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Plants for Rowan

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Abstract

An upcoming landmark anniversary for Rowan University presents an excellent opportunity to upgrade and improve the campus. This paper details a solution to the improvements proposed by an on-campus, student-organized environmental organization. As students who live on our university's campus, our group felt that, among other issues, building updates and renovations were much needed to improve the sustainability of the university. Given the large amount of infrastructure on campus, research was conducted to identify unique issues.

These are the very issues that must be addressed in order to build the ideal environment we are all seeking. Old buildings are susceptible to energy loss which is inefficient and costly over time. Furthermore, as proven through survey research that collected information from a diverse group of students, many felt that their mental health was not fully taken into consideration in the design of their living and workspaces. With the addition of greenery into the interior of buildings on campus, we would be able to tackle all of these problems. Installing plants inside buildings has shown to have many benefits. Not only can it improve energy sustainability, but it has shown to increase concentration levels of workers and improve students' mental health in academic buildings and dormitories. These plants can further boost sustainability by increasing the quality of air. Low maintenance plants such as the spider plant and golden pothos would be most ideal as they do not have to be watered frequently and do not require much sunlight.

With the addition of interior plants, there are some constraints to be considered. The cost and maintenance required to keep the plants thriving indoors is another concern. Even though the most favorable plants will end up being low maintenance, some level of attention will be required. All plants will need occasional watering and pruning to remain healthy. Once the concept is approved, the plant layout inside residence halls and academic buildings must be determined which will act as a main attraction upon entering the building and be cooperative with not only administration's needs but also the needs of professors and students. Our plan of action addresses these issues and other possible problems successfully and effectively.

Finally, when there is enough funding, the solution can be implemented on campus by first obtaining the plants, then scheduling and proceeding with their installation. Budgeting is estimated to be around $15,000 with a monthly maintenance charge of around $100. Fundraising can be taken care of through school sanctioned events or volunteering. There may be possible obstacles when ensuring funding is sufficient enough to provide for this consistent change, but we have found that these can be easily overcome by either student participation or funding through multiple sources. Knowing that there are multiple options available to provide this extremely effective next step for our university, it is necessary that these steps be taken in order to provide a better life for our campus community and to help reduce our impact on our environment globally.

Introduction

When imagining college, one thinks of images of students gathered together and sitting on a university green. Blankets laid out, frisbees, textbooks, bikes, and backpacks all about, and smiles on all the students' faces. Almost like a brochure cover of a perfect spring day on a

college campus. Fresh air, trees and bright green grass, and a lovely picturesque campus around them, one that obviously creates a safe, healthy and calming atmosphere. As students, we want our college campuses to be a place that models this mental image, instead, our campus is surrounded by older, non-sustainable buildings and a lack of green space. Now is the time to make this beautiful picture a reality.

Statement of problem

On a college campus, there are always sources for improvement. Better food, recycling habits, opportunities, etc. However one of the biggest issues on our Rowan's campus is the improvement of buildings and renovations to enhance the quality of life and sustainability on campus now and in the future. The Rowan Environmental Action League (REAL) created a list of issues pertaining to our university's sustainability, but currently one of most problematic issues is the poor energy usage and carbon footprint brought on from the campus buildings, along with the quality of workspace not being conducive for focusing and mental well-being.

Overall, poor quality air filtration systems and energy usage create further issues in the climate fight. Just from housing and commercial buildings alone, 20% of global carbon emissions are produced [1]. This means that the carbon emissions not only from our housing and dorms but from our large academic buildings are extremely problematic. Specifically, when discussing CO_2, which makes up 74 % of greenhouse gas emissions [1], the "average CO_2 levels were highest in classrooms (513 ppm), common areas demonstrated the second highest concentrations (498 ppm)" according to a study done showing the amount of harmful gases present in multiple college campuses [2]. Furthermore, when looking at the cost of air filtration systems in large residential and commercial buildings, "increased system runtime due to diminished airflow is the dominant factor in determining energy impacts" [3]. This means that the largest issue when it comes to energy costs comes to how much the filtration systems need to work which is a direct result of how poor the air quality is. Multiple answers have been discovered on how to address VOC (Volatile organic chemicals) presence issues, however many of them include spending large amounts of money on air system updates. One of the cheaper options with even greater benefits than just air quality is the use of plants in buildings, as "more pronounced reductions in concentrations [of VOC] were evidenced in both buildings in the presence of plants" [4]. Therefore, a good answer to our air pollution issues would be to add plants to our buildings.

Also, issues such as a lack of green space, have been proven to reduce mental health in those living and working in areas with a lack of green space and air quality [5]. On college campuses specifically this has been observed heavily and published in academic journals, however research done here on Rowan's campus showed the issues first hand. When asked, 35 students responded, and 80% responded saying they did not believe their mental health was being taken into consideration by their living and work spaces. Furthermore, 74.3% said they believed that their health would greatly improve if there were more green spaces within our buildings, as shown by the Figure 1 chart [6]. Published plans have been created to help improve the mental health on college campuses in such books as [7]. The authors recommend adding more green spaces and natural environments to students' daily lives, as multiple studies have proven the infinite benefits to this [7]. However, many of the improvements recommended in the

plans such as these would be expensive under takings, and currently, especially during a pandemic, that may not be possible. So small manageable undertakings are encouraged to help relieve some of the sustainability issues of Rowan University.

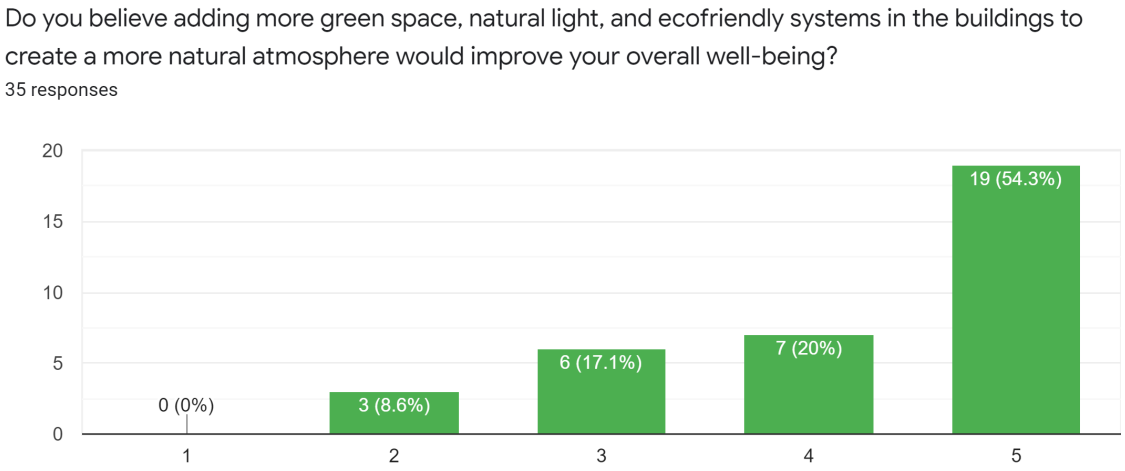

Figure 1: This is a chart showing the responses of students, based on a scale of 1-5, of how effective they believe providing green spaces and more biophilic design choices would be to improving their mental health on campus [6].

Overall, if these issues are not addressed by the Rowan University's administration, we will fall behind in the push for sustainability, both environmentally and socially, and will turn into a place that is not only not environmentally sustainable, but also not sustainable for students' mental health.

Objectives

Sustainability, a common term that is used to refer to the practice of limiting the usage of natural resources and creating self sustaining systems. While there are many solutions for sustainability issues ranging from complex large scale wind turbines to simple solutions such as collecting rainwater, every step towards a more sustainable world is a step in the correct direction. When it comes to our university's sustainability practices there is definitely room for improvement. One such improvement, and the main objective of this project, is to better the overall sustainability and well being of Rowan's inhabitants through the addition of indoor greenery.

The implementation of plants inside buildings has been proven to improve air quality by filtering pollutants, dust, bacteria, and removing carbon dioxide from the atmosphere which can decrease the cost of running air filtration systems across campus. Specifically it has been found that indoor plants can "reduce carbon dioxide levels by about 10% in air-conditioned offices, and by about 25% in buildings without air conditioning" [8]. Overall, this natural air filtration system by using plants proves to be a sustainable solution by decreasing the amount of electricity required to provide clean air on campus. In addition to these benefits, plants in the workspace have shown to increase the concentration level of workers and students alike which in turn

increases productivity, decreases mental fatigue, and reduces stress. In specific, the addition of plants that require low to medium light levels such as the spider plant, golden pothos, and peace lily require low maintenance while providing all the previous benefits listed.

The main goal of this project is the addition of plants into as many classrooms as possible along with lounge areas in academic buildings and common areas in dorms. The largest constraints to the addition of plants into so many areas around campus are acquiring the funding to purchase these plants, having enough people to maintain the plants well being, and possible allergies related to either pollen or to the plants themselves. These constraints place limitations on the selection of which plants that would be implemented into the final design. The ideal plant for this solution would be a low maintenance plant, that does not require much sunlight, and does not produce copious amounts of pollen. The only remaining critical design issues are the possibility of teachers not approving of the implementation of plants into the classroom setting and people mistreating the plants by either neglecting to water them or stealing them. Many of these constraints and issues can be resolved by simply selecting plant breeds that fit the parameters laid out and by polling a large selection of teachers about how they feel about plant additions to their classrooms.

Technical approach

While the idea of adding greenery in buildings around campus seems like a simple idea, actually getting this done could prove to be a long process. The first step would be to get this idea approved. This can be done by filling out the Space and Capital Project Request Form that can be found on our Rowan University's website. This approval would be needed before any other steps could be taken. Once this plan has been approved by the university, the next big step would be to get funding for this project. An in depth description on how the funding will be obtained and the budget for this project can be found later in the report.

With two of the biggest obstacles tackled, approval and budget, this plan becomes pretty simple. We have to determine the exact locations of where we want to put the plants, starting with the educational buildings based on the budget allocated to each building. The first educational buildings we will focus on are those that are used the most by students. If we see success in air quality management and student mental health after a semester, then we will transition into implementing this idea in residential and recreational buildings as well. In these buildings we will start with a main attraction in the lobby areas on the first floors, and then scatter additional plants throughout the hallways and classrooms. In the main lobby area, our ideal set up would be a much more simplified version of what is shown in the picture below.

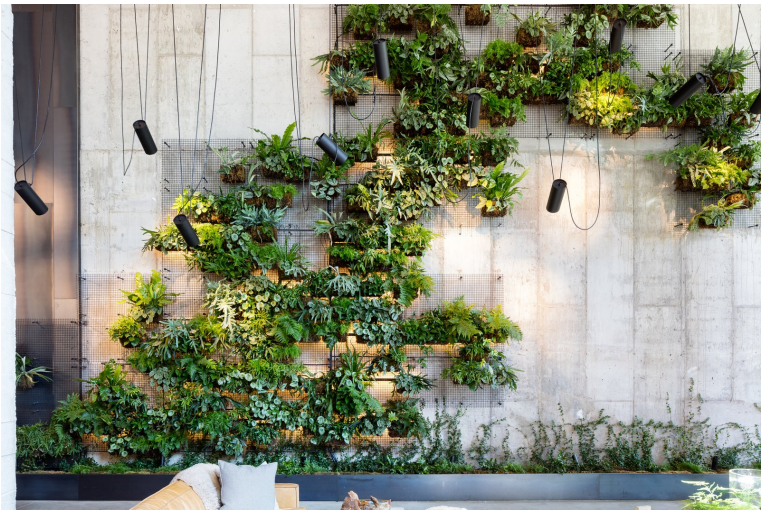

Figure 2: Example of plant set-up that could be put in the lobbies of educational buildings [9].

Having the plants close to or even hanging on the wall not only creates beautiful, living wall art, but it also keeps the plants out of the way of foot traffic. We would try to do something similar in classrooms and hallways, where the plants are out of the way as to not become bothersome. The original plan will include putting plants in individual classrooms, not including lab areas or other rooms with restrictions. If a teacher complains about not wanting a plant in their classroom we will have someone relocate it to a wallway area or to a different space where it would be less bothersome. As we are using low maintenance, indoor plants, they would be watered by the maintenance or the janitorial staff every few days on a schedule.

With all of these plans, approval, and a budget in place, the very last step is to make it happen. We can enlist the help of the campus' environmental clubs and offer volunteer hours to students interested in making the campus a more sustainable place. These volunteers, accompanied by someone in charge of this project, would be responsible for retrieving the pre-purchased plants, whether it be picking them up or awaiting deliveries, and then putting them in predetermined locations. Any plants needing to be hung on the walls or that need to be put into more difficult locations will be handled by maintenance.

Schedule and plan of action

Based on research from our Rowan University's website, the team was able to find basic information on what would need to be done in order to make these changes to our campus. The information we found explained that we needed to obtain approval through a submission form that would go to our university's Department of Planning and would go through a review process in order to be approved in all departments [10]. Due to the long process this would need, during the time it takes for it to be approved, we would also meet with the departments separately to hopefully speed up the process and add more to the proposal if each department finds issues with it before a final decision is made. Once an approval for the project and funding has been made, the project can then commence over the summer, as that is when plants would be alive and ready to be installed. The place of purchase of the plants would be left up to the administrators, and once a decision was made purchasing can begin. Once purchasing and installation is finished

over the summer, the project is basically self-sustaining, as the plants would need only maintenance either by employees for when school is not in session, or during the semesters by volunteer students. Finally, fundraising and volunteer work would commence the first semester in place to help raise money for more greenery in the dorms, and hopefully for greater changes in the future. The entire gantt chart for this project can be found in the Appendix

Budget

The total proposed budget for this project is around $15,000, with around $1,200 being allocated per each of the nine educational buildings. This budget is subject to increase as the scope of this project transitions form just educational buildings to recreational and residential buildings.

The types of plants that we plan on incorporating in this design are indoor plants that require only low to medium light in order to thrive. These plants include, but aren't limited to, such as a spider plant, golden pothos, peace lily, Chinese evergreen, snake plant, heartleaf philodendron, and friendship plant as recommended by Clemson University's College of Agriculture [11].

The budget was calculated by estimating the amount of plants needed per building, multiplying by the number of educational buildings, and using the estimated cost per plant. Although we searched for bulk and wholesale prices for these plants, it was difficult to find, so we had to go with our best estimates. Based on the prices of single plants, we estimated that each plant would most likely average at about $20 per plant. This takes into account that some plants may be slightly more expensive while others are slightly cheaper. At this cost and the given budget of $1,200 per building, this means that each building would get around 55 plants. 10 to 20 of these plants would be used in a display in the lobby while the rest would be put in the classrooms and hallways. While these numbers aren't exact, it does give a somewhat clear outline as to what it might cost to place almost 500 plants around campus.

If we only give each building $1,200 worth of plants that leaves the question, why do we need $15,000? All of those plants total to around $10,800, but we believe the extra money is a necessity. This is because not only are these plant prices estimates, so there will be some variations in price when implemented, but we also need to consider maintenance costs.

"An interior plant program can cost anywhere from $9 to $600 a month. That's a wide range, but it's impossible to pinpoint a price without taking into account the many variables that are a part of any interior plant program." [12]. While this won't be a complicated plant program, it will still probably cost at least $100 a month in maintenance. That means this extra money will be able to keep this program going for a few years before more funding may be needed.

The money for this project will come from a mixture of allocated funds from the university and fundraising. Fundraising will be done by environmental clubs on Rowan's campus, if they are willing to participate, and students who are willing to help out in return for volunteer hours.

Evaluation

One of the most important aspects of this project will actually occur after implementation. While being able to successfully place beautiful plants strategically around campus may seem like the main goal of this project, our one true goal is to make a difference. We won't know if our project has truly made an impact until we move into the evaluation phase after the first semester that this project has been implemented. Before we start this project we will have sent out a campus wide survey to all of the students to ask them for their opinions on their mental health, grades, and the overall scenery in campus buildings. They will not have to tell us their grades or any specific information because the survey will be completely anonymous. After a full semester of experiencing the added greenery on campus, we will send out another, optional survey to students and faculty on campus to get their opinions on Plants for Campus. We will ask them questions pertaining to their mental health this semester versus last semester, if they feel like the plants had any impact on their mood, mental health, or grades, and if they feel as if this is a step in the right direction towards campus-wide sustainability. This survey will also include a comment section at the end where the student or faculty member can give suggestions as to how the program could be improved. We will then compare these survey results to the results from before this program was initiated to see if there was an overall positive outcome.

The other way we will evaluate the progress of Plants for Campus is to take air quality measurements in certain buildings before the plants are introduced and compare them to monthly measurements and an end of semester measurement. This will help give us insight as to how well the plants are improving sustainability and air quality in buildings, and if some buildings require more plants to meet our standards. If the results of these evaluations are neutral or positive after a semester we will repeat these again after a full year. If the results are negative we will adapt our plan according to the feedback and repeat at the one year mark. These results after a year of implementation will help us to really understand how our plan could be improved to ensure our impact is as great as possible.

Expansion

After evaluating the impact of Plants for Campus and the results are positive, then the next logical step would be to begin expanding the project. The first step in expanding Plants for Campus would be advertising its successes to the public. By making the success of Plants for Campus well known it will make other campuses and work spaces more readily willing to accept our project in their work environment. Plants for Campus is not a tailor made plan for our specific campus but an initiative that can improve the sustainability of campuses across the nation. Expansion of Plants for Campus would not just include spreading its influence to campuses across the country but also involve improving its potential to provide a positive sustainable work environment for students and faculty alike.

Improvements to this project can be made through optional surveys about the specific plants that are used and their effects on students' mental health based on each campus's needs. These surveys would gauge the positive impacts of specific plants so that those plants can be utilized in greater quantity. In addition to this, plants that yield better quality of air filtration in campus buildings can also be used in favor of other plants that have lower capability of air

filtration. At these other locations we will use the same evaluation methods that we will use at our campus. Through comprehensive surveys and air quality testing, we can make sure Plants for Campus is a success no matter its location. Overall the expansion of this project can be done through advertising its successes and implementing plants that better suit specific campuses and their needs to further improve Plants for Campus reputation.

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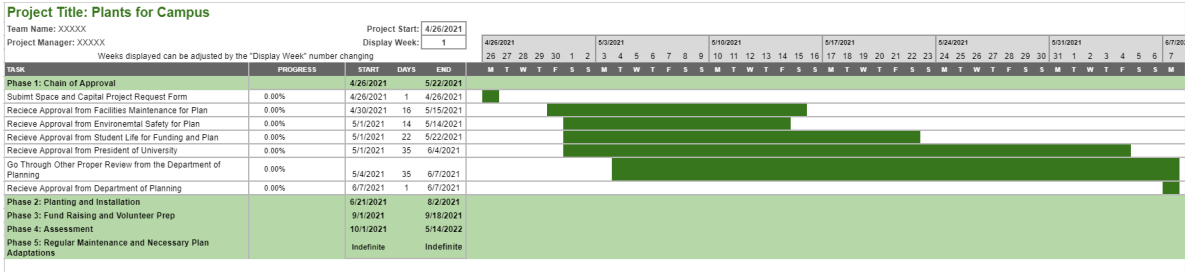
Appendix



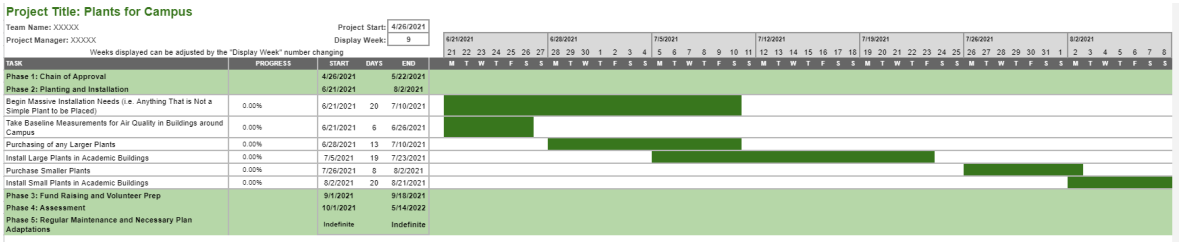
Project Title: Plants for Campus

Team Name: XXXXX | Project Manager: XXXXX | Project Start: 4/26/2021 | Display Week: 1

Weeks displayed can be adjusted by the "Display Week" number changing

TASK	PROGRESS	START	DAYS	END
Phase 1: Chain of Approval		**4/26/2021**		**5/22/2021**
Subimt Space and Capital Project Request Form	0.00%	4/26/2021	1	4/26/2021
Reciece Approval from Facilities Maintenance for Plan	0.00%	4/30/2021	16	5/15/2021
Recieve Approval from Environemtal Safety for Plan	0.00%	5/1/2021	14	5/14/2021
Recieve Approval from Student Life for Funding and Plan	0.00%	5/1/2021	22	5/22/2021
Recieve Approval from President of University	0.00%	5/1/2021	35	6/4/2021
Go Through Other Proper Review from the Department of Planning	0.00%	5/4/2021	35	6/7/2021
Recieve Approval from Department of Planning	0.00%	6/7/2021	1	6/7/2021
Phase 2: Planting and Installation		**6/21/2021**		**8/2/2021**
Phase 3: Fund Raising and Volunteer Prep		**9/1/2021**		**9/18/2021**
Phase 4: Assessment		**10/1/2021**		**5/14/2022**
Phase 5: Regular Maintenance and Necessary Plan Adaptations		**Indefinite**		**Indefinite**

Figure 3:This figure shows the first phase of the project organized on our Gantt Chart with the rest of the phases compressed.



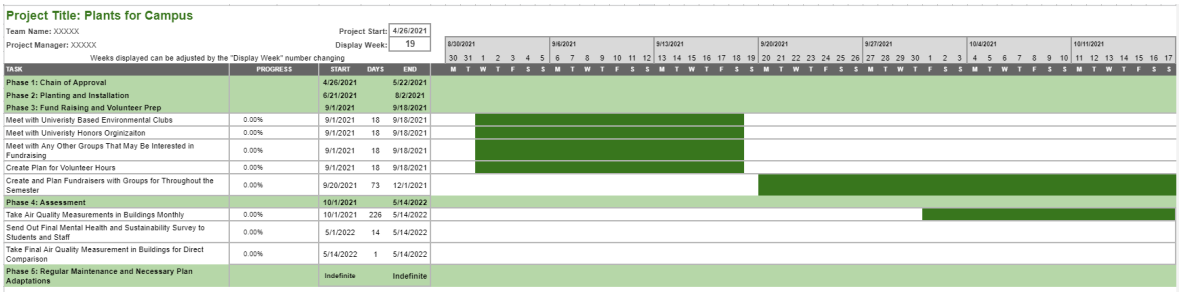
Project Title: Plants for Campus

Team Name: XXXXX | Project Manager: XXXXX | Project Start: 4/26/2021 | Display Week: 9

Weeks displayed can be adjusted by the "Display Week" number changing

TASK	PROGRESS	START	DAYS	END
Phase 1: Chain of Approval		**4/26/2021**		**5/22/2021**
Phase 2: Planting and Installation		**6/21/2021**		**8/2/2021**
Begin Massive Installation Needs (i.e. Anything That is Not a Simple Plant to be Placed)	0.00%	6/21/2021	20	7/10/2021
Take Baseline Measurements for Air Quality in Buildings around Campus	0.00%	6/21/2021	6	6/26/2021
Purchasing of any Larger Plants	0.00%	6/28/2021	13	7/10/2021
Install Large Plants in Academic Buildings	0.00%	7/5/2021	19	7/23/2021
Purchase Smaller Plants	0.00%	7/26/2021	6	8/2/2021
Install Small Plants in Academic Buildings	0.00%	8/2/2021	20	8/21/2021
Phase 3: Fund Raising and Volunteer Prep		**9/1/2021**		**9/18/2021**
Phase 4: Assessment		**10/1/2021**		**5/14/2022**
Phase 5: Regular Maintenance and Necessary Plan Adaptations		**Indefinite**		**Indefinite**

Figure 4: This figure shows the second phase of the project organized on our Gantt Chart with the rest of the phases compressed.



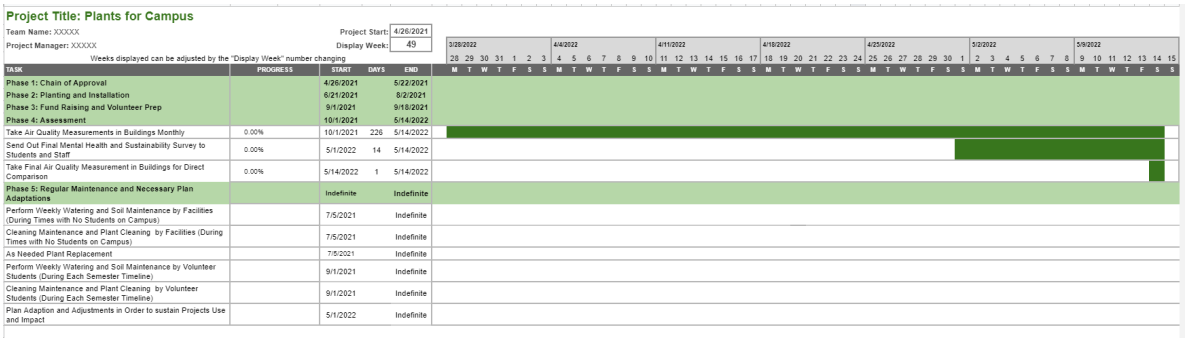
Project Title: Plants for Campus

Team Name: XXXXX | Project Manager: XXXXX | Project Start: 4/26/2021 | Display Week: 19

Weeks displayed can be adjusted by the "Display Week" number changing

TASK	PROGRESS	START	DAYS	END
Phase 1: Chain of Approval		**4/26/2021**		**5/22/2021**
Phase 2: Planting and Installation		**6/21/2021**		**8/2/2021**
Phase 3: Fund Raising and Volunteer Prep		**9/1/2021**		**9/18/2021**
Meet with Univeristy Based Environmental Clubs	0.00%	9/1/2021	18	9/18/2021
Meet with Univeristy Honors Orginizaiton	0.00%	9/1/2021	18	9/18/2021
Meet with Any Other Groups That May Be Interested in Fundraising	0.00%	9/1/2021	18	9/18/2021
Create Plan for Volunteer Hours	0.00%	9/1/2021	18	9/18/2021
Create and Plan Fundraisers with Groups for Throughout the Semester	0.00%	9/20/2021	73	12/1/2021
Phase 4: Assessment		**10/1/2021**		**5/14/2022**
Take Air Quality Measurements in Buildings Monthly	0.00%	10/1/2021	226	5/14/2022
Send Out Final Mental Health and Sustainability Survey to Students and Staff	0.00%	5/1/2022	14	5/14/2022
Take Final Air Quality Measurement in Buildings for Direct Comparison	0.00%	5/14/2022	1	5/14/2022
Phase 5: Regular Maintenance and Necessary Plan Adaptations		**Indefinite**		**Indefinite**

Figure 5: This figure shows a segment of both the third and fourth phases of the project organized on our Gantt Chart with the rest of the phases compressed. The third and fourth phase both have much longer timelines that go on until the end date of their phases that are not shown here.



Project Title: Plants for Campus

Team Name: XXXXX | Project Start: 4/26/2021

Project Manager: XXXXX | Display Week: 49

Weeks displayed can be adjusted by the "Display Week" number changing

TASK	PROGRESS	START	DAYS	END
Phase 1: Chain of Approval		**4/26/2021**		**5/22/2021**
Phase 2: Planting and Installation		**6/21/2021**		**8/2/2021**
Phase 3: Fund Raising and Volunteer Prep		**9/1/2021**		**9/15/2021**
Phase 4: Assessment		**10/1/2021**		**5/14/2022**
Take Air Quality Measurements in Buildings Monthly	0.00%	10/1/2021	226	5/14/2022
Send Out Final Mental Health and Sustainability Survey to Students and Staff	0.00%	5/1/2022	14	5/14/2022
Take Final Air Quality Measurement in Buildings for Direct Comparison	0.00%	5/14/2022	1	5/14/2022
Phase 5: Regular Maintenance and Necessary Plan Adaptations		**Indefinite**		**Indefinite**
Perform Weekly Watering and Soil Maintenance by Facilities (During Times with No Students on Campus)		7/5/2021		Indefinite
Cleaning Maintenance and Plant Cleaning by Facilities (During Times with No Students on Campus)		7/5/2021		Indefinite
As Needed Plant Replacement		7/5/2021		Indefinite
Perform Weekly Watering and Soil Maintenance by Volunteer Students (During Each Semester Timeline)		9/1/2021		Indefinite
Cleaning Maintenance and Plant Cleaning by Volunteer Students (During Each Semester Timeline)		9/1/2021		Indefinite
Plan Adaption and Adjustments in Order to sustain Projects Use and Impact		5/1/2022		Indefinite

Figure 6:This figure shows the end of the fourth phase and the expanded fifth phase of the project organized on our Gantt Chart with the rest of the phases compressed. The fifth phase is tasks that would need to be done for indefinite periods of time once the project has started and for as long as it lives, so there are no progress bars or end dates.