A SURVEY OVERVIEWING TECHNOLOGICAL ASPECTS OF WASTEWATER TRETMENT FACILITIES IN THE STATE OF TENNESSEE

Claire Myers[1], Diego Bautista[1], Luke Horne[1], Madeline Kidder[1], Dipendra Wagle[2.1], Dr. Pedro E. Arce[2.2], Dr. J. Robby Sanders[2.2]

[1] Chemical Engineering BS Program, College of Engineering

[2.1] Chemical Engineering PhD Program, College of Engineering

[2.2] Department of Chemical Engineering, College of Engineering

Tennessee Technological University, Cookeville, TN

Motivation & Relevance to Research

Wastewater treatment plants (WWTPs) are operated in the cities and towns at different capacities suitable to handle the water volume. Although all these facilities display a basically similar treatment process, there exists a few variations depending upon the capacities, location, cost of operation, population it serves, and type of contaminants required to remove. We believe that the outcome of this research will be a useful information for potentially improving sewage treatment potentially across the State of Tennessee of the current scenarios and provides a future direction.

Introduction

Wastewater is produced from several business, industrial, and household effluents and includes the sources such as showers, sinks, washing machines, dishwasher, toilet, manufacturing equipment, etc. Wastewater infrastructure (sewerage system) consists of a network of sewer pipes that collect, pump, and carry the sewage to the cleaning facilities called wastewater treatment plants (WWTPs). It contains microbes, pathogens, and several other organic and inorganic substances that are harmful to the environment. Within these plants, wastewater goes through several physical, biological, and chemical processes to remove these harmful constituents below the regulated levels.

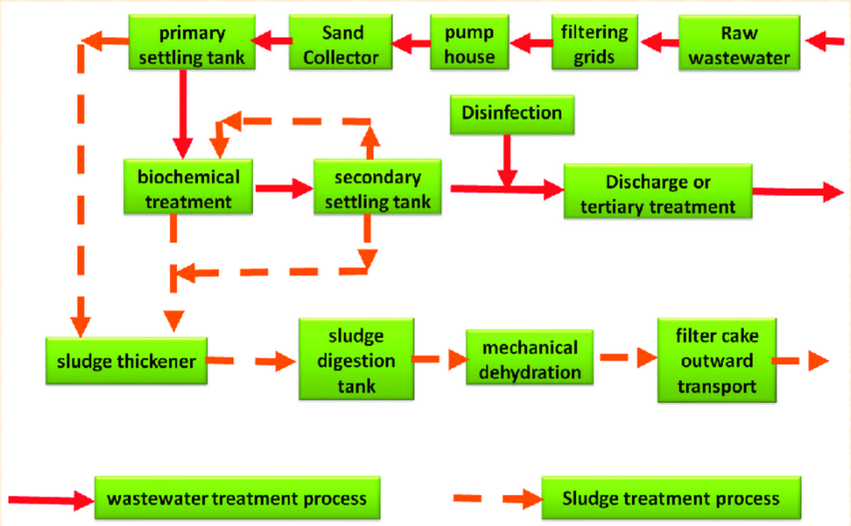

Fig. 1: Flow diagram of typical Wastewater Treatment Process (Reference [4])

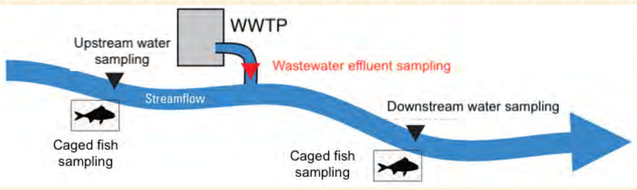

Fig. 2: diagram showing the sampling technique to evaluate the efficiency of the WWTP for decontamination of the wastewater effluent that receives in the natural water stream. (Reference: modified from : https://mn.water.usgs.gov/projects/EACWWTP/approach.html)

Objectives

1. Developing a comprehensive report illustrating the different aspects of WWTPs in the State of Tennessee
   - Evaluating and summarizing the similarities and variations among the different facilities
2. Producing a general discussion about the pros and cons of these similarities and differences
3. Recommending some potentially novel technologies that may be susceptible of upscaling and adaptable to treat sewage more effective and cost-efficient ways.

Methodology

The task of surveying the general overview of the total number of wastewater treatment plants present in the fourteen counties in the Upper Cumberland region in the state of Tennessee, has been distributed between the four undergraduate students, such that each would choose the treatment facilities present in three counties. In order to obtain the data, in addition to rarely available information on the internet search, students also contacted the person-in-charge either by email or phone call. Once the information has been obtained, these plants are classified based on the similarity and differences in their operation processes. The overview of the WWTP present in Putnam county in Cookeville, Tennessee has been referenced and reviewed as a typical model plant.

Examples of Plants Reviewed

1. Cookeville WWTP

Built in 1984, the plant operates in a treatment capacity of 14 million gallon per day (MGD), serves the City of Cookeville and Algood. Treatment process starts with preliminary & primary treatment consisting of bar screening & grit removal of suspended or floating solids. It follows secondary biological treatment by activated sludge method, and finally, UV disinfection tertiary treatment (updated in 2016 by replacing chlorine disinfection). Treated water is returned to *Pigeon Roost Creek*. Additionally, the facility also contains "sludge treatment system" that produces a "Class A biosolid" which is used as a soil conditioner. In 2016, the plant got updated in Supervisory control and data acquisition (SCADA). The facility has achieved Tennessee Achievement award & KY/TN Operational Excellence Award.

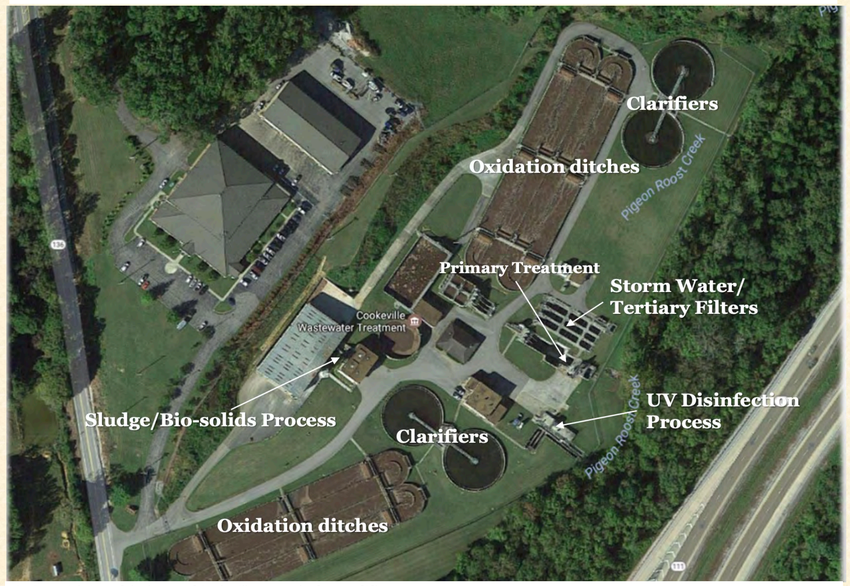

Fig. 3 : Aerial view of the layout of Cookeville WWTP (Reference [2])

2. McMinnville WWTP

Operated in a capacity of 4 MGD, the plant contains 3.22 million gallon "Envirex Oxidation Ditch". The pre & primary treatment consists of three two-staged screw pumps & two bar screens. Secondary treatment consists of a two-channel aerated systems & two 80 ft. diameter Envirex Rim-Flo Tow-Bro clarifiers. Sodium Hypochlorite is used as tertiary disinfection process while SO_2 is used for dechlorination. The sludge processing is also operated in the same facility; uses two sludge holding tanks & a two-meter belt filter press to dewater the sludge. The dewatered sludge is processed through a lime stabilization process to produce a Class-A biosolid.

Examples of Plants Reviewed Cont....

3. Crossville WWTP

Located in 468 Sparta Hwy, Crossville, TN 38572, the Crossville WWTP the plant operates in a treatment capacity of 2.5 million gallon per day (MGD). The treatment process starts with preliminary treatment consisting of bar screening & grit removal of suspended or floating solids. It follows secondary biological treatment by activated sludge method, and finally, UV disinfection tertiary treatment. The four secondary clarifiers, each of 40 feet diameter, are operating at a time to clarify water from the sludge. Facility also contains "sludge Processing" units to process the sludge produced from pretreatment and secondary treatment processes.

Research Findings

The brief summary of the research findings is listed in the table below:

WWTPs	County	Location	Population	MGD	2^0	3^0
Cookeville	Putnam	1870 S Jefferson Ave, Cookeville, TN 38506	40,0000	14	Activated Sludge	UV lamp
Crossville	Cumberland	468 Sparta Hwy, Crossville, TN 38572	12,000	2.5	Activated sludge	UV lamp
Mc Minnville	Warren	100 Cope St, McMinnville, TN 37110	15,000	3.22	Activated Sludge	Chlorine

Future Work

The team is continuously working on researching the following WWTPs. Filling up these blank boxes in the table below is the future project of the FUEL team.

WWTPs	County	Location	Population	MGD	2^0	3^0
Baxter WWTP	Putnam	810 Elmore Town Rd, Baxter, TN 38544	2,000			
Sparta WWTP	White	1099 McMinnville Hwy, Sparta, TN 38583				
Livingstone WWTP	Overtone	225 W Volunteer Dr, Livingston, TN 38570				
Carthage WWTP	Smith	214 1st Ave W, Carthage, TN 37030				
Smithville Sewer Plant	DeKalb	104 E Main St, Smithville, TN 37166				
Monterey City Sewer Plant	Putnam	13785 Woodcliff Rd, Monterey, TN 38574				

References

1. https://www.mcminnvilletn.gov/departments/water/water_treatment_plant.php
2. https://www.cookeville-tn.gov/268/Sewer-Treatment
3. https://www.ewg.org/
4. https://www.researchgate.net/figure/Typical-process-flow-diagram-of-a-wastewater-treatment-plant-WWTP_fig1_332338946/download
5. Phone calls and email correspondences to the plant in-charge person

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