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How Effluent Compares to Storm Runoff in Relation with Surface Water Quality

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ABSTRACT

Waste water treatment plants are considered simple solutions for poor surface water quality and are used in every developed and developing society. There are varying types of waste treatment plants. The systems are rarely able to purify all water that passes through the system. The problem with a mix-and-treat waste water system is the strain from sudden influxes of water. Systems that combine storm runoff accept variability in the volume of water that needs treating. Effluent is discharged when the plant cannot treat all the waste. The purpose of this review is to determine which system is the closest to meeting the theoretical goal by analyzing the long-term effects of how effluent, verses unfiltered storm runoff, affect the quality of surface water. The results of this review will provide a direction for future research in determining a water treatment system with the least impact on the environment.

KEYWORDS: Surface water quality, effluent, riparian buffer, Combined sewer system, storm runoff

INTRODUCTION

The purpose of every water treatment plant is to convert non-potable water into water that is safe to ingest. Although there are a variety of systems designed for purpose of water purity, all water has undergone some process to ensure its quality for consumption. All water treatment centers used to treat public water utilize biological and chemical processes to purify water either for consumption or releasing it into a water body. The most common systems include a multi-step processes for removing unwanted particles from the water. The wastewater is sent through a screen to remove large physical objects from the water. The next stage is the grit chamber, where a difference in current speeds allows finer particles to settle to the bottom of the tank as waste while the water continues to a sludge tank. The sludge tank is used to breakdown organic particles in the water by hosting bacteria in the sludge and aerating the water. The water moves through a series of chambers. The first chamber is anaerobic, followed by anoxic and oxic tanks. Each one of the tanks targets a specific type of bacteria to exterminate from the water. The final two steps are to have the water move through various fine filters including a biofilm and then it is sent through a chamber where the water passes under a strong UV lamp to eliminate any other bacterium in the water[1].

Some water systems have storm runoff channeled through the water facility, Combined Sewer System, CSS. The flaw in this type of system is that when the system is under too much strain it can result in combined sewer overflows, CSO. A CSO results in partially treated or untreated water being discharged as effluent into a water body[2]. In contrast, other city designs channel storm runoff directly into the surface water supply, collecting contaminants along the way[3]. In either system, contaminants are discharged into local ecosystems[4-5]. In this review, I will discuss the impact of these water systems on surface water quality and the surrounding ecosystem.

COMBINED SEWERS

Combined Sewer systems are a common water infrastructure design. It consists of a treatment facility that has both sewage and storm runoff channeled into the plant. One benefit of a CSS facility is the dilution of pharmaceutical waste. The current water system techniques and filters are only capable of eliminating some pharmaceutical wastes from the water. Although the same amount of medical waste would be present in either system, because of the higher volume of water in a CSS the concentration is lower[6]. Water treatment facilities that treat storm runoff as well as waste water, results in the sporadic discharge of effluent. Effluent is water evacuated from the plant that has not been fully treated, still containing contaminants[7]. Combined sewer systems handle a higher volume of water than non-combined systems. The higher volume of water can decrease the concentration of pollutants bringing them within legal limits for potable water[8].

WHY EFFLUENT IS DISCHARGED

Effluent is discharged because the water treatment plant receives a volume of water greater than the capacity for treatment at the site. Water discharges occur from combined sewer overflows[2]. The plants will evacuate some of the waters either treated, partially treated, or untreated. Partially treated water is when only a few preliminary steps of water treatment occur prior to discharge[5]. The minimum treatment water can receive and be considered partially treated is the initial passing though the screen and the final step of UV radiation[1]. UV radiation is a crucial step in the process in order to prevent bacterium, including antibiotic-resistant bacteria, from replicating after the water is discharged[9].

LONG TERM EFFECTS OF EFFLUENT

Long term effects of effluent in natural water systems has been the center for several studies. Often an overlooked aspect of CSO is the downstream effect. Multiple water treatment plants will need to discharge in a similar timeframe causing greater concentrations of E. Coli downstream[2]. Regular discharge of effluents into water bodies will result in elevated levels of nitrogen and phosphorus in the water[10]. Higher levels of nitrogen and phosphorus can drastically change ecosystems through eutrophication. The excess of nitrogen and phosphorus will alter populations within the ecosystem, most commonly increasing algae populations, decreasing the amount of dissolved oxygen in the system[10]. In some cases, the level of available oxygen can decrease to zero and forming dead-zones. Along the coast of the Gulf of Mexico there is a large dead-zone where the dissolved oxygen levels have been depleted to the point where only a select few organisms can survive in the area. The zone stretches from the Mississippi delta to eastern Texas.[11]

STORM RUNOFF

Storm runoff can provide varying strain on water treatment facilities. Storm water presents an unknown volume of water and contamination to some water infrastructure designs. The systems that treat storm runoff separately from sewage can avoid discharges of sewage effluent. The concentration of pollution from storm runoff varies with the physical components of the area[12]. There are methods for decreasing storm water pollutants without the use of a combined water treatment plant. In most cases runoff quality is managed through the upkeep of riparian buffers. In most cases these buffers are preferred for preventing sediments, nitrogen, and phosphorus from entering the water system[13]. The pollutants found in untreated storm runoff can be classified by PSD (Particle size distribution) and TSS (total suspend solids)[12] (Table 1.).

The effectiveness of riparian buffers was tested along the edge of the Jobos Bay watershed in Puerto Rico[14]. The study ran for three years and faced two tropical storms. The study was focused on three aspects of water flow impacted by riparian buffers. The study compared four zones of land two protected from the buffer one closest to buffer and one directly behind it and two unaffected land areas of approximately the same size. The results from the experiment determined that the areas impacted by the buffer showed an overall decrease in water by 16% and subsurface flow decreased by 99%, and the overall sedimentation had a decrease in 24% relative to the land-zones without a riparian buffer. The buffer demonstrated a decrease of Nitrogen by 31% and Phosphorus 29% in the water collected by the sampling wells[14]. Riparian buffers are also useful to combat temperature pollution of water systems. When the rain water hits the surface, the thermal energy leaves the surface and is transferred to the water. Due to waters high specific heat capacity, it is capable of carrying the thermal energy for long periods of time and will continually gain thermal energy as it travels across surfaces heated by the sun or other means. Riparian buffers aid in temperature control by slowing the rate of influx into the system, allowing the thermal energy time to dissipate. Buffers are also responsible for lower surface temperatures by shading the system from the sun as well as limiting the influence of wind on changing the systems temperature[15].

CONCLUSION

This research is important to everyday life because safe water is required in any functioning society. As water systems change with time to suite a growing population it is important to consider how the facilities will impact the environment. Future research in this area should consider different biological process for limiting the impact of effluent and surface runoff and how pharmaceutical waste in water should be treated[3]. Surface water quality is essential to a healthy community and a trademark of developed nations.[4] When surface water quality is increased and preserved, all ecosystems will show an increased health and productivity.

Table 1. The average Total Suspended Solids (TSS) in Storm runoff, and Effluent around industrialized cities.

Type of Water	TSS (PPM)	Study
Storm runoff	150	Surface water quality in a water run-off canal system: A case study in Jubail Industrial City, Kingdom of Saudi Arabia[16]
Effluent	450	Developing the remote sensing-based early warning system for monitoring TSS concentrations in Lake Mead[17]

PPM = Parts Per Million

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