Campus Pond: A Filtered Pond Ecosystem Built at CCNY

City College of New York

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Summary

Nature is an essential part of daily life, we rely on it to provide us with food, water, nutrients, and many resources needed for survival. Nature exists all around us, sometimes its beauty being overlooked. Being surrounded by a body of water can have a tremendous effect on one's mind, calming their mood and improving their mental health. Another service provided by nature is the learning opportunities it holds for humans. Charles Darwin spent time on the island of Galapagos, and established the theory of natural selection by studying organisms that existed in the ecosystem. This proposal explores the opportunities and benefits a campus pond will bring to The City College of New York (CCNY). We propose building a filtered excavated pond in front of the Shepard Hall. The pond will harbor an ecosystem of frogs, fishes, worms, and plants that will add biodiversity to the campus. This paper will be essential in understanding the engineering plans such as dimensions and location as well as technologies inside the pond, which includes the filtration system, pond pumps, heating system, and aerators. This paper also depicts the time it will take to build the pond and how much it will cost to build and maintain. The project will take about a week to build and the fundamental cost to build and maintain this pond will be an estimated $15,250.93. Lastly, the project will be beneficial for the students at CCNY, in terms of allowing improved mental health and providing learning opportunities for those studying ecology, biology, and geography.

Author's Note

This paper was prepared for English 21007 taught by Professor Susan Delamare.

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Introduction

Natural formations and structures have always been a definitive driving force for people throughout our history of the world. Things like creativity, inspiration and wonder created a drive to explore and discover the secrets of the things around us. This inquisitive nature embedded within us over time cultivated and acted as a jump start into our push for scientific research. Isaac Newton is said to have discovered the laws of gravity by observing an apple that fell from a tree, which eventually allowed him to establish the law of gravitation. Similarly, Charles Darwin theorized the ideas of natural selection and evolution by observing the ecosystem of birds on the Galapagos Islands. Nature allows people to observe, question, and learn about the world around them. People have also used natural structures such as lakes, ponds, hills, large boulders and mountains for mental health purposes, as surrounding oneself with the beauty of nature can have positive effects on one's mood. For example, taking walks through forests, hiking up hills, swimming, and boating are all activities humans engage in to clear their mind and improve their mood. In addition to that, these environmental structures formed around us are often home to very diverse and rare ecosystems. Observing these ecosystems closely can showcase the different chain reactions, food webs, and symbioses that occur when two or more natural variables are in contact with each other. Many students, especially those who have an inclination to natural sciences majors and fields such as biology and ecology, can study and learn from the natural structures and ecosystem that surround them. The idea of natural structures like ponds being valuable to the world because of the environmental and aesthetic value they add is prevalent. So much so, that owners of public parks and other outdoor spaces often build artificial ponds in these areas as they are one of the easiest man made structures to make.

Figure 1

Springtime At Our Lily Pond

Note. Reprinted from "Springtime at our Lily Pond" by Brooklyn College (n.d.). *Academic training (AT) for J-1 students after degree*. Brooklyn College WebCentral. http://www.brooklyn.cuny.edu/web/academics/centers/magner/employers/hiring-international-students/at-for-j1-ad.php

That's where our project comes in. We would like to propose the creation of a pond located next to the entryway of Shepard Hall in the City College of New York (CCNY) campus. The purpose of the pond is to both educate and improve the mental health of students at CCNY. This project will add to the aesthetic value on campus, allow students to spend their leisure time surrounded by a natural body of water through the use of benches near the pond and provide a rich diverse ecosystem sustainable for many animals like frogs, fishes, and plants. In addition, this pond can allow for knowledge advancement on this campus as it can be used for laboratory field work for many science classes. This will build an awareness and offer a visual representation of the systems taught in class, which is a core and essential skill all scientific

researchers need on their resume. The convenient nature of the pond being on campus means students don't have to travel far outside of campus to gain field work experience either. The ecosystem selected for this pond consists of koi fish, water lilies, algae, tadpoles, minnows, and worms, all of which are compatible with freshwater and require little space to thrive. These will be the core of the ecosystem that can be studied in ecology, environmental science, and marine biology classes.

We will go about creating this pond by first finding leveled ground by use of a bubble level, carefully picking the most even ground level for our pond. We will then measure the complete area of the landscape so we can gauge where exactly we will start our excavation. After carefully determining our space for our pond we will measure out our desired dimensions optimal for our water environment. We will then mark the desired size of our pond structure using excavation pins to be precise. The excavation process can then begin following the blueprint from other small man made ponds. Using the dimensions, we can then estimate the complete volume for the pond which will be critical in the process of picking a filter. Using the estimated volume, we can determine the technology we will place inside our pond as they are different options for varying volumes. We will then add the filament layer in the form of a pond liner so the water can remain in the pond and not seep through. We can then add a small amount of the dirt excavated on top of the pond liner to give it a more natural look. The next step would be to pick a proper placement area for the filter that will be able to filter the full amount of water unhindered. We will then connect to the nearest water source and fill the pond until it's at capacity through the piping places alongside the pond. After all of this is complete we can introduce our plants and marine animals into our newly formed pond structure.

Objective

This project is aimed at proposing the idea of building an excavated pond with a diverse ecosystem on the CCNY campus. The objectives of this project are:

1.1. Identifying the benefits of building a pond on campus academically by creating a hands-on learning environment for students at CCNY taking biology, ecology, and geography courses.

1.2. Establishing the importance of a pond in acting as a mental health sanctuary for individuals at CCNY.

1.3. Describing the location, dimensions, and technical descriptions of each technology and part of the pond.

The budget (Figure 6) depicts the total cost for the building and maintenance of the pond. The task schedule (Appendix B) indicates the length of required time and tasks for the completion of the project.

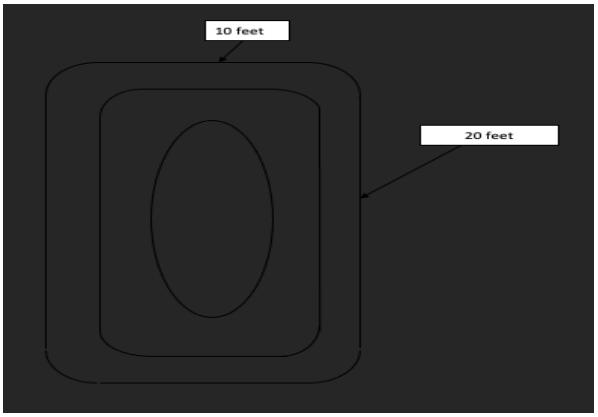
Technical Description of Campus Pond

Description of the pond:

The pond's top view will be rectangular with rounded edges and the following measurements: 20 ft length, 10 ft width, and 9 feet depth. This is shown in figure 1.

Figure 2

POND SCHEMATICS: TOP VIEW

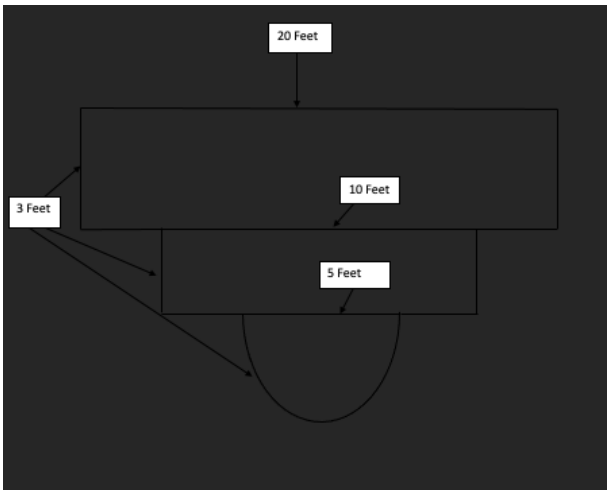


Note. Printed by a student (2022, December 12).

The pond consists of three levels. All of the levels have a width of 10ft. The difference in their length, height, and geometry is shown in figure 2 and will be described further in the order of increasing depth.

Figure 3

POND SCHEMATICS: SIDE VIEW



Note. Printed by a student. (2022, December 12).

The first pond level extends 20 inches across and is 3 feet deep. Below is the second level, it has a length of 10 inches and a depth of an additional 3 ft. The third level is not rectangular like the previous levels. This level consists of a semicircle that is 5 ft in length and an additional 3 ft in depth. The result is a staircase-like formation to mimic the structure of a natural pond as shown in figure 4. Also, stair-like levels in contrast to steeper levels is a more stable structure to build and it also makes the pond easier to get in and out of during its excavation and maintenance.

This pond will be located on the grass area surrounded by Shepard hall at CCNY. This area was chosen due to the adequate amount of space and it being a well leveled base for the pond. Figure 3 shows the exact area the pond will be built and the image provides perspective of the levelness of the land.

Figure 4

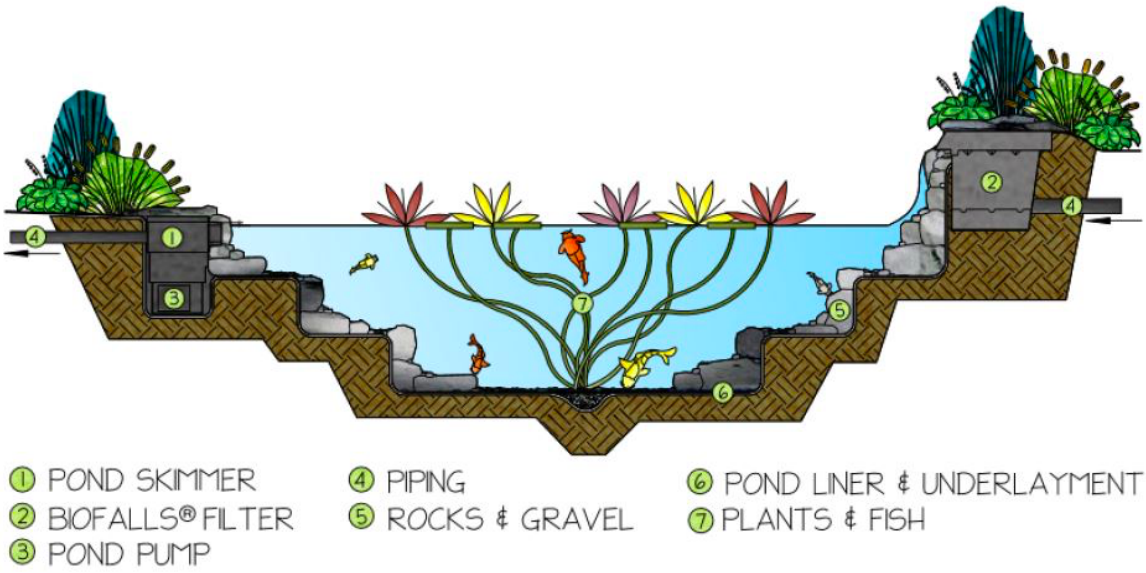
POND PLACEMENT AREA

Note. Printed by a student.(2022, December 12).

Placing the pond in this area allows anyone near a window at Shepard Hall the ability to view the pond from their classrooms. It is a convenient place for everyone on campus as well. Figure 3b, an image of the pond at Brooklyn College is a depiction of the transition of figure 3 to a completed pond and shows the interaction of students with the area.

Figure 5

PARTS OF POND AND EQUIPMENT DEFINED



Note. Reprinted from *Parts of a pond and equipment: Colorado Ponds, waterfalls and service*. Colorado Pond Pros. (2022, October 4). Retrieved December 11, 2022, from https://coloradopondpros.com/parts-of-a-pond/

Lists of Parts and Functions:

The equipment that will be used for the pond are: a pump, filter, aerator, and heater. The purpose of this equipment is to ensure that functions necessary for good pond health occur. These functions are: recirculating and providing oxygen to the water, filtration, and heating. A description of this and other components of the pond are described below. Figure 4 is a reference image for the standard equipment.

1. Pond Skimmer (Mechanical Filter)

The pond skimmer removes debris and other waste materials that float in the water. Its purpose is to prevent the waste from falling to the bottom floor of the pond which will make it harder to clean (Everything Ponds, n.d.).

2. Biological Filtration System

Biological filters house beneficial bacteria that clean the pond water on a molecular level (Everything Ponds, n.d.). This allows the water to be chemically safe to ensure survival of organisms. Having a filtration system will maintain good water quality and support the ecosystems' longevity and survival.

3. Pond Pump

The pump pulls water to its inlet and releases it through its outlet and into piping. Without the pump, water would not travel vertically through the pipe in the pond and thus, water will not travel to the filter and heater. (University of Michigan, n.d.) The pump is also necessary for different parts of the water to be in direct contact with the air through the recirculation of water. (cite)

4. Piping

The pond needs a rigid pipe that will be used to connect the pond to the filter, skimmer, and a water source.

5. Rocks and Gravel

Rocks and gravel are needed to cover the floor of the pond in order to replicate a natural environment for the organisms that will live in the pond (Zuri, 2021). They also help pond liners stay in place and protect liners from coming in contact with the sun which helps it not deteriorate (Zuri, 2021).

6. Pond Liner and Underlayment

The pond liner and underlayment provides a barrier between the soil and the water that will be in the pond (Perkins, 2017). If the water was filled directly on the ground, the water would seep inside and would not have a solid foundation in comparison to having liner and underlayment placed over the ground (Perkins, 2017).

7. Plants and Fish

The plants and fish work together in a symbiotic relationship to form an ecosystem in the pond. The organisms that will be present in the campus pond are freshwater worms, bullfrog tadpoles, water lilies, minnows, plants , and koi fishes. These organisms and the ecosystem they create will add biodiversity to the campus community.

8. Aeration (not shown in figure 5): The aerator system supplies oxygen to the pond water.(Garden Pond USA, n.d.) The compressor retrieves air from the atmosphere and delivers it to diffusers which then release that air into the pond. (Everything Ponds, n.d.)

9. Heater (not shown in figure 5): The pond heater will only be used during certain times of the year when the weather is colder, such as late fall or winter. It will be used to keep the water warm enough for the organisms such as koi fish to survive comfortably.

Equipment location:

The location of the equipment in this pond is as follows. The pump is on the ground in close proximity to the pond. The filter and heater are on the ground as well. Piping connects the pump, filter, and heater together as one system and all of these units are level with the pond surface. The aerator consists of a compressor and diffusers. The aerator's compressor is on the ground at a height at least level to the pond surface. The compressor will be near an outlet and the diffusers will be placed in the pond.

Preliminary Literature Review

Drake et al., (2022) show the application of a campus pond in adding educational value to biology, ecology, and geography courses at Missouri Western State University (MWSU) through highlighting the learning experiences gained by students. Applied and hands-on learning improves students skills by having them apply their knowledge learned in classrooms to do field work research out in the real world (Drake et al., 2022). At MWSU, students were able to use the nine ponds located on campus as a hands-on learning environment (Drake et al., 2022). The article tells stories of students who learned about their interest for field work and research through studying the pond ecosystems. Another student explains the geospatial skills developed through researching the location of the ponds (Drake et al., 2022). This project allowed students to experience field work that would be impossible without the presence of the campus ponds, such as biology students going out to collect turtles and macroinvertebrates or measuring the dissolved oxygen level contents in the water (Drake et al., 2022). One student at MWSU can be seen in a lab using collected samples of pond water to process for flocculation and pelleting for virus particles (Drake et al., 2022). All of these experiences gained by MWSU students provides abundant evidence that a campus pond can add immense educational experience for students. Adding a pond to the City College of New York campus should yield a similar response amongst the students and faculties in the biology, chemistry, geography, and ecology departments who yearn for on campus field work opportunities.

Figure 6

Two Biology Students Collecting Macroinvertebrates

Note. Reprinted from Drake, D. M., Elias, A., Ganong, C., Grantham, M. L., & Mills, M. S. (2022). Transforming the Applied Learning Experience Through Interdisciplinary Fieldwork. *Geographical Bulletin*, *63*(2), 59–66. [Figure].

Barton and Pretty (2010) argue that proximity to nature has a direct positive impact on one's mood, as one participating in green exercising (activity in nature) will have improved mental health. The CCNY campus is located in New York City, an urban environment where students lack access to natural bodies of water such as lakes and ponds on a daily basis without having to commute far outside of campus. Barton and Pretty (2010) state that 16% of the general population are affected by mental health disorders at any given time. However, according to the Mayo Clinic Health System, up to 44% of college students experience symptoms of depression

and anxiety (Druckenmiller, 2022). Depression and anxiety can directly impact a student's ability to focus on schoolwork and stay motivated. Green spaces are of importance when it comes to improving mental health, engaging in green spaces by simply having a view of nature through a window or being in the presence of nature has shown to dramatically improve one's mental health (Barton and Pretty, 2010). Simple green exercise such as walking or meditating amongst nature leads to positive outcomes in mental health (Barton and Pretty, 2010). Presence of water in green spaces generates more positive outcomes in mood, encouraging people to spend time near waterside such as ponds, rivers, and lakes (Batron and Pretty, 2010). Improved mental health of students leads to a happier overall student body, which can have a positive impact on a student's academic performance. Building a pond on the CCNY campus can directly contribute to improved mental health of thousands of students.

Gelengenis et al., (2006) address a possible obstacle and consideration to make in maintaining an outdoor open pond ecosystem that arises during the winter and assess the best solution to maintaining a warm water temperature suitable for fish cultivation. Open ponds will be directly affected by the outdoor temperature during the winter, dropping in temperature and even freezing over as the weather gets colder. Increasing the temperature of the water during winter can improve the pond organism's chance of survival, by improving their metabolic rate and cellular respiration (Pond Informer, 2018). The article discusses an alternative solution to heating fish ponds, which is using warm fluids from geothermal wells built nearby to keep the open-air pond from freezing over (Gelegenis et al., 2006). This biggest strength of this alternative is the sustainability and eco-friendly aspect, as the geothermal wells are a renewable source of energy. The injecting of warm fluids from geothermal wells is extremely successful in the research, showing the temperature of the pond would be raised by 5°C whereas the heat

exchangers would lower temperature by 2°C (Gelengenis et al., 2006). In the context of this project, a weakness of using geothermal wells to maintain pond water temperature is that it's not feasible because building a well for a small campus pond is not cost effective. The paper also puts emphasis on aquaculture and fish cultivation and growth whereas the campus pond will only be used for academic and aesthetic purposes (Gelengenis et al., 2006). Thus, using a fish pond heater would be more efficient for the purpose of this campus pond.

Budget

The budget of the pond construction and maintenance can be divided into three main components. The first component is the equipment needed for pond maintenance. This will include a pond kit that comes with pump, filter, skimmer, drain cover, air diffuser, custom plumping, and much more. The cost also includes a pond heater and aerators needed to maintain water quality and ensure organism survival. The second component includes the cost of the ecosystem, which includes the fishes, worms, minnows, frogs, plants, rocks, and water lilies. The third component is the cost of personnel. This includes the cost of hiring two construction workers and one architectural engineer.

Figure 7

BUDGET

Total

$15,250.93

Column1	Cost
Equipment:	
Pond Kit	$10,000.00
20x25 Pond liner	$152.99
Pond Heater	$1,424.95
Pond aerator	$300.99
Ecosystem:	
10 Koifish	$100.00
12 Tadpoles	$300.00
3 bags of bio rocks	$96.00
Water Lillies	$32.00
12 Hornwort	$15.00
4 bags of mini water bareroots	$24.00
4 pounds of water minnows	$145.00
Labor over a week time frame:	
2 construction workers	$1,330.00
Architectural engineer	$1,330.00

Note. Printed by a student. (2022, December 12).

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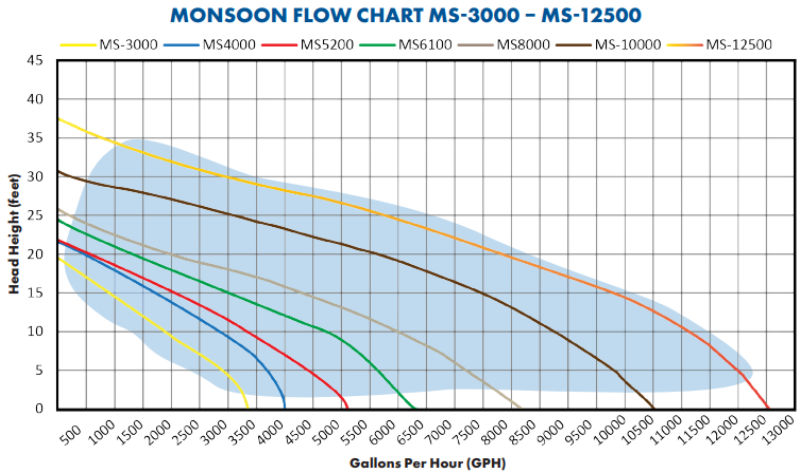
Appendix A- Technical Description of the Chosen Equipments

Pump: The pump that will be used is the Anjon MS-12500. The inlet of the pump will be connected to a pipe that extends nine feet to the depth of the pond. The pump must have the capability to recirculate all the water in the pond once per hour. (Aquanooga, n.d.) There are 10,250 gallons of water in the pond and this is the amount of water the pump has to pump through a height of nine feet.

Figure 8

MS-12500 Capability



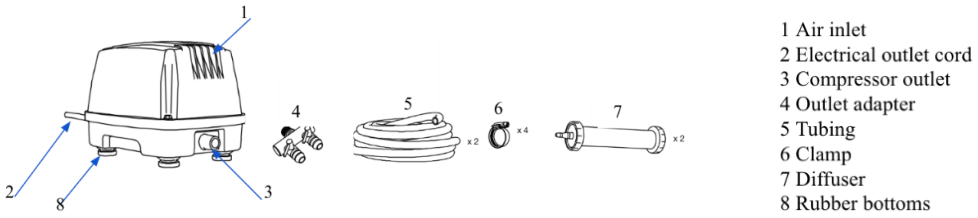
Note. Image from *Anjon Monsoon 12500 Pond & Waterfall Pump.* Pond USA. Retrieved December 12, 2022, from https://www.pondusa.com/product/anjon-monsoon-12500-pond-waterfall-pump/

Figure 8 shows that this pump meets the recirculation requirement and will pump ~11,250 gallons of water to a height of 9 feet per hour.

Aerator: The aerator consists of a compressor, which collects air from the atmosphere, and diffusers which release that air to the water (Everything Ponds, n.d.). The aerator that will be used is the Aquascape Pond Aerator PRO 60 Kit (Everything Ponds, n.d.). This aerator is capable of aerating the sized pond as it is within the 15,000 gallon limit (Splash Supply Co., n.d.). Below are the specific components of the product, as depicted in figure 6:

Figure 9

Aerator Components



Note: Adapted from *Instructions and Maintenance: Aquascape Pro Air 60 Pond Aeration Kit*. Splash Supply Co. Retrieved December 11, 2022 https://splashsupplyco.com/wp-content/uploads/2020/10/Pro-Air-60-Kit-61008.pdf

Air inlet: The air inlet is where the compressor receives air.

Compressor outlet: The air travels to this location. The compressor outlet is fitted with an adapter that allows the air to be sent to two diffusers (Splash Supply Co., n.d.).

Diffusers: The diffusers release the air bubbles into the pond. For most of the year, the diffusers will be placed at opposite sides of the pond at a depth of eight feet. In the winter, the placement is restricted to a depth of 1-1.5ft (Splash Supply Co., n.d.). The diffusers may prevent the pond from completely icing over, allowing the pond to have more access to the air during the winter (Pond Informer, 2022).

Note: The eight foot depth for diffuser placement allows it to be closer to other levels which reduces the risk of the bubbles being confined to the short length of the third level. Also,

aeration is best when the diffusers are at great depths in the pond (The Pond Guy, n.d., para. 3).

Tubing: 60 feet of tubing is available, allowing the product to be placed near an outlet and still reach the pond (Garden Pond USA, n.d.). The tubing comes with valves attached which are used to prevent water from entering the compressor (Splash Supply Co., n.d.).

Clamps: Clamps are provided to firmly attach the tubes to the outlet adapter. The clamps are also used to secure the diffusers to the tubes (Splash Supply Co., n.d.).

Electrical outlet cord: The length of this power cord is 6ft (Garden Pond USA, n.d.). This system can only be plugged into a GFCI outlet (Splash Supply Co., n.d.).

Filter: The filter that will be used is the GCTek AlphaONE 10.3 filter. It is shown in figure 7.

Figure 10

GCTek Filter

Note. Adapted from AlphaONE. (n.d.). *AlphaONE Instructions*. Manualslib. https://www.manualslib.com/manual/1568767/Gctek-Alphaone.html#manual

The filter does both mechanical and biological filtration. This filter can handle incoming flow up to 220 gallons per minute (gpm) (Play it Koi, n.d. a). In this pond, the estimated flow the

filter will receive is 189 gpm (the amount that the pump distributes water in an hour). This filter then, will handle that flow rate while having tolerance for errors in the inflow estimation.

Tank door: When opened, the user can add and replace the filtering material.

Inlet: Water from the pump will enter this port.

Pond outlet: This is where the filtered water will exit.

Waste outlet: When open, this outlet lets out the debris the filter removed from the water. Note that when the waste outlet is open, the other streams must be closed. (cite:manual)

Pressure gauge: This provides information on the pressure the unit experiences.

With this information, the system can be monitored to ensure the pressure is at a safe level.

Appendix B - Task Schedule

Figure 11

TASK SCHEDULE

Koi Fish Pond Project

	Day 1 1/01/23	Day 2 1/02/23	Day 3 1/03/23	Day 4 1/04/23	Day 5 1/05/23	Day 6 1/06/23	Day 7 1/07/23
Digging the pond							
Adding piping/filter							
Adding the underlayment							
Adding the bio rocks							
Filling the pond with water							
Introducing the fish and organisms							
Pond project completion							

Note. Printed by a student.. (2022, December 12).

The task schedule shows the timeline this pond project would take to complete. With an architectural engineer overseeing the project and working alongside construction workers, the project should take a week to fully be built.