Filtration and Repurposing of Storm Drain Water in LA County for Increased Sustainability and Environmental Awareness

Dymier Steele, Rick Surga, Leo Tang, Tiana Thich, Kylie Weaver, and Goutham Yegappan

University of Southern California Summer Program

Abstract

This paper explains the history of water treatment in general and specifically the history of water treatment in Los Angeles County. Also this paper examines the impetus for implementing an improved storm drain system in Los Angeles County (LA County). While all four existing water treatment plants currently operating in LA County deal with sewage there is currently no system for treating storm drain runoff. Also the four existing water treatment plants send their treated water to bodies of water that are in the vicinity of the plant. The possibility of creating a new water treatment plant in Los Angeles County with the purpose of converting storm drain runoff into greywater to be used for irrigation, industrial processes, and also in the home is introduced and explored. Greywater can be defined as wastewater that does not contain serious containments (gray water). Conversely blackwater, also referred to as sludge, is defined as wastewater containing bodily or other biological wastes. This new plant would take in runoff from storm drains to be purified so it is not hazardous to humans, but not for expressed purpose of being potable water.

Keywords: greywater, blackwater, potable water

Filtration and Repurposing of Storm Drain Water in LA County for Increased Sustainability and Environmental Awareness

Historically Ancient civilizations settled around water sources: the Sumerians had the Tigris and the Euphrates, the Yellow River is referred to as the cradle of Chinese civilization, and the Egyptians would have never existed without the Nile. The ancient people knew it was important to be situated near a large quantity of water, but an understanding of water quality was not well documented or known. The original interest in water treatment steamed from a desire to make water more aesthetically pleasing. The Egyptians used the element alum to clarify water as early as 1500 BCE. Coincidentally alum is still used in some cases as a coagulator to clarify today. In the 1700s, filtration was an effective way to remove particles from water. However, the clarity achieved could not be measured at the time so the effectiveness of the filtration cannot be accurately measured. In 1855, British scientist John Snow discovered that cholera was transmitted through water (Office of Water, 2000). This finding resulted in chlorination of water to purify it and kill bacteria (a practice that is continued today). Louis Pasteur's germ theory also propagated the concept that disease could be spread through unclean water. Pasteur's findings also documented that some bacteria could by exposure to high temperatures. The idea of water purification became more prevalent in America during the 1900s as people attempted to remove disease-causing microbes from their water (Office of Water, 2000). While these examples deal primarily with the purification of water for human consumption, the same principles can be applied to the purification of wastewater for producing greywater.

In 1894, the first steps towards sewage treatment were taken when, the first and largest wastewater treatment plant, the Hyperion Treatment plant, in Los Angeles County began operation. Originally the Hyperion Plant would discharge sewage into the ocean waters nearby.

This practice continued until 1925, when beachgoers to the surrounding beaches complained about the raw sewage being dumped into their waters. So in response, the city of Los Angeles built a simple screening plant at the Hyperion site. In 1950 it became apparent that merely screening the wastewater was not enough to deal with the large amounts of pollution. The plant that was created in 1950 included a secondary treatment system (The City of Los Angeles Department of Public Works, 2014). Then in the 1990s it was apparent that the plant in place was no longer adequate. In 1998, a new system was finished and it is still in use today. This remodel of the plant increased the capacity of Hyperion, improved the filtration, and has helped eliminate the dead-zone that exists at the mouth of the sludge outfall.

In LA County there are three other water treatment plants. However, the remaining three are all smaller than the Hyperion plant and these plants are water reclamation plants so they require tertiary treatment of their water. Tertiary treatment of water can produce an effluent that is almost drinking-water quality (The World Bank Group, 2015). The water reclamation plants reuse the water for landscaping, industrial processes, and one plant uses the reclaimed water to create a barrier in the harbor to protect against seawater intrusion (The City of Los Angeles Department of Public Works, 2014). While LA County has an extensive system for the treatment of sewage, there is no system in place for dealing with storm drain runoff. Currently all storm drain runoff is discharged into the ocean without any filtration or removal of potentially hazardous components.

Storm water runoff is a serious problem because it is a leading cause of pollution in oceans, streams, and rivers. Water from storm drains carry a large amount of pollutants such as fertilizer, pesticides, animal feces, oil, grease, and trash (Environmental Protection Agency, 2003). When that water flows into the ocean it carries the risk of polluting the ocean and killing marine life. This pollution can also threaten the health and wellbeing of the human population because it can make water unsafe for swimming and other forms of recreation. An improved system for dealing with storm drain runoff would contribute to a healthier LA County.

Another impetus for the creation of a better system of storm drain water treatment is the current drought. Since 2012, the state of California has been plagued by a historic drought. Recently Los Angeles County has become one of the areas most impacted by the drought. Los Angeles covers a wide geographic area; however, it is primarily a desert basin surrounded by mountains on one side and coastline on the other. While man has been able to turn the desert into a green manicured wonderland in the midst of a desert, nature is slowly taking back the land and returning it to its originally dry state. LA County receives about18.67 inches of rainfall annually (US Climate Data, 2015). As water scarcity increases it is apparent that water technology needs to improve (Mordor Intelligence, 2015). Sustainability is necessary for moving forward in the future. Water is technically a renewable resource and about seventy percent of the Earth's surface is covered in water. However, most of that seventy percent is salt water or frozen in polar icecaps.

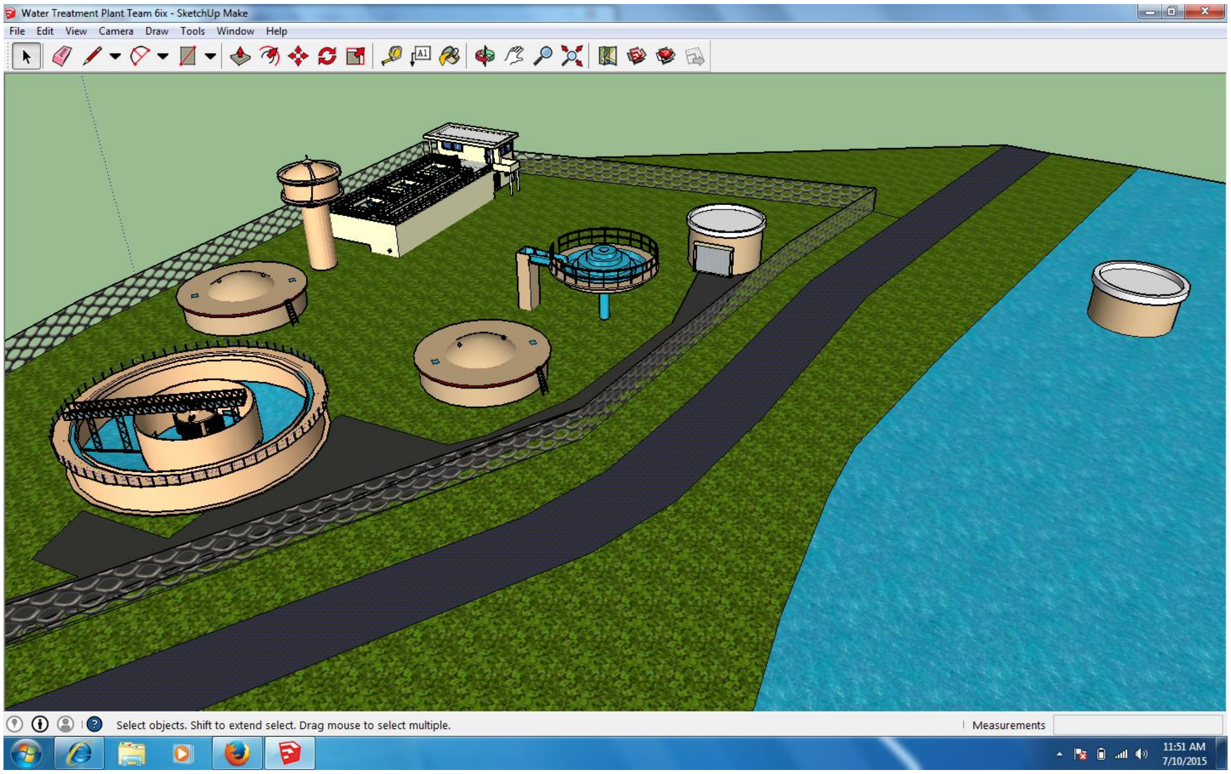
A new system of treating storm drain runoff would benefit LA County because of not only the drought, but also for future sustainability. Some scientists estimate that California has about a year of water remaining in its groundwater supply (Famiglietti, 2015). The utilization of storm drain runoff as greywater reduces water waste, ocean pollution, and for consumers it can offer economic benefits too. The greywater would be used for municipal irrigation and landscaping while private citizens could utilize the greywater for gardening and toilet flushing if they connect to the greywater pipes. To incentivize the use of greywater by private citizens, greywater would be less expensive than regular water, and then there would be rebates offered to cover some construction costs that may occur during connection to the greywater pipes.

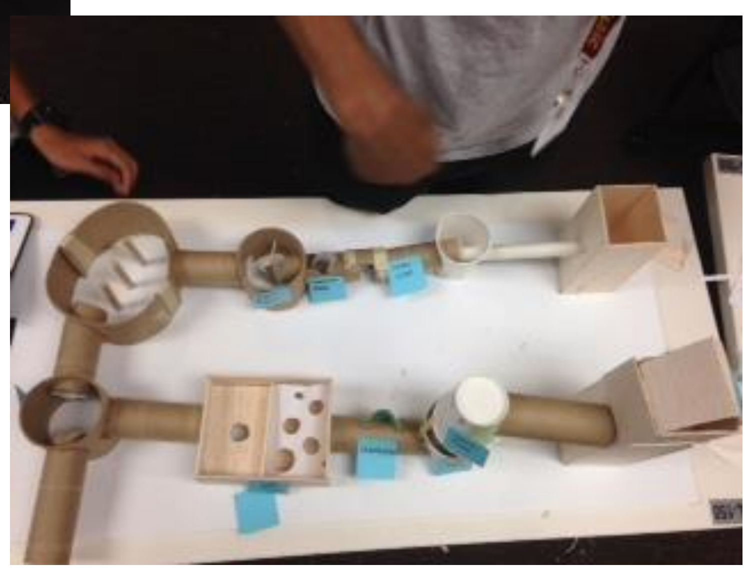
The new storm drain treatment system would be an important improvement to the infrastructure of LA County. The treatment plant would serve the Antelope, San Fernando, and San Gabriel Valleys, Metro, West, South, and East LA, and the South Bay areas. The treatment plant would be located in the South Bay area near the coast so the pipes that deliver the storm drain runoff can use gravity to transport the water to the plant. Then after the water is treated it will be stored in a large container until it is pumped back uphill to the consumers.

The process of treating the storm drain runoff is less comprehensive than treating blackwater or purifying water for human consumption. Since greywater is water that has no major contaminants the storm water will be cleaned so that is not hazardous to humans, but not meant for human consumption. A four-part process that removes debris, pollutants, and major contamination from the water will be used to treat the storm drain runoff. The four parts of the water treatment are debris filtration, coagulation, sedimentation, and filtration.

The first part of the process is debris filtration; large contaminants and debris are removed from the water when it passes through intake screens. Then small gritty debris is also removed so that it does not wear down the equipment. After being the filtered the water enters a pipe where coagulants, ferric chloride ($FeCl_3$) and ferrous chloride ($FeCl_2$), are added to the water. The addition of ferric chloride and ferrous chloride will filter out the heavy metals and chromate compounds as they react with the flocculating agents. The water with the added coagulants flows into the flash-mix tank. In the flash-mix tank, the water and coagulants are rapidly mixed together to attract the particles that will settle out from the water. Then the water flows into the flocculation tank where the water is gently mixed again and the particles stick together to form heavier particles called “floc.” After flocculation, the water flows into the sedimentation tank where the large suspended particles and the floc created during flocculation settle to the bottom of the tank while the water flows out into the pipe that leads to the filter. The sludge that settles to the bottom is piped out of the sedimentation tank into the sludge disposal pipe. Then the water in the pipe goes into the filtration tank, the filtration tank has a dual filter. One filter is a sand filter and the other is an activated charcoal filter. These filters help remove the remaining contaminants from the water and then the water flows into pipes and a small amount of chlorine is added to kill the remaining bacteria. This water then flows into a storage container where it is kept until it is needed by consumers. Finally, when this water is needed by consumers it is pumped from the container into the pipes that go to the people and it goes through another activated charcoal filter to remove possible toxins.

This project will improve the existing infrastructure of LA County and promote sustainability in the area. The proposed project would cost around $20 million in construction and equipment. Then the existing storm drainpipes would be improved and also extended. Then piping from the treatment plant would also be created to deliver the greywater to the consumers and places that utilize greywater. The new piping work would cost around $15 million to ensure that everything functions properly and all people can have access to the greywater network.


Water Treatment Plant Team 6ix - SketchUp Make
File Edit View Camera Draw Tools Window Help
Select objects. Shift to extend select. Drag mouse to select multiple.
Measurements
11:51 AM
7/10/2015



Reference:

Environmental Protection Agency. (2003). *"After the Storm"*. Retrieved July 9, 2015, from United States Environmental Protection Agency: http://water.epa.gov/action/weatherchannel/stormwater.cfm

Famiglietti, J. (2015, March 12). *California has about one year of water stored.* Retrieved July 9, 2015, from Los Angeles Times : http://www.latimes.com/opinion/op-ed/la-oe-famiglietti-drought-california-20150313-story.htm

Gray water. (n.d.). Retrieved July 9, 2015

International Code Council. (2015). *International Code Adoptions*. Retrieved July 9, 2015, from International Code Council : http://www.iccsafe.org/about-icc/overview/international-code-adoptions/

Mordor Intelligence. (2015, July 9). *Global Water Treatment Technologies Market - Trends and Forecasts.* Retrieved July 10, 2015, from PR Newswire: http://www.prnewswire.com/news-releases/global-water-treatment-technologies-market---trends-and-forecasts---aquatech-dow-water--process-solutions-ch2m-hill-and-mott-macdonald-among-the-major-players-512744921.html

Office of Water. (2000, February). *The History of Water Treatment.* Retrieved July 9, 2015, from epa.gov: http://www.epa.gov/ogwdw/consumer/pdf/hist.pdf

Public Works Department. (2015). *Columbia Regional Wastewater Treatment Plant*. Retrieved July 9, 2015, from City of Columbia Missouri: https://www.gocolumbiamo.com/PublicWorks/Sewer/wwtppg_4.php

The City of Los Angeles Department of Public Works. (2014). *Treatment Plants*. Retrieved July 9, 2015, from LA Sewers: http://www.lasewers.org/treatment_plants/about/index.htm

The World Bank Group. (2015). *Water.* Retrieved July 9, 2015, from The World Bank Group: http://water.worldbank.org/shw-resource-guide/infrastructure/menu-technical-options/wastewater-treatment

US Climate Data. (2015). *Climate Los Angeles - California*. Retrieved July 9, 2015, from US Climate Data: http://www.usclimatedata.com/climate/los-angeles/california/united-states/usca1339

water purification. (2015). In Encyclopædia Britannica. Retrieved July 9, 2015, from Retrievedfrom http://www.britannica.com/topic/water-purification