NORTHERN ARIZONA UNIVERSITY

Memorandum

TO: Jeffrey Heiderscheidt, Ph.D.

FROM: WEF Team

DATE: December 10, 2019

SUBJECT: CENE 476 – Section 1

RE: Final Proposal

Hello Dr. Jeffrey Heiderscheidt,

Attached below is a team compiled edited final proposal for the Water Environment Federation and Arizona Water Student Design Competition for a wastewater facility. It contains a project understanding, list of tasks, the schedule of the project, the staffing hours, and the cost of the project. If you have further questions, feel free to contact Jocelyn Ramirez via email at jr2677@nau.edu.

Thank you for the opportunity. We look forward to working with you again in the future.

Best,

WEF 20

Project Proposal:
WEF and AZ Waters Student Design Competition

CENE 476, Fall 2019

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Prepared For: Jeffrey Heiderscheidt, Ph. D, Senior Lecturer

NAU
Civil and Environmental Engineering

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List of Abbreviations

AA	Administrative Assistant
ADEQ	Arizona Department of Environmental Quality
AZ	Arizona
BOD	Biochemical Oxygen Demand
CBOD	Carbonaceous Biochemical Oxygen Demand
CMF	Compacted Media Filtration
CWA	Clean Water Act
EIT	Engineer in Training
ENG	Engineer
GAC	Granular Activated Carbon
INT	Intern
NAU	Northern Arizona University
RO	Reverse Osmosis
SENG	Senior Engineer
USGS	United States Geological Survey
UV	Ultra-Violet
WEF	Water Environment Federation
WWTP	Wastewater Treatment Plant

1.0 Project Understanding

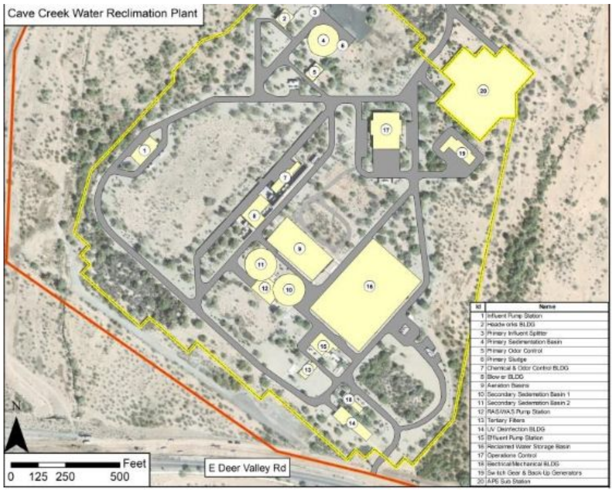
1.1 Purpose of Project

The purpose of this project is to design, retrofit, and/or expand a wastewater treatment facility for the Water Environment Federation (WEF) and Arizona Water Student Design Competition. Northern Arizona University (NAU) will compete against teams from other major Arizona institutions like Arizona State University and the University of Arizona. The competition fosters a “real-world” experience which provides students with professional skills in protecting and designing water resources like sewers, wastewater treatment plants (WWTP), biological treatments, constructed wetlands, and other sustainable efforts [1].

1.2 Background Information

Every year, universities in Arizona that are part of the AZ Water Student Chapter are eligible to apply and compete on a problem statement that is hosted by the Arizona Water Student Design Competition. This design problem varies from year to year, and includes the design or redesign of a WWTP that is located in a city throughout the state of Arizona. The specific problem statement can cover a vast majority of topics such as retro-fitting for a size upgrade or to meet new regulations, retro-fitting to include new uses such as secondary or tertiary, or retro-fitting to add in other technologies such as biosolids handling or wetlands The competition stipulations and guidelines are expected to be released on January of 2020. Some of the competition information will include location, existing conditions of the site and city, design and analysis requirements, and common WEF competition rules [1]. Due to the fact that the exact project has not been released for 2020, careful research and analysis of past WEF competitions and nearby wastewater treatment plants will be conducted in order to properly prepare for the 2020 competition.

For example, the 2018-2019 NAU WEF team was responsible for the expansion and reopening of the Cave Creek Water Reclamation Plant which is located north of the Central Metropolitan Phoenix. This plant produced A+ reclaimed irrigation and recharge water; it was shut down in 2009 but is expected to reopen in 2025 in order to meet the demand of the increased population of the area [2]. This team won the 2019 AZ Waters competition and is currently competing in the 2019 WEF Student Design Competition. The before and after layout photos are shown below in Figure 1.1 and Figure 1.2, respectively.



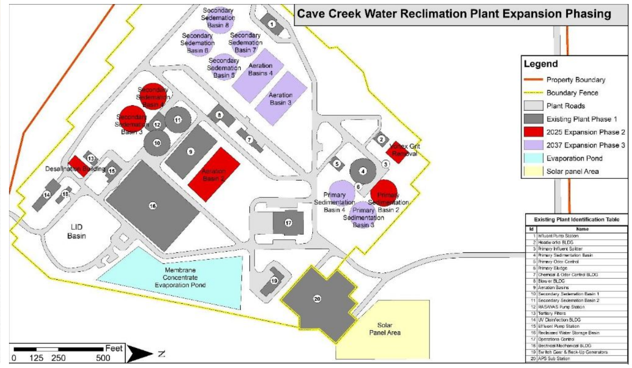


Figure 1.1: Existing facility with no new work [2]

Figure 1.2: Facility with new improvements [2]

1.3 Technical Aspects of Project

In order to complete this design technical aspects like water sources and conveyances, primary, secondary, and tertiary treatments, as well as regulations must be analyzed.

1.3.1 Wastewater Source Estimation

It is fundamental to determine the design capacity when designing a WWTP. It can be based on the region's population and industrial activities. Other factors that influence inflow include climate, the number and types of commercial, institutional, recreational, and agricultural areas[3]. Additionally, the design capacity is determined by the design life and the growth and/or decline of a population[3]. In order to appropriately size a WWTP, the hourly, daily, weekly, seasonly, and annually average peak flows should be determined. The volume of each basin and tank also need to be designed to ensure that the WWTP is capable of treating wastewater being produced.

1.3.2 Conveyance

The conveyance of water from residential and commercial areas to the plant and within the plant needs a delivery system, which consists of pumps, pipes, culverts, and open channels. Based on the amount of water flowing into the plant, the size of pipes and pumps may vary. The flow rate and velocity of the flow are also important for the design of the plant. Depending on the difference of elevation and the distance between the locations, the energy of water in the system can be found to determine the number of connections and pumps needed. In addition to pressurized pumps, it is possible to use gravity pipes to transfer water [4]. Deciding on the type of system and network employed depends on the terrain and layout of the site. It can also affect the cost, since steep slopes may require more pressurized pipes.

Moreover, a conveyance system for the sludge processing system is needed because the settled sludge produced in the primary and secondary treatment needs to be cleaned out from treatment tanks. Consideration and analysis of the needs of this conveyance is determined upon the extent of RAS in the secondary treatment.

1.3.3 Primary Treatment

Preliminary treatment is a physical treatment process including screening, coarse screens, fine screens, comminutors and grinders, grit removal, detritus tank, and hydrocyclone[5]. In this step, solids, rags, debris can be removed from wastewater. The technologies listed above should be selected and combined according to the water quality from source. The analysis needed is to determine the probable contents and contaminants of the influent. This analysis, as described above, will depend on estimations and observations of the types of industries and other infrastructures with the typical waste each produces.

1.3.4 Secondary Treatment

Pursuant of the Clean Water Act (CWA), wastewater treatment plants are required to provide secondary treatment before the effluent is discharged into natural bodies of water. In short, secondary treatment standards require the effluent to meet the monthly averaged standards for BOD_5, suspended solids, pH, and $CBOD_5$ [7]. There are more requirements concerning thermal limits, bacterial effluent limits, and other such limits that are prescribed by the Arizona Department of Environmental Quality (ADEQ) and must be followed.

The technologies that are conventionally used can be broken into six categories: Fixed Film Filtration, Membrane Bioreactors, Activated Sludge, Lagoons, Land Treatment, Constructed Wetlands, and Disinfection [8]. Except for disinfection, not all of these technologies must necessarily be employed, nor does an inclusion of one technology exclude the possibility of another. For example, it is typical for a WWTP to use either a fixed film filtration or a suspended growth digestion, but these technologies may possibly be used in conjunction with a constructed wetland.

The technologies needed are determined by considering several factors. The major factors are the efficacy of the process, site features such as climate and physical space, quantity of wastewater and efficiency of the technology, and cost. Each technology may beneficial in one factor, but disadvantageous in another, and so a careful analysis of these features are to be taken to determine the best fit technology.

1.3.5 Tertiary Treatment

Tertiary, or advanced, treatment is any treatment that follows after secondary treatment in order to meet or exceed expectations of effluent set by regulations [8]. Treating water beyond regulations may sometimes be necessary if the effluent would negatively affect the environment under conditions meeting the standards [8].

Tertiary treatment may include extended secondary treatment processes such as land treatment, but it also contains its own unique technologies. Biological treatment, such as digesters, beyond the secondary treatment sometimes are necessary if the nitrogen presence is high enough [8]. Coagulation and sedimentation is considered a tertiary treatment in a WWTP because, although it is standard in a water treatment plant, it is not conventionally used in a municipal WWTP [8]. Coagulation and sedimentation specifically targets phosphorus and suspended solids. Another tertiary technology is carbon adsorption, traditionally by granular-activated carbon (GAC), in which organic matter is adsorbed and removed from the wastewater [8]. Additional tertiary technology include microfiltration, using chemically designed media such as Blue PRO and other media, compressed media filtration (CMF), and Reverse Osmosis (RO) systems [9]

The employment of these technologies is entirely dependent on the characteristics of the effluent of the secondary treatment. The effluent must be analyzed and determined if it meets the requirements of the effluent proscribed by ADEQ and the EPA. Tertiary treatment must be used if any aspect of the effluent fails to meet the standards. A cost analysis of each technology must be conducted to determine the extent the technology can be employed. Finally, the relationship between the WWTP and its environment must be considered so as to determine if treatment must exceed the standards of secondary effluent, and if so in what way exactly.

1.3.6 Specifications and Standards

Treated water in Arizona for reuse must follow regulations set by the ADEQ, which follow the set national EPA regulations closely. Compliant regulations for reclaimed wastewater reuse classify effluent into 5 classes; A+, A, B+, B, or C [10]. In order to meet regulations a WWTP must consider what contaminants are in the influent. This can be affected by the geography of the area and/or by the industrial and agricultural activity in the area. Additionally, the location where the effluent is discharged must also be considered and analyzed. If an effluent that meets the standards of ADEQ negatively impacts the environment, the wastewater must be treated even further [8]. If the effluent is destined for a reuse purpose, such as irrigation, toilet flushing, and other reclaimed water uses, additional requirements are made for each specific reuse purpose.

1.4 Project Challenges to be Overcome

A potential challenge that is likely to affect the wastewater treatment project is the competition rules. This is because the projects will be limited in various areas such as what the teams can design, the specifics of the design, the budget, and also the time given will be a short period of time. For instance, a proposed design may not be adequate for all cities depending on the size of the site. This could change the infrastructure used. Another challenge associated with the project is the fact that Arizona varies greatly in terms of climate, such as the dry and hot climate of Phoenix compared to the wet and cold climate of Flagstaff. Thus, the design is supposed to be altered to fit the location of the city because of the changing climates. In order to avoid these problems, research can be done for both types of climate. However, the project can only start when the rules of the competition and site are released.

The difficulty of knowing which contaminants are present in each city and at what levels may also pose a problem. This ties into the potential challenge of timely communication with AZ Waters and WEF competition to clarify and specify any vague or missing information. Because time is a limited resource, it will be a challenge to balance requesting further information and designing based off assumptions and given information.

1.5 Stakeholders

The projects stakeholders include the community the WWTP is being designed for, WEF, AZ Waters, and NAU. The community will benefit from the project the most. They will experience economic, societal, and environmental impacts. WEF and AZ Waters act as clients. These organizations will be judging any designs and deliverables for the competition. ADEQ is categorized as a stakeholder in this project due to their role in supervising water regulations. Finally, NAU holds interest in this competition as the students are a representation of the institution.

2.0 Scope

2.1 Task 1: Research Preparation

2.1.1 Task 1.1: Application Process

The competition is hosted by AZ Waters and WEF, these are the state and national water associations. The competition requires student and instructor memberships for both organizations in order to participate. The total cost to join both is $35 per student. It costs $20 per year to be a WEF member and $15 per year to be an AZ Water member [11] [12]. Each team member is to sign up as a member of each organization. After becoming members, students need to apply for and register into the competition.

2.1.2 Task 1.2: Treatment Technology Research

The team will research technologies that are applicable for the various stages of wastewater treatment design: preliminary, primary, secondary, tertiary, and biosolids treatment. Technologies that are conventionally utilized in WWTPs will be studies by researching the structure of previously constructed WWTPs. Emerging and innovative technologies will also be researched through the study of EPA Emerging technology reports and research articles.

2.2 Task 2: Site Assessment

2.2.1 Task 2.1: Site Research

Once the site is assigned sites analyses need to be made using google maps, United States Geological Survey (USGS), and other online map imagery tools in order to map any existing infrastructure and geographic features that could potentially affect the final WWTP design. Some notable features include: slopes, channels, floodplains, rivers, etc. After all this information is acquired, the team can proceed to compile this information to properly generate a site map and layout of design on AutoCAD.

2.2.2 Task 2.2: Site Visit

The team can complete multiple site visits. Visiting a similar existing WWTP can be beneficial to get an idea on what to aim for and/or improve when designing for the actual site. It is also important to visit the actual site. The site will provide more detailed information that the online tools may not show as well as well as any significant information concerning the city's demographics that could impact the design.

2.3 Task 3: Treatment Design

The team will analyze the design specifications of each stage of wastewater treatment based on the needs of the community and the characteristics of the wastewater. Previous studies will be used to determine the most efficient technology in similar scenarios. Decision Matrices will be used to decide on the proper technology to use. After the design of each stage is determined, a technical memo will be written summarizing and discussing any results. All analyses will be based on the characteristics of the influent, inflow, regulation and code requirements, site restrictions, and climate.

2.3.2 Task 3.1: Plant Requirements

Plant requirements must be determined through various sources of RFIs, Arizona and county specific requirements and codes, and common assumptions made by the team. The information determined in these steps will provide the basis of the treatment in the plant.

2.3.1.1 Task 3.1.1: Source Water Characteristics

The extent of the treatment depends on the contaminants already present in the influent. Therefore, this information is necessary before designing a WWTP. The majority of the information will be based on the instructions of the WEF competition RIFs, and assumptions of common influent characteristics.

2.3.1.2 Task 3.1.2: Population Estimation

The current population of the area will be based on given information of the area from the competition rules. In addition, governmental census data will also be used to determine the most likely future population of the furthest time in the design life of the WWTP.

2.3.1.3 Task 3.1.3: Codes and Effluent Limits

The effluent limit will be set according to the codes and standards of the state of Arizona, and, depending on the area of the project, any further requirements based on either county and/or city standards.

2.3.2 Task 3.2: Preliminary Treatment

Preliminary Treatment is employed in treatment plants to remove large solids and grit. Priorities of concern include efficient technology, cost, easy maintenance, and the protection of downstream treatment technologies.

2.3.2.1 Task 3.2.1 Screen Design Decision

Various screen sizes and designs will be proposed along with technologies such as comminutors and barminutors. A decision matrix will be utilized to determine the most appropriate technology.

2.3.2.2 Task 3.2.2: Grit Chamber Design Decision

A grit chamber will be considered if necessary through a decision matrix based on cost and influent needs. If it is needed, the grit chamber will be designed through analysis and a fine screen will be considered through decision matrix to be placed subsequent to the grit chamber.

2.3.3 Task 3.3: Primary Treatment

Primary treatment is the stage in which dissolved matter is settled and removed. Factors that influence the decision of the design are cost, removal efficiency, climate, and physical site constraints.

2.3.3.1 Task 3.3.1 Sedimentation Basin Design

Sedimentation basins of various sizes, dimensions, and redundancies will be created. Different types of basins, such as rectangular and/or circular, up-flow basins, and more, will be considered. A decision matrix will be used to determine the most appropriate and efficient basin design. Additionally, the placement of sedimentation basin(s) will also be decided using a decision matrix.

2.3.3.2 Task 3.3.2 Coagulation and Flocculation

Coagulation and flocculation will be considered if necessary based on the requirements of the effluent. A coagulant will be decided upon with a decision matrix based on cost and efficiency. Flocculation will be analyzed to determine optimal mixing times. These considerations will contribute to the design of the sedimentation basin.

2.3.3.3 Task 3.3.3 Primary Sludge Handling

The frequency and method of collecting primary sludge will be determined via a decision matrix to decide on the most efficient solution.

2.3.4 Task 3.4: Secondary Treatment

The purpose of the secondary treatment is the removal of BOD and organic matter. Decisions will be based upon the physical constraints of the site in terms of area, climate, and average weather patterns.

2.3.4.1 Task 3.4.1: Organic Matter and BOD Removal

The various conventionally used technologies will be analyzed through a decision matrix to determine the best suited technology. The technologies analyzed and designed for consideration will be fixed film bioreactors, activated sludge, membrane bioreactors, lagoons, constructed wetlands, and land treatment. Once the type of technologies are decided upon, those technologies will undergo various designs, and a second decision matrix will be employed to choose the most suited form of those technologies.

2.3.4.2 Task 3.4.2: Disinfection

A decision matrix will be employed to decide the best single or combined disinfection technology of chlorine and its derived forms, Ultra-Violet (UV) radiation, and ozone.

2.3.5 Task 3.5: Tertiary Treatment

Tertiary treatment is used in wastewater treatment plants to remove any inorganic matter that exceeds the regulation requirements. Major factors included in the decision analysis process are effluent requirements, influent characteristics, and cost. Levels of contaminants, conventionally being at this stage nutrients and inorganic matter, will be determined based on the previous treatments, and technologies, such as extended biological treatments, adsorption, and others, will be considered through a decision matrix.

2.3.6 Task 3.6: Sludge/Biosolids Management

The treatment and disposal of sludge is a complex and necessary stage in itself. Factors which affect the final decisions on the handling process/methods may include; the legal and illegal status of certain biosolids application in the state of Arizona, cost, quantity of sludge inflow, and the climate and size of the site. The purpose of the sludge will be determined using a decision matrix based on the logistics and legality of permissible application in Arizona. The application purposes analyzed will be land application, incineration, and beneficial use products. Having determined these goals, the standards of treatment will be decided. The technologies used, such as gravity belt thickeners, will be analyzed through a decision matrix.

2.4 Task 4: Cost/ Economics

2.4.1 Task 4.1: Life Expectancy

The life expectancy of this plant is different from the design life in the sense that this will be solely based off of the estimated maximum life seen in equipment and buildings. For equipment and machines, the life expectancy will be based off the demand for clean water and all processes that create damage to equipment overtime, while building and structure expectancies will fall under a larger range that isn’t impacted by water demand as much [3].

2.4.2 Task 4.2: Construction Costs

The cost of construction for the retrofit of the plant will be based on several sources, such as the team advisors and other professors, past projects, and general construction processes found in textbooks. Advice and knowledge from the Technical Advisor and other professionals in the department will be sought after due to their experience. The two past WEF competition projects will provide guidance and help in identifying the essential areas of cost that need to be accounted for in the construction cost estimation. Information gathered from textbooks will help attain specific information needed for accurate cost estimation. The retrofit construction cost will encompass costs that relate to the acquisition of new land, project financing, bid processing, actual construction (including labor costs), and project record documents (legal, federal, and environmental) [3].

2.4.3 Task 4.3: Maintenance Costs

Maintenance costs will be evaluated on the chosen infrastructure and processes used in the new retrofit and/or expansion. It will be adjusted based off of population fluxes and design performance requirements that happen over the period of the plants life. New regulations, laws, retrofits, and damages may change maintenance costs overtime compared to the original maintenance cost estimation.

2.4.4 Task 4.4: Operation Costs

Operation costs will entail the labor costs of plant workers, costs needed to power the plant with energy in order to treat water, and costs related to pumping water in and out of the plant. In order to get as close an estimation as possible, other water treatment facilities with similar processes and size will be researched. The specific operation cost for the chosen process will be analyzed.

2.5 Task 5: Project Impacts

2.5.1 Task 5.1: Social Impacts

Social Impacts will be found by analyzing how the possible increase in water supply and or quality may affect the community around the area. This can include the social benefits of higher quality drinking water, easier access to reused water for personal or industrial needs, or the social upbringing that more usable water brings to an area when it comes to business and home development. This could also affect recreational purposes. Other social impacts that will be analyzed are possible negative impacts that citizens may have with the possible use of chemicals, new treatment methods, size, and local effect that the plant may cause to the area.

2.5.2 Task 5.2: Economic Impacts

Economic impacts will be found by researching the current status of the targeted area in order to find what feasible economic influencing results can come out of a new project to the existing plant. These results can range from the economic gain from new businesses and homes being built, new and alternative business that may thrive off of reclaimed water such as golf courses, rise in home and land value, and the new jobs that will need to be filled if the new site requires such.

2.5.3 Task 5.3: Regulatory Impacts

Regulatory impacts will focus upon federal, state, and local regulatory laws, codes, and practices. The discharge of water, use of energy, handling of by-products, and safety regulations are examples of what will have to be researched and followed in order to meet all levels required of the plant to operate.

2.5.4 Environmental Impacts

Environmental impacts will be found by studying the original difference in the influent/effluent compared to the proposed influent/effluent impact that the retrofit will bring. This impact will also cover how the possibility for an increase in discharge for new areas will affect the environment.

2.6 Task 6: Project Deliverables

2.6.1 Task 6.1: Reports

The team will compile reports for 30%, 60% and 90% of the progress of the project updating the information gathered and design completed at that time. These documents will be submitted to the grading instructor.

2.6.1.1 Task 6.1.1: 30% Progress Report

30% progress report includes the work before preliminary treatment. The team should complete Task 1 Research Preparation, Task 2 Site Assessment, and Task 3.1 Plant Requirements in Task 3 Site Assessment.

2.6.1.2 Task 6.1.2: 60% Progress Report

60% progress report contains the work done in 30% progress report. The new work in 60% progress report is from Task 3.2 Preliminary Treatment to Task 3.6 Sludge/Biosolids Management.

2.6.1.3 Task 6.1.3: 90% Progress Report

This progress report is the first draft report containing the design and analysis of this project.

2.6.1.4 Task 6.1.4: Final Report

A final report containing the total design of WWTP will be combined and submitted to instructors with the full conclusions and results of the project at completion.

2.6.2 Task 6.2: Presentations

The presentation provides the information about the project and the description of work that is done during the project. Presentations will be completed for a 30%, 60%, 90% and Final Reports.

2.6.2.1 Task 6.2.1: 30% Progress Presentation

This presentation demonstrates the work team done by 30% progress report.

2.6.2.2 Task 6.2.2: 60% Progress Presentation

This presentation introduces the work and details by 60% progress report.

2.6.2.3 Task 6.2.3: 90% Progress Presentation

This presentation shows all works, the design and analysis of WWTP, of this project.

2.6.2.4 Task 6.2.4: Final Presentation

Final presentation is at the end of the semester and it presents the design and analysis of this project.

2.6.2.5 Task 6.2.5: UGRAD Presentation

The UGRAD presentation is on April 24th, 2020. This presentation demonstrates the final design for the competition.

2.6.3 Task 6.3: Website

The website consists of the home page, project information page, documents page, and communication page. This deliverable can present and publish the information about this project, which includes the description and introduction of the project, client information, team information, technical advisor information, and detailed document and presentation information.

2.6.4 Task 6.4: Competition Submittals

The deliverables information should be found in the student design competition from the WEF website. The submittals from competition need to be achieved.

2.7 Task 7: Project management

2.7.1. Task 7.1: Meetings

Setting up meetings allows the team to discuss, share ideas, as well as enables the team to progress on the project while remaining on the same page by sharing resources and updating the other team members. Some meetings will also involve advisors/ clients to better inform the team on their needs and/or constraints. All meetings must be recorded for reference use in the future. This aims to give team members a better understanding of the project.

2.7.2. Task 7.2: Schedule Management

The team is expected to meet once or twice every week. The team needs to manage and update the schedule according to any changes throughout the project.

2.7.3. Task 7.3: Resource Management

The team must manage financial resources, inventory, human skills, production resources, technology resources, and natural resources. The team is expected to be familiar with the resources available like AutoCAD, FlowMaster, CulvertMaster, and other software.

2.8 Exclusions

2.8.4.1 Environmental Impact Study/Environmental Assessment

This is an important part of the project that should be considered before, during, and after construction, however the team will not be conducting this analysis or assessment due to lack of time and funding.

2.8.4.2 Site Construction

The team will also not be responsible for any site planning for the purpose of construction. This is because this would require a considerable amount of construction plans that would look at grades and structural analysis. The team will design a layout and decide on the technologies that will be used, but will not detail how to construct them.

2.8.4.3 Physical Site Surveying

Any surveying and geotechnical work will also be done by a different contracting company prior to the construction of the WWTP design, if any is to be done. The team will not perform this action.

2.8.4.4 Acquisition of Permits

No permits required for the operation of WWTPs, such as National Pollutant Discharge Elimination System Permit, nor any permits required for the construction or development of land will be sought out nor acquired by this team.

2.8.4.5 Lab/Pilot Studies

We will not be conducting any lab work or pilot studies since WWTP systems are well established and follow similar processes.

3.0 Schedule

3.1 Milestones

The milestones include the 30%, 60%, 90%, Final Reports, and competition deliverables. The first three milestones serve as project status update (PSU). Each PSU is expected to be completed 25 work days from each other. The Final report and competition deliverables will have due dates not long after the PSU's are completed. The UGRAD Presentation will be on April 24th, 2020. Although the completion date has not been set, the competition is also expected to be in mid-April. For further detail on the schedule, see the Attached Gantt chart which also contains the critical path.

3.1.1 PSU 1: 30% Progress Report

The 30% Progress Report is set be completed on Thursday 2/13/2020 . It will include previous information completed from the Gantt Chart.

3.1.2 PSU 2: 60% Progress Report

The 60% Progress Report is set be completed on Friday 3/13/2020. It will also include previous information completed from the Gantt Chart.

3.1.3 PSU 3: 90% Progress Report

The 90% Progress Report is set be completed on Friday 4/10/2020. It will include previous information completed from the Gantt Chart. At this point the project should be complete and will only require a review by the technical advisor, before submitting the final report.

3.1.4 Final Report

The Final Report is set be completed on 4/28/20. The final report is the polished 90% deliverable. It will be the final design proposal.

3.1.5 Competition Deliverables

Deliverables include the technical paper and actual presentation. This should be completed prior to the submission date in order to allow for any edits that may be needed. Finally, these should be submitted prior to the competition which is typically held in mid-April.

3.1.6 UGRAD Presentation

The actual Presentation is on April 24th, 2020. The poster board, powerpoint, and any additional material should be completed prior in order to allow for edits and printing.

3.2 Critical Path

The critical path must be followed in order to avoid falling behind. These tasks are the most important to the progression of our project. Some of the tasks in the path include; the application process, the site research, the population estimation, design of the tertiary treatment, and the competition submittals. See attached Gantt chart for further detail.

4.0 Staffing

The staffing of this project is divided into five different roles: the Senior Engineer (SENG), the Engineer (ENG), the Engineer in Training (EIT), the Intern (INT), and the Administrative Associate (AA). Typically, the role of the SENG is to direct and supervise over the general progress of the engineering project. Commonly, SENG is a registered professional engineer (PE), and has the duties of a more administrative and business nature. The ENG, in this proposal, acts as the PE during the course of the project. The ENG's role and duties include that of project manager as they will be the one who more personally than the SENG directs and manages the work for the project. Additionally, the ENG reviews the vast majority of the work done. The EIT, in the engineering industry, is an engineer who has passed the fundamental engineering exam with little experience in the industry. The EIT will be doing a great amount of the researching, designing, and work for the project. The ENG will closely supervise the EIT and assist. The INT is most commonly an undergraduate student working in an engineering firm. Due to the lack of experience, the work of the INT requires no more technical work than an undergraduate may be assumed to be competent in, and thus is relegated to tasks of research, data collection, and other such work. Finally, the AA requires little technical skills in engineering, but rather records and keeps information gathered or created throughout the process. This work includes taking notes of meetings, writing reports based on the results of the engineers, and other work that requires records.

Table 1 shows the staffing hour break down. The design should take a total of approximately 960 hours split among the team.

Table 1: Staffing Hour Estimation

Task	SENG	ENG	EIT	AA	INT	Task Total
1.0 Research Preparation	**2**	**2**	**12**	**7**	**32**	**55**
1.1 Application Process	**2**	**2**	**2**	**2**	**2**	**10**
1.2 Treatment Technology Research	**0**	**0**	**10**	**5**	**30**	**45**
2.0 Site Assessment	**5**	**8**	**18**	**3**	**8**	**42**
2.1 Site Research	**0**	**0**	**10**	**3**	**0**	**13**
2.2 Site Visit	**5**	**8**	**8**	**0**	**8**	**29**
3.0 Treatment Design	**15**	**133**	**77**	**17**	**52**	**372**
3.1 Plant Requirements	**3**	**3**	**4**	**0**	**7**	**11**
3.1.1 Source Water Characteristics	1	1	2	0	4	6
3.1.2 Population Estimation	1	1	0	0	1	1
3.1.3 Codes and Effluent Limits	1	1	2	0	2	4
3.2 Preliminary Treatment	**2**	**20**	**10**	**0**	**4**	**36**
3.2.1 Screen Design Decision	1	10	5	0	2	18
3.2.2 Grit Chamber Design Decision	1	10	5	0	2	18
3.3 Primary Treatment	**3**	**30**	**13**	**0**	**4**	**50**
3.3.1 Sedimentation Basin Design	1	20	7	0	4	32
3.3.2 Coagulation and Flocculation	1	5	3	0	0	9
3.3.3 Primary Sludge Handling	1	5	3	0	0	9
3.4 Secondary Treatment	**3**	**30**	**15**	**5**	**12**	**96**

Table 1 (Continued): Staffing Hour Estimations

Task	SENG	ENG	EIT	AA	INT	Task Total
3.4.1 Organic Matter and BOD Removal	2	20	10	5	10	78
3.4.2 Disinfection	1	10	5	0	2	18
3.5 Tertiary Treatment	**2**	**30**	**20**	**7**	**15**	**101**
3.6 Sludge/Biosolids Management	**2**	**20**	**15**	**5**	**10**	**78**
4.0 Cost/Economics	**8**	**16**	**16**	**16**	**8**	**64**
4.1 Life Expectancy	**2**	**4**	**4**	**4**	**2**	**16**
4.2 Construction Costs	**2**	**4**	**4**	**4**	**2**	**16**
4.3 Maintenance Costs	**2**	**4**	**4**	**4**	**2**	**16**
4.4 Operation Costs	**2**	**4**	**4**	**4**	**2**	**16**
5.0 Project Impacts	**4**	**8**	**32**	**0**	**0**	**44**
5.1 Social Impacts	**1**	**2**	**8**	**0**	**0**	**11**
5.2 Economic Impacts	**1**	**2**	**8**	**0**	**0**	**11**
5.3 Regulatory Impacts	**1**	**2**	**8**	**0**	**0**	**11**
5.4 Environmental Impacts	**1**	**2**	**8**	**0**	**0**	**11**
6.0 Project Deliverables	**16**	**150**	**82**	**27**	**27**	**302**
6.1 Reports	**6**	**80**	**45**	**17**	**17**	**165**
6.1.1 30% Progress Report	1	10	10	2	2	25
6.1.2 60% Progress Report	1	20	10	5	5	41
6.1.3 90% Progress Report	2	20	10	5	5	42
6.1.4 Final Report	2	30	15	5	5	57
6.2 Presentations	**4**	**40**	**22**	**0**	**0**	**66**
6.2.1 30% Progress Presentation	1	5	5	0	0	11
6.2.2 60% Progress Presentation	1	10	5	0	0	16
6.2.3 90% Progress Presentation	1	10	5	0	0	16
6.2.4 Final Presentation	1	15	7	0	0	23
6.3 Website	**1**	**10**	**5**	**5**	**5**	**26**
6.4 Competition Submittals	**5**	**20**	**10**	**5**	**5**	**45**
7.0 Project Management	**14**	**41**	**21**	**21**	**0**	**97**
7.1 Meetings	**14**	**21**	**21**	**21**	**0**	**77**
7.2 Scheduling	**0**	**20**	**0**	**0**	**0**	**20**
TOTAL	**64**	**358**	**258**	**91**	**127**	**898**

The hours described is summarized in Table 2, which only displays the major tasks of the project with the corresponding hours of each position. From this, it can be seen that the estimated total hours of the project requires 898 hours. Amongst the five members, these hours divide to approximately 180 hours for each team-member. It is common that for such a project as this, each team-member would work 150 to 200 hours. Thus, as the total hours fall in this range, this seems to prove that this is a rational estimate.

Table 2: Summary Staff Hours

Task	SENG	ENG	EIT	AA	INT	Task Total
1.0 Research Preparation	2	2	12	7	32	55
2.0 Site Assessment	5	8	18	3	8	42
3.0 Treatment Design	15	133	77	17	52	372
4.0 Cost/Economics	8	16	16	16	8	64
5.0 Project Impacts	4	8	32	0	0	44
6.0 Project Deliverables	16	150	82	27	27	302
7.0 Project Management	14	41	21	21	0	97
TOTAL	64	358	258	91	127	**898**

Furthermore, from Table 2, it can be seen that the ENG and EIT are the positions that have the most hours. Due to the technical nature of designing a WWTP, it is estimated that the majority of the work will be done by the technically-proficient positions: the ENG and EIT. The AA and INT have roughly half of the EIT and ENG's hours. The AA and the INT are assumed to do work mostly concerned with writing and editing documents and double checking computations. Because of the less intensive nature of the work, the hours of the AA and INT are much less than those of the ENG and EIT. Finally, the SENG has the least amount of hours dedicated to that position, summing to a total of 64 hours. There are several reasons that the SENG has the least amount of hours. The first is that the position of SENG mostly is involved with management of the project on the broadest scale, ensuring that the direction of work is correct, but leaving the details of the work to the other positions. The second reason is that the SENG is the most expensive in terms of billing, and so, in order to be most effective with cost, the SENG's hours have been reduced to only the necessities.

5.0 Cost

The largest contributor to cost is the personnel cost. In order to keep the cost down most of the work is to be completed by the engineer and engineer in training. The senior engineer will only be included to verify information as well as some administrative management and client contact issues. The travel costs indicated the worst case scenario for a site visit. Since the site might be in a warmer climate the team could make a site visit to Phoenix (288 mile 1-day round trip). The cost was calculated at $0.58/mi. It also includes a van rental rate of $43/ day. In addition, the cost also accounts for a 3 day conference that will require hotel stay in tempe (310 mile round trip). This cost includes the same travel rates mentioned before for the site visit. However, this trip also includes a hotel stay of two nights ($133 per room/ night). Furthermore, no software costs will be included, since the software needed is already available to the team. Finally, the supplies cost includes 3D printing for a physical model of the design as well as membership costs for AZ Water and WEF. The cost is $0.05/gram for 1000g. In total the design should cost around $90,000.

Below Table 3 contains the breakdown of cost. It includes costs due to personnel pay, travel and supply expenses, as well as the overall costs.

Table 3: Cost Estimate for Engineering Services

1.0 Personnel	**Classification**	**hours**	**Rate $/hr**	**Cost**
	Senior Engineer	64	195	$12,480
	Engineer	358	120	$42,960
	EIT	258	100	$25,800
	Admin. Assist	91	50	$4,550
	Intern	127	20	$2,540
			Personnel Sub-total	**$88,330**
2.0 Travel	**Classification**	**Items**	**Rates**	**Cost**
	Site Visit	288 mi max	$0.58 / mi	$168
		Van Fee	$43 / day	$43
	Competition	310 mi	$0.58 / mi	$180
		Van Fee	$43 / day	$ 129
		2 Rooms 2 Nights	$ 133/room/ night	$532
			Travel Sub-total	**$1,040**
3.0 Supplies	**Classification**	**Items**	**Rate $/mi**	**Cost**
	3D Printing	1kg	$0.05 / g	$50
	Memberships	5 people	$35 / person	$175
			Supplies Subtotal	**$225**
Total				**$89,395**

6.0 References

[1] Water Environment Federation, "WEF Student Design Entry Guidelines," 2019 February. [Online]. Available: https://www.wef.org/globalassets/assets-wef/2---membership member-associations/students-and-young-professionals/wef-competition-guidelines-2019 Pdf.

[2] 2019 AZ Water Student Design Competition, “CCWRP Rehabilitation Project: Final Report” 2019April. [Online].Available: https://www.cefns.nau.edu/capstone/projects/CENE /2019/WEF/ Technical_Drawing/ Final_Design_Report.pdf.

[3] Davis, M. (2017). Water and wastewater engineering. New York: McGraw-Hill Education

[4] U.S. Fire Administration. “Water Supply Systems and Evaluation Methods,” FEMA, Oct. 2008. [Online]. Available:https://www.usfa.fema.gov/downloads/pdf/publications/water _supply_systems_volume_i.pdf

[5] EPA. “Wastewater Technology Fact Sheet,” [Online]. Available: https://www3.epa.gov/npdes/pubs/final_sgrit_removal.pdf

[6] M.B. Pescod. (1992). Wastewater Treatment and Use in Agriculture. [Online]. Available: http://www.fao.org/3/t0551e/t0551e05.htm

[7] M. Davis, Water and Wastewater Engineering: Design Principles and Practice, McGraw Hill ,

2010.

[8] EPA, "Primer for Municipal Wastewater Treatment Systems," Environmental Protection Agency, Washington D.C. , 2004.

[9] EPA, "Emerging Technologies for Wastewater Treatment and In-Plant Wet Weather Management," Environmental Protection Agency, Washington D.C., 2013.

[10] AZDEQ, "ARTICLE 3. RECLAIMED WATER QUALITY STANDARDS," AZDEQ, 2001.

[11] . W. Association, "AZ Water Membership," [Online]. Available: https://cdn.ymaws.com/ww

w.azwater.org/resource/resmgr/register-membership/2016AZWaterMembershipForm.pdf
.

[12] W. E. Federation, "WEF Membership," [Online]. Available:

https://www.wef.org/membership/join-wef/membership-categories/students/.