility of sewage utilization without offense, and of the right principle in taking care of the wastes of an establishment by itself," speaking to a principle of accountability between people, to their larger communities, and to the land ("The Disappointing First Thrust of Euthenics").

IV. The Richards solution

The alternative that Richards proposed to the board of trustees was that of filtration beds, also called "leach fields." Instead of pumping the sewage directly from the college into the Hudson, Richards argued, the sewage could actually be utilized through the creation of a "sewage farm," an innovative new system that resembles the processes of a septic system. As this plan was only one fifth of the cost of the pipeline[3] and necessitated far fewer struggles over land rights, it was not difficult for Richards' to convince the trustees that her plan was the better option.

In fact, during the 1894 trustee meeting, the minutes state: "Resolved that the Executive Committee be authorized to build a sewer from the college to the Hudson River which was freely discussed." After a short recess for dinner, however, the board reconvened, with the minutes then reading, "The following resolution was then on motion, adopted. Resolved that the whole subject of sewage be referred to the Executive Committee with power, with the expression of our desire that the system of a sewage farm be tried if practicable." The minutes do not state exactly what Richards said to convince the other trustees, but by the end of the session they were fully

[3] "The total cost of the works as constructed, including the preliminary expense involved in considering the various projects proposed before the final adoption of the sewage utilization project, is stated at $7,500, exclusive of the land," which is much lower than the $20,000 limit decided by the trustees (U.S. Dept. of the Interior).

supportive of the sewage farm and empowered the Executive Committee to purchase the land needed (*Vassar College Board of Trustee Minutes 93/94*).

To implement this system, Vassar purchased the 200 acre plot of land that is now known as the Vassar Farm in 1895. This wastewater treatment process (illustrated in Figures 1-6 below) started with a screening tank, where large solids that could damage the pipes and system were blocked by iron bars seven-eighths of an inch apart from each other and then collected, drained on a platform, and incinerated at the boiler house. The rest of the wastewater flowed into a receiving tank or reservoir of 44,000 gallon capacity. From there, the wastewater was transferred to one of the two filtration beds, which extended over a total area of 1.03 acres and were made up of porous, coarse, sandy soil of 0.3-0.4 millimeters grain size. These beds were approximately 15 feet above the water table, so the wastewater had a significant amount of space to filter down and become more purified before it reached the ground water. During the growing season, these beds were planted with corn and cereals, and the wastewater was also used for irrigation in other areas of the farm (*New York Times* and U.S. Dept. of the Interior). At its peak, the system processed 113,000 gallons of wastewater a day -- a high volume because stormwater runoff was included in the effluent (*Conservation by Sanitation*).

The Board of Trustee minutes from the 1895/96 school year note that “Trustee Richards then gave to the Board a very full and plain account of the new sewage system giving figures and data showing how successful the plan had proven thus far” (*Vassar College Board of Trustee Minutes 95/96*). Later, in 1911, the corn yield at the farm was fifty tons to the acre, which was double the yield from the first two years of the filter beds, as the wastewater had replenished the nutrient levels in the soil and made it better for growing (*Conservation by Sanitation*). Lauded in a national scientific journal as the ideal system of sanitation, and admired in an article from the New York Times, Vassar's wastewater treatment system was widely praised, although Richards herself was rarely mentioned or credited, with much of the recognition going to Boston engineering firm Noyes & Hazen, which helped execute Richards' vision ("The Vassar Farm" and *New York Times*).

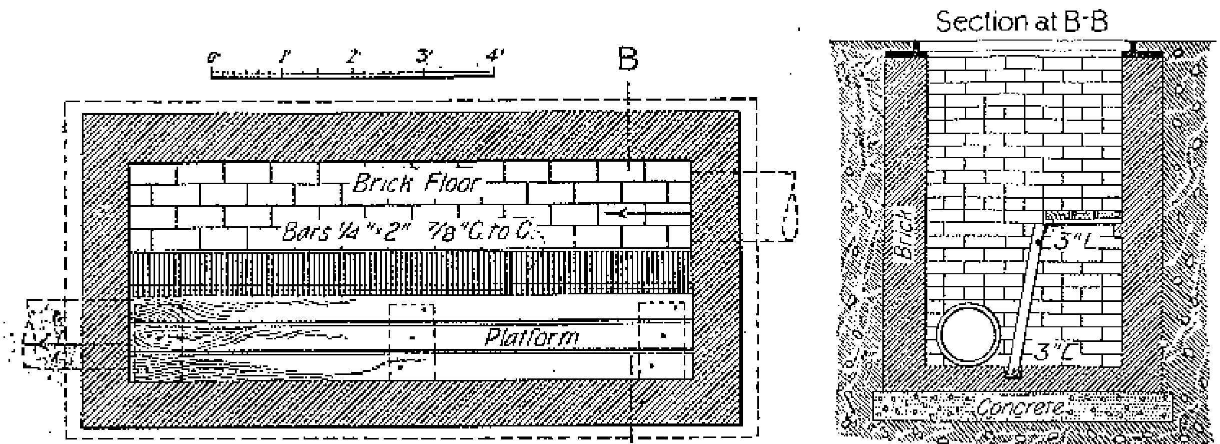

FIG.1 FIG.2

Fig. 1 and fig. 2: illustrations of the screening chamber (Noyes & Hazen, 1896).

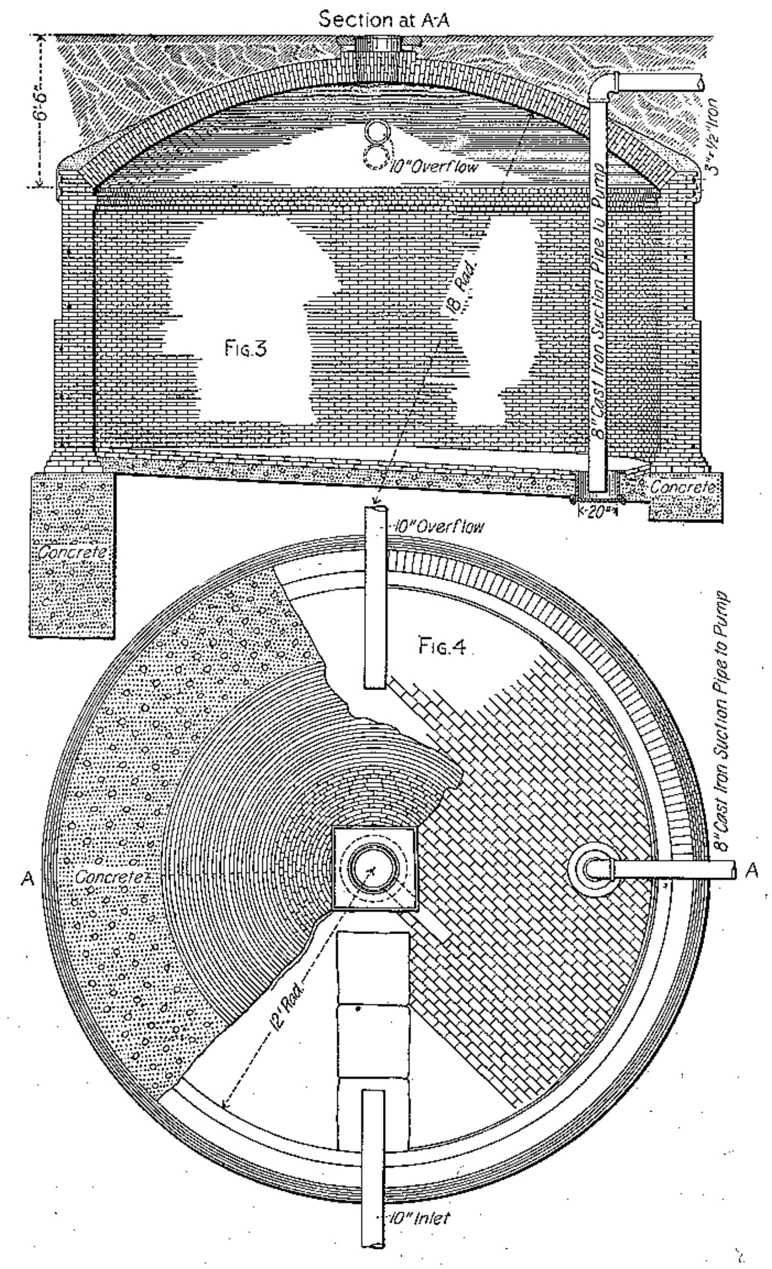

Fig. 3 and fig. 4: Receiving tanks (Noyes & Hazen, 1896).

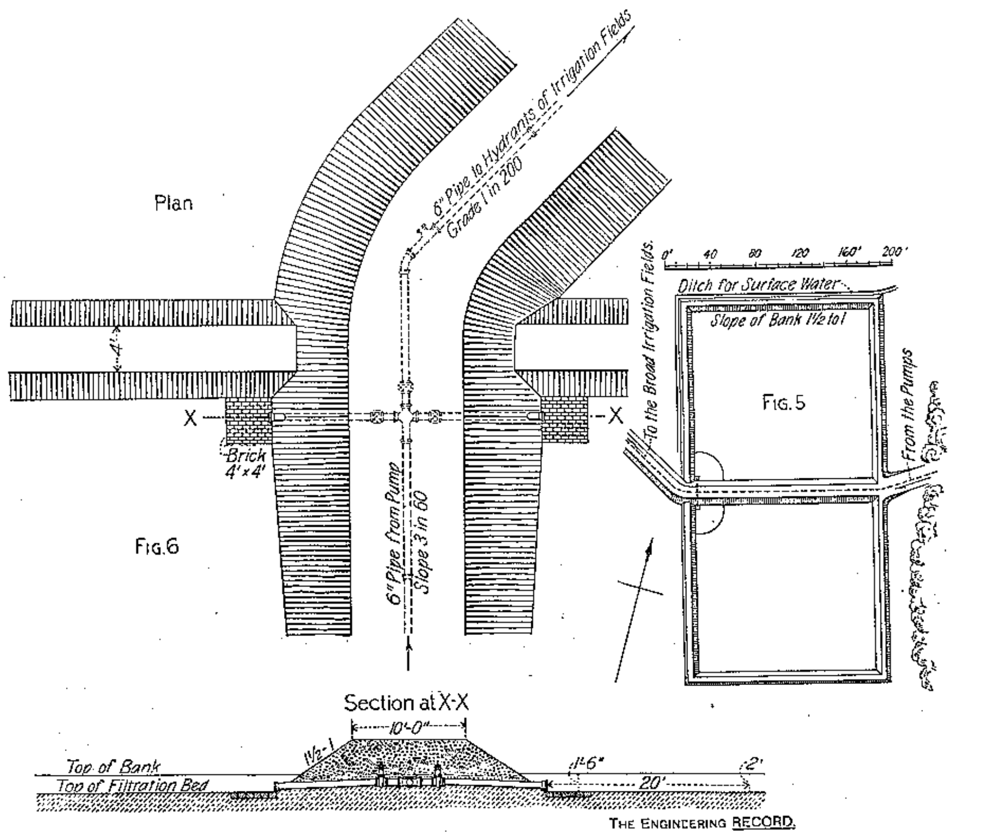

Fig. 5: Arrangement of filter beds, and **Fig. 6:** Details of piping (Noyes & Hazen, 1896).

Following the implementation of the filter beds, Edward E. Elsworth, trustee and member of the Executive Committee of trustees, declared that "the question of sewage disposal for Vassar is solved for all time to come. The pollution of streams is avoided, and the college itself put upon the most approved sanitary basis" (*New York Times*). This confidence echoes that which surrounded the original sewage situation of directing the wastewater into the Casperkill Creek, described as nearly perfect at the time. As wastewater treatment technology and strategy has progressed, however, both of these systems have been largely abandoned.

Upon chemical analysis (much of which was conducted by Richards) of the brook receiving the runoff from the farm, the water seemed to be just as clean downstream of the runoff location as it was above it, indicating that there was no detectable sewage pollution from the effluent. (Of course, this only means that there was no contamination that was detectable at the time, not that the effluent was perfectly pristine.) If the same analyses were to have been conducted with modern equipment, they likely would have found contamination, but it was a negligible amount in relation to the effluent that visibly denigrated the health of the waterways preceding the implementation of the filter beds. Richards also believed that the unique, regional quality of soil was important to consider in planning sanitation efforts, and after studying the soil on the farm, decided that it was especially well-suited for filtration, making it an "outstanding medium for sewage treatment and alleviated the need to dump sewage into bodies of freshwater" (Schneiderman 2018).

V. Contemporary Wastewater Treatment

It is unclear exactly when Vassar stopped using the filtration bed system at the farm and opted for a municipal sewage treatment plant instead. Today, Vassar's sewage goes to the Arlington Wastewater Treatment Plant, which was built in 1957 and treats an average of approximately 3 million gallons of wastewater per day (*Arlington Wastewater Treatment*).

Arlington Wastewater Treatment Plant is a secondary treatment plant, meaning that it goes through a secondary filtration and purification process to remove pollutants in addition to filtering and settling the solids out of the wastewater. The process (seen in Fig. 7 below) begins like that of the filter beds, with the influent wastewater going through a screening chamber with metal bars like those described earlier. The wastewater then goes through a smaller screening chamber called a grit chamber before proceeding to the primary settling tanks. Here, the wastewater separates as the small solid particles settle at the bottom of the tanks and create a sort of sludge, whereas the liquid wastewater continues to flow into the next tanks, where aeration takes place. The aeration tanks help reduce the pathogens, excessive nutrients, and biological oxygen demand (BOD) of the wastewater, things that are regulated by federal standards. The wastewater then goes into a secondary settling tank, where the earlier process is essentially repeated. Lastly, the wastewater is disinfected with chlorine before it is deposited into the Hudson River (*Arlington Wastewater Treatment*).

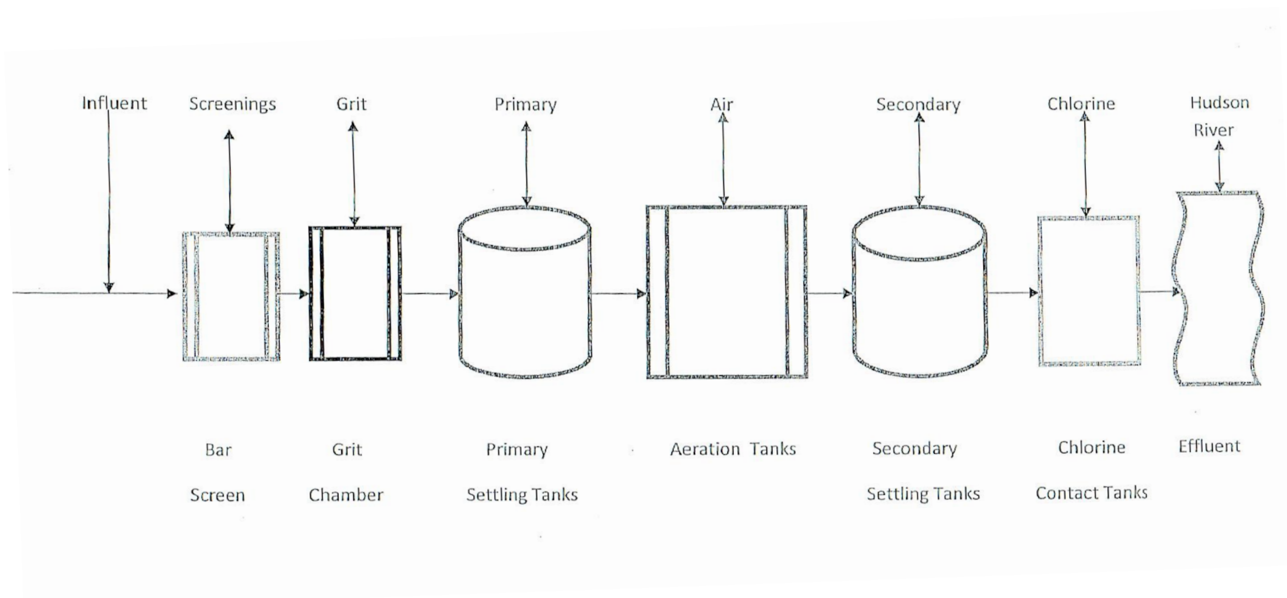

Fig. 7: Arlington Treatment Plant Flow Diagram (*Arlington Wastewater Treatment*)

VI. The Omega Institute and Eco Machine™

About 16 miles from Vassar College, at the Omega Center for Sustainable Living, is a 10-year-old wastewater[4] reclamation system designed by John Todd called the Eco Machine™. All wastewater from the Omega Center is directed to the Eco Machine, where it is treated in seven steps involving algae, fungi, bacteria, plants, and snails, "mimicking the processes of the natural world" without adding chemicals. After being treated, the water trickles down back into the natural below-ground aquifer from which Omega draws its water.

The system is capable of processing up to 52,000 gallons of wastewater per day, although it averages about 25,000 gallons during the Omega Center's peak season. On average, it takes about 36 hours for wastewater to go through the entire treatment process. The Omega center is on a hill, so much of the flowing of the wastewater from tank to tank is done by gravity, although the rest of the energy needed to power the system comes from solar energy.

First, the wastewater is collected in solid settlement tanks, where the solids settle into "sludge" and decomposed using microorganisms (anything that is not decomposed is "pumped out by a licensed facility" and likely goes to landfill or incinerators, though Omega does not specify this). The liquid then moves from the settlement tanks to one of the two 6,000 gallon equalization tanks that help regulate the flow of wastewater. This is important because the microbial organisms in the system need a regular supply of wastewater to feed off of, which is not always constant. The wastewater continues into one of the two 5,000 gallon underground anoxic tanks, where the aforementioned microorganisms digest the excessive amounts of

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[4] The CEO of the Omega Center, Skip Backus, points out that "If you're calling it waste, then you've just decided to end the process in the wrong place." While I see the validity of this statement, I have been and will continue to refer to wastewater as such, in order to clearly differentiate it from water that is potable.

minerals and substances including potassium, phosphorus, and nitrogen, producing a "modest amount" of methane gas (but "not enough to harvest and use," according to Omega).

Next, the wastewater is channeled into the two upper constructed wetlands, basketball-court-sized areas that are "three feet deep, lined with rubber, and filled with gravel" where native plants and microorganisms work together to further denitrification, deodorization, and general purification. The wastewater goes from the upper wetlands to the two lower wetlands. At this step, some of the water is evaporated or soaked up by the plants, but the remaining wastewater experiences a "75 percent increase in the water's clarity and a 90 percent reduction in the water's odor" because of the digestion that happens thanks to the bacteria.

After the wetlands, the wastewater travels to two 10-ft-deep aerated, or high in oxygen, lagoons. Fungi, snails, and algae join the microorganisms to further reduce the levels of ammonia and other toxins, making the water visibly quite clean, but not yet potable. Lush tropical plants also assist in this step of the process, as their roots provide habitats for the lagoon's other organisms. The remaining wastewater goes into a "recirculating sand filter," the penultimate step in the treatment process, where microorganisms pick off the last of the nitrates and unwanted substances and the sand filters the wastewater further, making it officially clean enough to be returned to freshwater bodies like lakes and rivers. Instead, however, the Omega Center chooses to make a "closed hydrological loop" by sending the water to its dispersal fields, located under Omega's parking lot. The trickling down of the water through the 250-300 feet of earth further cleans it so that it is safe to drink by the time it reaches the underground water table.

VII. Comparisons: Filter Beds, Arlington Wastewater Treatment, Eco Machine™

There are many commonalities between the processes that have been discussed in this paper. The various systems of wastewater treatment are similar in their foundations, and differ in the way that these basic things are done. For example, the methods all involve some sort of screening and settlement tanks, where the solids are separated from the rest of the wastewater, with the exact shape/model/form of the settlement tanks varying depending on the technology available. All the systems utilize gravity and some form of filtration to at least partially purify the wastewater, and bacteria to decrease the excessive nutrient levels. The biggest differences are found in the final purification steps of the processes: where the Eco Machine uses wetlands and filtration, the modern municipal sewage treatment plants use chlorine, and the filter bed method lacked a further purification step altogether. Thus, one of the most important and impressive distinctions is that sustainable water treatment systems like the Eco Machine are still able to purify water using biological processes and without the use of harsh chemicals.

VIII. The Future of Vassar's Wastewater

The question is raised: Could Vassar have a sort of Eco Machine? Could we implement some sort of sustainability-focused wastewater treatment system? The answer is yes. Oberlin College, for example, instituted a system in 2000 called the Living Machine, which is basically a small-scale Eco Machine, using plants and bacteria to purify wastewater into water that, while not potable, is clean enough to be recycled for things like flushing toilets on campus. The Living Machine can intake 2,300 gallons of waste per day (from sinks, toilets, and urinals) and purifies water to a level that surpasses the federal standards of tertiary wastewater treatment, but does so with biological processes rather than the use of chemicals (Orr 167).

The main obstacle is the lack of demand. Implementing some sort of sustainable wastewater treatment plant would be a profound investment in the study of sanitation, biology, chemistry, urban studies, environmental studies, and other fields, as well as a tribute to Vassar's history of innovative wastewater treatment efforts. However, it would be a costly undertaking, and the current administrative and bureaucratic climate at Vassar seems unwilling to invest the level of funding needed into ecological initiatives.

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