EXECUTIVE SUMMARY

FLASH ENGINEERING

Introduction

San Diego State University's Mission Valley Campus is in the wake of design. This cutting-edge proposed campus offers a unique opportunity to provide innovative research facilities to students, such as the prospective Decentralized Wastewater Treatment System (DEWATS) Learning Lab. This Learning Lab will be designed to intercept wastewater before it reaches the sewer system to treat and use for research opportunities. Students will be able to learn essential water engineering skills in a hands-on learning environment that deals with real wastewater and interactive treatment processes. This report will analyze the components needed to achieve a successful DEWATS Learning Lab for SDSU Mission Valley.

Background

Currently, the Mission Valley site is home to San Diego County Credit Union (SDCCU) Stadium, formerly known as Qualcomm Stadium. The SDSU Football team became the main occupier of SDCCU Stadium in 2017 when the NFL Chargers relocated to Los Angeles. The stadium currently has a capacity of 70,000 people, but SDSU football only averages between 20,000-30,000 fans per game (Kenny, 2019). At present, the size of the stadium is too large and unfit to serve SDSU athletics and the surrounding community, and much of the area is taken up by an often unused paved parking lot. The SDSU Mission Valley Campus is planned to replace SDCCU Stadium and the surrounding parking lot with a stadium that is appropriately sized to the community's need, as well as many other amenities.

The number of students attending San Diego State University is increasing, and the current housing status is not sufficient to keep up with this increase. This new campus site will feature housing consisting of 4,600 units to accomodate students, faculty, staff as well as the general public. Ten percent of the housing will be set aside as affordable housing (SDSU Mission Valley Campus Overview).

Other components of the campus will consist of retail, green space, a river park, and learning environments. 1.6 million square feet will be dedicated to academic and research space to enhance the education of SDSU's students (SDSU Mission Valley Campus Overview). Intended plans for the San Diego Mission Valley West site are being deliberated with many innovative opportunities being proposed. This DEWATS will be a ground-breaking laboratory that will serve students by strengthening their hands-on knowledge and experience in realistic wastewater engineering situations.

Project Need, Purpose and Objective

Using Scopus, a citation database with data from over 5,000 publishers, a key search tool was used to discover how many published research articles could be found written in the United States for the search terms found in titles, abstracts, or key terms for "Wastewater AND Treatment" and "Decentralized AND Wastewater AND Treatment" for years 2010 through 2019. From figure 1 below, there appears to be a growing trend in research around wastewater treatment but compared to Figure 2 there is a necessity for research in decentralized aspects of a treatment system.

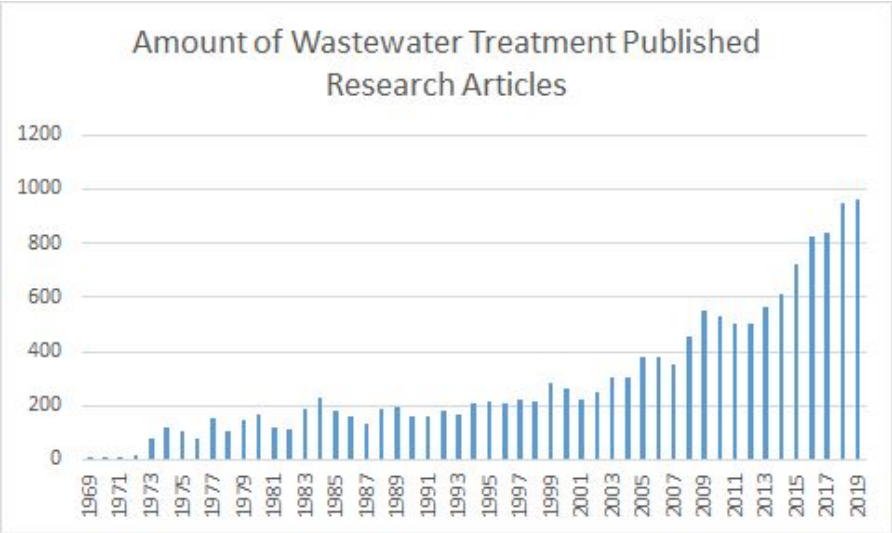

Fig. 1 Trends in Publications of Wastewater Treatment (Source: Scopus; date, 3/9/2020; subject, all fields; keywords used: wastewater AND treatment; document type: articles; publication years: all)

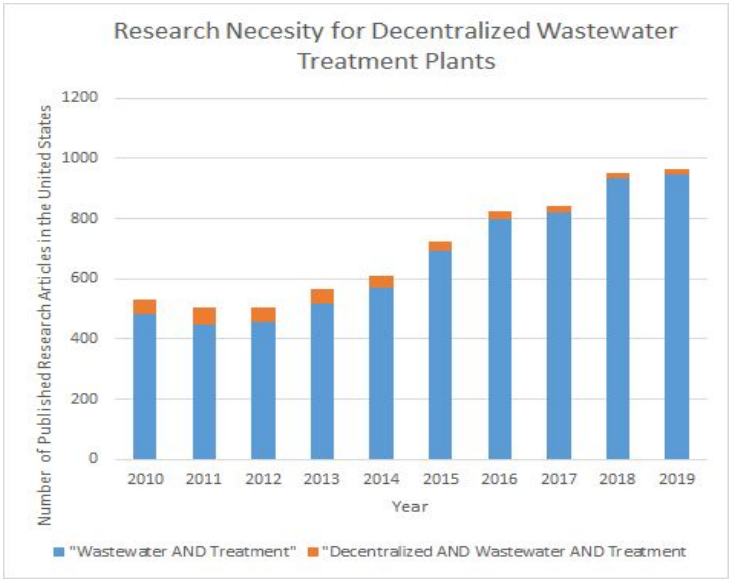

Fig. 2 Publications of Wastewater Treatment During the Last Decade (Source: Scopus; date, 3/9/2020; subject, all fields; keywords used: wastewater AND treatment, wastewater AND treatment AND decentralized; document type: articles; publication years: 2010-2019)

100% Submittal

Currently, SDSU is a Carnegie classified "R2" research-active university. It would be extremely beneficial in the goal of attaining an upgraded "R1" rating for SDSU's College of Engineering to implement a proposed independant doctoral program in Environmental Engineering and increasing additional research space. There are currently 131 "R1" classified colleges and universities in the US. Out of these, only one is found in San Diego county: UC-San Diego. However, UC San Diego does not have a Civil or Environmental Engineering department for graduate students. The closest university where a San Diego resident could obtain their master's degree in Civil or Environmental Engineering at a "R1" university is UC-Irvine. The design will serve as a progressive research space for students interested in wastewater treatment and technology to perform a wide variety of innovative studies.

A wastewater learning lab will add an additional element to the learning experience of future environmental engineers in water and wastewater treatment. This DEWATS will feature a completely modular system to allow undergraduate, masters, and doctoral students the freedom to create and conduct their own treatment trains and processes at any point in the system. The collection system will be innovative, allowing students to also conduct studies regarding treatment byproducts as well as research on the wastewater itself.

Findings

SDSU academic buildings are mostly used from 7 am to 6 pm, and wastewater sources include toilets, urinals, and sinks (of all kinds). Dual plumbing in the building is found to be a potential option that can reduce wasted water as well as provide a simple way to separate out waste streams for further future research. Because treatment processes run optimally at steady state, a constant flow throughout the system is essential. The incoming wastewater characteristics will be as follows:

Constituent	Units[a]	Typical Domestic Wastewater
Biochemical Oxygen Demand	mg/L	200-290 [b]
Total Suspended Solids	mg/L	200-290 [b]
Ammonia (as N)	mg/L	6-18 [b]
Total Nitrogen	mg/L	35-100 [b]
Nitrite and Nitrate (as N)	mg/L	<1 [b]
Total Phosphorus (as P)	mg/L	6-12 [b]

Table 1: Typical Wastewater Constituents (State Water Resources Control Board).

Due to the low concentration of the influent, aerobic systems are ideal. Although an anaerobic system is more passive, they do not contain the biology that will sustain long periods of time where it won't be utilized, such as during low flow times during weekends, evenings and school holidays. The

treatment train is designed in a way that would eliminate the need for expensive chemicals and flocculants.

There are many alternative uses for the treated effluent. Most of the alternatives require burdensome paperwork, permitting and heavy regulations. Other hurdles to effluent uses include public perception and education; refer to Project Considerations and Design Summary. Recycled water is a proposed option in the Mission Valley Draft Environmental Impact Report. The intended use of the treated water will be used for irrigation on the Mission Valley Campus. A large green space is allotted for the adjacent River Park as well as additional green space on and nearby the campus.

There is an interest in different forms of research on the treatment train and separated waste streams. Alternative Solutions (Project Considerations) gives different research opportunities for undergraduate, masters, and doctoral students alike. By having a dual plumbing system, alongside the modular treatment system, it is implied that research can be conducted on the waste streams without interruption of the treatment train. This system is found to imitate industry standards and therefore provides a lab experience for students interested in water treatment operation.

These findings are significant to the recommendations and complete design of this project.

Recommendations

FLASH Engineering recommends a set of design parameters that not only minimize cost and energy but allow for a modular lab scale system. Initial design considerations allowed for a full scale treatment train with multiple sedimentation basins and alternative treatment processes. Through our findings, we suggest two initial holding tanks with separate dual plumbing to allow for nutrient recovery in either stream. The separate waste streams will be recombined after the holding tanks to be treated together while in regular use. Since this system will be designed in a modular fashion, either waste steam will be able to be separately utilized in experimentation before entering the treatment processes if needed for research.

An additional tank will be implemented before the treatment processes begin. This tank will be considered the “challenge tank,” which offers the opportunity for additional constituents to be added to the waste stream. The challenge tank offers the opportunity to add specific chemicals or strong wastes to experiment how the treatment process reacts. The challenge tank serves as a possible way for the entire treatment system to be tested against controlled constituents.

Following the holding tanks, a primary sedimentation basin will allow grit and solids to settle while nutrients continue to flow through to the bioreactors. Following the primary clarification, an aerobic system will be utilized due to the low concentration of influent. A conventional aeration bioreactor is recommended. The air will be introduced to the system through diffusers run on simple

pumps, allowing the microbial community to reduce many of the constituents within the wastewater. A secondary sedimentation basin is required and recommended to settle out bacterial biomass.

Lastly, the effluent will be disinfected with a steady flow of chlorine to comply with recycled water/purple pipe standards. With an estimated maximum volumetric flow rate of 3,500 gallons per day influent, a cistern underneath the lab building is recommended to hold the treated effluent for irrigation around the school. A week of treated effluent could provide the university with almost 20,000 gallons of water to use for irrigation purposes.

For the purpose of research, the treatment train is recommended to be completely modular. This modular train will allow for more research at different parts of the system to be conducted. The piping system will be equipped with valves so that the wastewater can be rerouted to a research bench at any point in the system. The dual plumbing can be tapped off to do nutrient recovery research for urine specific projects, such as struvite extraction. Another benefit of modular design is testing parameters for designs with anaerobic use, or different methods of biological treatment. By making a system with taps between each treatment process, research students are able to utilize this lab to its full research potential.

Conclusion

This DEWATS Learning Lab will be a state-of-the-art facility and will serve SDSU students and the surrounding community greatly. The system has the potential to provide water to most, if not all, the plants and lawns on SDSU's Mission Valley Campus. Using the recycled water for irrigation will save money as well as reduce SDSU's overall water usage.

The laboratory will expand student interest and involvement in on-campus research. Students will have the opportunity to gain unparalleled experience and knowledge regarding water and wastewater treatment technology. The modular interchangeable system will support wastewater studies ranging from experiments on the separated raw waste streams to the purple pipe treated effluent. Building a lab-scale decentralized system will offer an important contribution to the scientific community, and will hopefully be able to improve the way we treat, manage and use our wastewater..

Hopefully, this will intrigue a number of universities to offer more wastewater research facilities for faculty and students. This design may also serve as a blueprint for other institutions to implement similar DEWATS learning laboratories onto their campuses. The system will also serve as an educational opportunity for the San Diego community. A unique opportunity arises in which the negative sentiment surrounding recycled water is reversed and people can understand that wastewater can be used as a precious resource.