



## Team Advisors

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## Mission Folder: View Mission for 'Under Control'

<b>State</b>	Ohio
<b>Grade</b>	8th
<b>Mission Challenge</b>	Environment
<b>Method</b>	Engineering Design Process
<b>Students</b>	Kathir Maarikathykeyan (maarik) Soham Joshi (GS3579) Pranav Krishnamoorthy (keemus2004)

### Team Collaboration

*(1) Describe the plan your team used to complete your Mission Folder. Be sure to explain the role of each team member and how you shared and assigned responsibilities. Describe your team's process to ensure that assignments were completed on time and deadlines were met.*

We wanted to make sure we completed our mission folder with precision and effectiveness. We started out by dividing the questions into the team members:

Team Member 1:

What problem in your community did your team try to solve? Why is this problem important to your community?

List at least 10 resources you used to complete your research (e.g., websites, professional journals, periodicals, subject matter experts). Use multiple types of resources and do not limit yourself to only websites?

Describe what you learned in your research?

Develop a design statement. Be sure to describe what exactly your device should be able to do. Do not describe HOW it's going to do what it needs to do?

How could your design help solve your problem and benefit your community? Describe next steps for further research/design and how you have or how you could implement your solution in the future.

Team Member 2:

Determine the criteria for a successful solution and identify constraints for your design. Discuss what the device must have in order to accomplish its job and the restrictions of the device (i.e. the size, the cost, the weight, etc.)?

Identify the relevant variables you will use to test your prototype or model and explain how you will measure your variables?

Develop a design and list the materials you used in your design. Include technologies you used (e.g., scientific equipment, internet resources, computer programs, multimedia, etc.)?

Explain how you built your prototype(s) or model(s). Include each of the steps in your process. Include all safety precautions used by your team as step one?

Team Member 3:

Present the data you collected and observed in your testing. The use of data tables, charts and/or graphs is encouraged?

Analyze the data you collected and observed in your testing. Does your data support or refute your design statement? Do not answer with yes or no. Explain your answer using 'Our data supports/refutes the design statement because?'

Explain any sources of error and how these could have affected your results?

Interpret and evaluate your results and write a conclusion statement that includes the following: Describe what you would do if you wanted to retest or further test your design. Evaluate the usefulness of your prototype or model. What changes would you make to your prototype or model for the future, if any?

Every team member was tasked with contacting 2 experts and arranging 2 field trips/conference calls. Together we had 6 field trips and experts. Everyone had to get feedback from their experts which helped us improve our product.

Our team created a plan to optimize our time and a timeline of deadlines we had to meet.

Week 1: Decide a problem

Week 2-4: Brainstorm solutions

Week 5-6: Design Prototype Prototype + Testing

Week 7-9: Finish Testing + Finalize the first prototype + Create future iterations

We also set our teams core values which are continuous improvement, accountability, and persistence. These were the guidelines we had to follow. We had to be persistent throughout and not give up, for example, we had to persist through the different trials of testing. We all were also accountable and we took responsibility for completing our homework for the team. We also continuously improve our product and we are working on the next generation of our product.

Though we split up the questions we reviewed each other's work. We met every week to work on the question and answers. When we reviewed each others document we gave a couple of positive comments on what we liked about the document and we also gave a couple of things to improve on. This helped us stay motivated and keep improving our answers.

#### Uploaded Files:

- [\[ View \]](#) **Under Control Project Web Pages** (By: Advisor, 03/05/2018, .pdf)

*This is a summarized version of our whole project. It sums all the work we have done in 5 slides and shows how the team collaborated to create an eco-friendly product that can help communities globally.*

## Engineering Design

### Problem Statement

#### **(1) What problem in your community did your team try to solve? Why is this problem important to your community?**

Our research project is about preventing Harmful Algal Blooms (HABs) from lakes and ponds. They occur when colonies of algae which are simple plants that live in the sea and freshwater. They grow out of control while producing toxic and harmful effects on people, marine life, and birds. The human illnesses caused by HABs can be debilitating or even fatal.

HABs can:

Create dead zones in the water.  
Raise treatment costs for drinking water.  
Hurt industries that depend on clean water.

HABs are a major environmental problem in all 50 states. In 2013, only 16 states were affected by HABs, but in 2017 all 50 states in the US have been affected. Over 15,000 lakes are impacted by Harmful Algal Blooms.

Many HABs are increasing in severity and frequency, and biogeographical range. HABs are a worldwide phenomenon requiring international understanding leading ultimately to local and regional solutions.

HABs are caused by nutrient runoff. The two main nutrients that contribute to the growth of HABs are phosphorus and nitrogen. They come from agricultural, industrial and residential runoff of which, agricultural runoff is the biggest contributor.

The U.S. has spent over \$29 billion on dealing with algae since 2009. Currently, there is no stringent legislation that restricts the use of fertilizers and control of runoff. A legislation sponsored by Sen. Bill Nelson, D-Florida, could make toxic algal blooms "an event of national significance".

Agricultural is the main cause of HABs. There are two reasons why HABs have not been stopped:

Most fertilizers these days contain high phosphorus and there are few fertilizers with limited phosphorus.

There aren't many regulations limiting the fertilizer and manure that can be placed on fields.

Nitrogen is more commonly found in salty waters like seas and oceans and Phosphorus is more commonly found in freshwater bodies. Harmful algal blooms are one the biggest causes of aquatics and marine life deaths. There are many different types of algae such as red-tides, brown-tides, and blue-green algae.

HABs produce and release something called a cyanotoxin which is extremely harmful. The key bonded elements in cyanotoxin are carbon and nitrogen. The chemical instantly kills fishes and humans exposed to it can develop legionnaires disease. The algae also create dead zones in the waters where fish and plants can not live there, and existing animals are killed off by the toxins.

The algae can build up all over the lake and block sunlight for plants and animals underneath, also killing them. To add to that, algae can adjust to its environment in certain circumstances. For example, algae grow from spring to fall in warm conditions. If it gets too hot, algae can go underwater to protect itself.

There are no efficient and cost-effective solutions to prevent, control and mitigation HABs, although a lot of research is being at an international level. The solutions that exist today are cost prohibitive and cannot be used for small to medium-sized water bodies.

HABs are predicted to increase and cause more harm in the coming years.

View the attached "identifying problem" document to find pictures relating to our project. The first picture shows us at our local pond collecting algae. The second picture shows a pond covered with algae and the third picture shows chemicals they use to treat algae.

#### **(2) List at least 10 resources you used to complete your research (e.g., websites, professional journals, periodicals, subject matter experts). Use multiple types of resources and do not limit yourself to only websites.**

As part of our research we contacted these experts:

1. Mrs. Aimee Klei at the Ohio EPA- We asked her to review our solution and she gave us feedback on how we can improve upon it and make it better.
2. Mr. Ram Lalgudi from the Battelle Research Center- We learned a lot about carbon and biochars as they use a type of soy hull acting similar to our biochar and carbon. We also learned a lot about phosphorus and how it interacts with the environment and we received feedback on how we should design our boat and our solution.
3. Delaware Filtration plants- We visited their plants and learned about the processes used to filter water and make it drinkable
4. Del-co water filtration plants- We learned about they use activated carbon for filtering along with calcium to filter out the water to make it drinkable.
5. Delaware Wastewater Treatment plants.- We learned about how wastewater is treated and we were able to test our biochars there with chemicals and phosphorus to get results on it.

As part of our research we reached out to these manufacturers:

1. Wakefield Biochars- We learned about how they manufacture their biochar and who they sell their biochar to and how those companies and groups use the biochar.
2. The Pond Megastore- We saw the prices of plants and saw what plants are good for putting on our floating island to absorb nutrients out of the water.
3. The Orange Township Park Ponds- This is our community pond where we learned about how they use chemical treatments to kill the algae and we are planning on testing our solution there as we have permission to.
4. Biohaven- we learned about the different floating island that they manufacture and we asked them what floating islands they make.

5. Peanut shell association- We learned about the waste products that they produce and how we could use it in our solution.

These are some of the References from where we did our studies and researches:

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### (3) Describe what you learned in your research.

Please refer to the attached ResearchDoc document.

## Experimental Design

### (4) Develop a design statement. Be sure to describe what exactly your device should be able to do. Do not describe HOW it's going to do what it needs to do.

Our solution, BIFI, should be a reliable and eco-friendly device that adsorbs Phosphorus and Nitrogen from the water bodies, like lakes and ponds to prevent the growth of algae. BIFI will help by being an affordable, effective, and low-maintenance product to control, mitigate, and prevent Harmful Algal Blooms in the water.

### (5) Determine the criteria for a successful solution and identify constraints for your design. Discuss what the device must have in order to accomplish its job and the restrictions of the device (i.e. the size, the cost, the weight, etc.).

The criteria for a successful solution of our product are:

Phosphorus adsorption level of the biochar that will be used with our floating Island. It is very important to achieve close 95% adsorption level which will make this product very effective in removing the excess nutrients needed for the algae to thrive.

Our product should be customizable so that we can increase the quantity of biochar infused in the floating island thus increasing the adsorption level in waterways with very high levels of nutrients.

Our product should be scalable so that we can increase the size of the floating island so that it can be installed in large water bodies.

Our product would need to be manufactured in different shapes and size of Biochar brisket and sealed in water permeable membrane so that it can be installed under the floating island at a various depth of the water body.

This floating island if it has the ability to measure the concentration levels of phosphorus and nitrogen in water bodies could pay the way for more effective installation of Biochar.

Installation of this Floating Island in a water body with heavy winds.

Finding long root water plants with a high appetite for the nutrients and finding in abundant quantity, or having an in-house nursery to grow these plants.

Finding the right quantity of biochar to have the correct saturation level so that these biochars can be installed for one full season.

Some constraints we have are:

Our futuristic products constraints would be to have inbuilt Artificial Intelligence which can interact with other floating islands and deploy themselves in the water body where there is a high concentration of phosphorus and nitrogen. We can not do this because the technology has not been invented to detect the phosphorus levels immediately and not enough data has been gathered to detect patterns in algae growth.

This floating Island if it has the ability to move around the water body and has some paddling feature installed under the floating island which could keep the water move around which can actually reduce the algal blooms. To create the paddles we would need to test different shapes and sizes and make sure the paddles don't harm the environment.

Size and Shape of Floating Island Original Design:

Initially, we decided to have a floating island of just 4' X 2' rectangular shaped treated lumber wood and biochar infused at the boom of the lumber which will be in contact with water. The idea was to make the Bio-Char in contact with water so that Biochar can absorb phosphorus from water. What we submitted: We didn't change the initial dimension of the Floating Island, but we added 'U' shaped length being same as Floating Island and depth being 2' and thickness being 2" lumber mounted under the floating island. The sides were installed with 4' X 2' Bio-Char brisket wrapped around the water permeable membrane. This can be replaced are the saturation has been reached. The boom layer is filled with Biochar and the top layer is filled with pong soil mixed with coir. Then few more various sizes of Bio-Char Brisket enclosed in the membrane is installed in the floating island so that it can be submerged at various depths. Why original was rejected: Even though the original size and shape were effective, but it still lacked the contact surface area between the Biochar and water, the new design will have 3 to 4 times more contact surface area thus increasing the adsorption level. The new design is more customizable too. Type of Biochar installed in the Floating Island Original Design: We were testing with various bio-chars like wood, coconut shell, and peanut hull and planned to use these bio-chars in the mixture. Also according to the availability of these ingredients and the process to make biochar of these ingredients. What we submitted: We decided to use Peanut hull biochar, as it was more than 3 times effective than wood and 2 times effective than coconut shell. The peanut hull is readily available and also was very cheap compared to coconut shell and wood chips. Also, peanut hull char can be readily used as a fertilizer are they reached their saturation level. Why original was rejected: The mixture of wood chip, coconut shell, and the peanut hull bio-chars wasn't as effective as the peanut hull biochar. It was cheaper to acquire peanut hull and also less energy to prepare the biochar.

Type of Plants growing on the Floating Island Original Design:

We decided to grow plants like cabbage and squash because of their high nutrients absorbing abilities. We also wanted to grow flowering plants like tulips, lilly which will pleasant for the human eyes to watch and also these can absorb nutrients fast What we submitted: Then we ended up with hydroponic plants which have long roots and grow in the water so that it can directly absorb the nutrients like nitrogen and phosphorus from the water. We also started to grow succulents in the middle of the floating island which consists of pong-soil/Biochar/coconut-coir mixture which will absorb the nutrients from water and feed these plants. Why original was rejected: Plants like cabbage and squash, if grown, will invite small animals, which will try to feed on them. We do not want these animals to feed on the floating island as their wastes would cause more problems. The flowering plants will invite bees, insects and other small creatures which will be tough to control.

**(6) Identify the relevant variables you will use to test your prototype or model and explain how you will measure your variables.**

Please refer to VariablesTestECYB document

Build Prototype or Model

**(7) Develop a design and list the materials you used in your design. Include technologies you used (e.g., scientific equipment, internet resources, computer programs, multimedia, etc.).**

Please refer to DesignMaterialsECYB document

**(8) Explain how you built your prototype(s) or model(s). Include each of the steps in your process. Include all safety precautions used by your team as step one.**

Please refer to BuildPrototypeECYB document

Test Prototype or Model

**(9) Present the data you collected and observed in your testing. The use of data tables, charts and/or graphs is encouraged.**

Please refer to TestResultsECYB document

**(10) Analyze the data you collected and observed in your testing. Does your data support or refute your design statement? Do not answer with yes or no. Explain your answer using 'Our data supports/refutes the design statement because...'**

Our data supports our design statement because

1. The BIFI adsorbs the Phosphorus and Nitrogen out of the water at a very effective rate.
2. The BIFI is eco-friendly and organic, while also being reusable in several ways.
3. The BIFI is very cheap compared to other Algae solutions.
4. The BIFI is very low-maintenance and only needs to be replaced once every one to two seasons.

**(11) Explain any sources of error and how these could have affected your results**

1. One source of error is that after the biochar adsorbed phosphorus from the test sample, there is a small chance that the adsorption result numbers might not be accurate because we used a light spectrum based testing kit that measures the light visibility in the tube to find the (ppm). We had to get a different kit that had a better sensor to prevent this from happening.

2. Another source of error is not knowing how long the biochar should be kept in the water. The length of this time can vary based on the biochar. If not enough time is spent, then not enough phosphorus would have been adsorbed by the biochars.

3. When in the water, the nutrient absorption rates of the plants would be inconsistent with each test and also with the plant types.

Drawing Conclusions

**(12) Interpret and evaluate your results and write a conclusion statement that includes the following: Describe what you would do if you wanted to retest or further test your design. Evaluate the usefulness of your prototype or model. What changes would you make to your prototype or model for the future, if any?**

If we were to retest a solution to the following:

We are using treated lumber and when we would test we would find cheaper alternatives that are still as effective.

We are using a link that would connect our different floating islands. We would test different methods of linking our floating islands together to find a robust and lightweight solution.



He would test different combinations of our biochar to find a mixture that would reduce the most phosphorus in the water. We would also find a mixture that would last longer which would mean fewer replacements during the season.

We will also test different cover crops to reduce nitrogen in the water. This would make her solution more effective in salt and fresh water bodies.

We would use paddles to cause aeration in the water which would break up the algae but also to move the floating island around. You would kind of different shapes and sizes of the paddles to make sure it doesn't harm the wildlife, but also can break up the thick algae.

Our futuristic products would have inbuilt Artificial Intelligence which can interact with other floating islands and deploy and navigate themselves in the water body where there is high concentration of phosphorus and nitrogen. We can not do this because the technology has not been invented to detect the phosphorus levels immediately and not enough data has been gathered to detect patterns in algae growth.

#### Uploaded Files:

- [\[ View \]](#)     **Under Control Project Report - Part 1** (By: GS3579, 03/05/2018, .docx)  
*This is a report we created which describes our solution. This report explains: Problem Research and Analysis Solution Biochar Biochar DIY Process Solution Implementation Stages of Invention Expert Feedback Future State*
- [\[ View \]](#)     **Under Control Project Report - Product Testing** (By: GS3579, 03/05/2018, .docx)  
*This details: Controlled Testing Testing with different kits Test Results Saturation Limit*
- [\[ View \]](#)     **ResearchDoc** (By: maarik, 03/05/2018, .pdf)  
*Research Document*
- [\[ View \]](#)     **BuildPrototypeECYB** (By: maarik, 03/05/2018, .pdf)  
*Build Prototype Document*
- [\[ View \]](#)     **VariablesTestECYB** (By: maarik, 03/05/2018, .pdf)  
*Variables Tested Document*
- [\[ View \]](#)     **Identifying problem** (By: keemus2004, 03/05/2018, .pdf)  
*The document show pictures relating to our problem and why the problem is important to us.*
- [\[ View \]](#)     **TestResultsECYB** (By: maarik, 03/05/2018, .pdf)  
*Test Results Document*
- [\[ View \]](#)     **DesignMaterials** (By: maarik, 03/05/2018, .pdf)  
*Design and Materials Document*
- [\[ View \]](#)     **Under Control Project Report - Part 2** (By: GS3579, 03/05/2018, .docx)  
*This report explains: Legislation Field trip Reports Brainstorming Problems and Solutions Market and Patent Search Provisional Patent Contacting Manufacturers Costing and Pricing*

## Community Benefit

**(1) How could your design help solve your problem and benefit your community? Describe next steps for further research/design and how you have or how you could implement your solution in the future.**

Some of the important positive consequences are listed below:

Our biochar is made out of waste products like peanut shells, coconut shells, and wood chips. It helps recycle the waste products and convert them into a solution that can solve a major global problem.

The BIFI is more effective, as our biochar has reduced around 92 percent of the phosphorus, while chemical and ultrasonic treatments are not even near as effective.

The BIFI is eco-friendly and organic, assuring that there is not a harm to wildlife, while modern treatments are not very eco-friendly and organic.

The BIFI is very low maintenance, while traditional ultrasonic and chemical treatments need a lot more care to handle and are usually not used by private owners.

Our product will reduce the water treatment costs.

We can also save marine life and many animal deaths.

We can also help the economy by preserving the recreational activities and the jobs relating to them.

When the biochar reaches its saturation point, we can use the phosphorus filled biochar as a fertilizer because it is filled with phosphorus particulates, which would be perfect for a fertilizer.

Any product requires continuous improvement to be in the market, here are some of the ideas we are working on to tackle the cons of the first generation of BIFI and also make more effective in absorbing phosphorus as well as make it more potent for all year long even at high concentration phosphorus levels. Currently, with 4 by 2, the minimal surface contact area is 8 sq. ft. and then with the different brisket size, we increase the surface contact area. What if, we go ahead and increase the contact surface area by 2 or 3 times thus increasing the effectiveness of BIFI. We will expand the bottom layer into a curved boat shaped layer under the top layer of the BIFI. On the bottom layer, we will add Biochar brisket on both sides thus increasing by another 16 sq. ft. of the contact area. These briskets can be re-used as fertilizers in the farming lands. Thus recouping the money that was spent on adding more biochar layers. This doesn't change any pros from the previous model but fixes some of the cons for sure. This can be used for a long time like 3 to 4 years, thus reducing the cost. The lake owners don't have to buy the whole unit every time, they need to buy the Biochar Brisket and sell those back to the farmers thus keeping the maintenance cost low. The plants are reusable, the BIFI unit is reusable, the coir mesh with dirt can be reused. This is very much cost effective, other than the initial cost increase. The other change we are proposing is to have mechanical paddle attached which will be operated by the solar panel. Paddling helps with water circulation thus moving the water against the Biochar thus increasing the effectiveness. Next Gen BIFI should also be able to detect the

phosphorus concentration in the water body and move automatically to that location with high concentration thus more effective.

#### Future Implementation

We have also contacted the Orange Township and have gotten a response from them. They are interested in exploring our eco-friendly solution. We plan to implement our solution in a small pond that is not a primary source of water supply to a community. Once we successfully test our solution on a small scale, we plan to implement it in a medium-sized water body.

#### Uploaded Files:

- [\[ View \]](#) **Product Implementation Plan** (By: GS3579, 03/05/2018, .JPG)  
*This is our product implementation plan, also called a Gantt chart that outlines the next steps for our product. It has a timeline of events and the timeframe in which they will be completed. They also have activity dependences and shows our go-to-market strategy.*
- [\[ View \]](#) **Under Control Project Report - Legislation** (By: GS3579, 03/05/2018, .docx)  
*This is our Legislation and the meeting with Senator Kris Jordan. We also have included our community outreach.*

### Mission Verification

**(1) Does your Mission Folder project involve vertebrate testing, defined as animals with backbones and spinal columns (which include humans)? If yes, team must complete and attach an IRB approval form.**

No

**(2) Did your team use a survey for any part of your project? If yes, team must complete and attach a survey approval form.**

No

**(3) You will need to include an abstract of 250 words or less. As part of the abstract you will need to describe your project and explain how you used STEM (Science, Technology, Engineering and Mathematics) to improve your community**

Harmful algal blooms are a major environmental problem not only in the US but globally. As of 2017, all 50 states in the United States have been impacted and the deepest lake in Russia was also shut down due to harmful algal blooms. HABs are caused by nutrient runoff, the two main nutrients being phosphorus and nitrogen. Our solution called Biochar Infused Floating Island (BIFI) has layers of Biochar infused in the Floating Island. Biochar is an eco-friendly and organic stable solid, rich in carbon and made from biomass via pyrolysis. The biochar in the BIFI is used to adsorb phosphorus in the water. A water permeable membrane encloses the biochar. The standard BIFI comes in 4 feet by 2 feet rectangular shapes with layers of choir, dirt, and biochar. The top of BIFI consists of two types of plants which can grow on this island, one with roots submerged in the water and another where the roots grow in the dirt.

Below is how we used STEM to help our community:

Science - We brainstormed and came up with several problems that would help our community. Example: We used HABS because it was a global environmental problem.

Technology - We researched online and found experts who helped us learn about different aspects of our solution. Example: We used a Hanna Digital Instruments Phosphorus Testing Kit.

Engineering - Our product BIFI is designed to maximize contact surface area and uses many engineering concepts.

Mathematics - We recorded testing results and plotted the points on the graph.

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[Past and Present  
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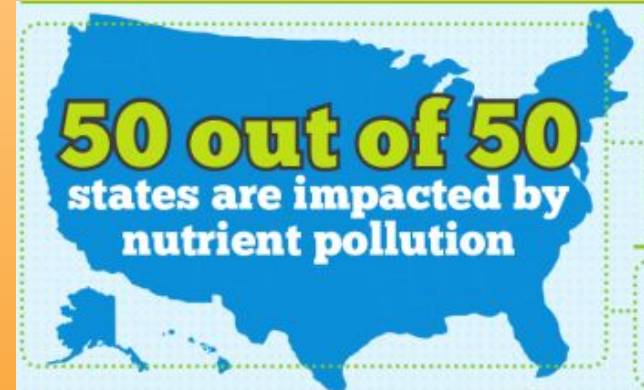
[Our Technology](#)

[Consequences](#)

[Testing Our  
Solution](#)

# The Biochar Infused Floating Island (BIFI)

Harmful Algal Blooms, a major problem in all 50 states, caused by nutrients like Phosphorus and Nitrogen runoff into the waterways. This is also one of the leading causes of sea life deaths and also is a big contributor to the dead zone problem. This also releases harmful toxins into the environment.



Biochar Infused Floating Island is a multifaceted, eco-friendly, and organic solution, which is designed to get rid of nutrients in the water to reduce Harmful Algal Blooms. The prototype is shown in the picture.

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# Past and Present Technology

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## Past Technology

Chemical control of algae in water supply storage has been a widespread water quality management practice for over 100 years.

Historically, copper sulfate and other algaecides have been used to destroy or breakdown this excessive algae biomass before it enters the drinking water treatment plant

### Cons:

- It is not eco-friendly at all, and was harmful to many different aquatic ecosystems.
- Also, it wasn't a very effective treatment to get rid of the algae.



Past

Present

## Present Technology

In recent years, many companies still use chemical control methods to get rid of the algae, but a lot of companies have started to use other more eco-friendly methods.

Many companies have started to use ultrasonic waves at a certain frequency to break the cell wall of algae and ultimately kill the algae.

### Cons:

- These ultrasonic systems cost lot of money (around 2000-4000 dollars per system).
- These systems break the cell wall of the algae, which in turn helps the algae release a toxin.



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# **Our Technology**

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## **Our Plant Layer**

Our plant layers will be comprised of long rooted hydroponic plants. These plants' roots will suck up free Nitrogen particulates from the water. Second, we will have small rooted plants that will grow in the soil/biochar mixture layer, so that these plants can feed off the nutrients that the biochar adsorbs. These plants will be used to feed on nutrients that are in the water, so that algae can't thrive on these nutrients and create Harmful Algal Blooms.

## **Our Soil/Biochar Layer**

This layer is where the small rooted plants will grow on. This layer is made up of soil and our biochar mixture. Biochar is an eco-friendly and organic charcoal, which is very porous giving it the ability to adsorb phosphorus particulates. This soil/biochar layer is enclosed by a water permeable membrane, so that biochar and soil cannot mix in the water and so only water can go in and out of the island. The water goes in through the membrane and the biochar adsorbs the phosphorus particulates from the water, while over time the water leaves.

## **Our Biochar Briskets**

We will have briskets shaped removable attachment (kind of like an air filter) on the side, which can be deployed if the phosphorus levels are high. These briskets will contain biochar and enclosed in the water permeable membrane, so that water can come in and mix with the biochar. These briskets will go deeper into the water because phosphorus isn't just at the top. These will be on the side of the BIFI, so they can be deployed into deeper levels or can be taken apart and placed in different parts of the water if needed.

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# **Consequences**

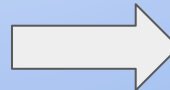
## **Positive Consequence**

- The BIFI is much cheaper than ultrasonic and chemical treatments.
- The BIFI is more effective as our biochar has reduced around 92 percent of the phosphorus.
- The BIFI is eco-friendly and organic assuring that there is not a harm for wildlife.
- It is very low maintenance , while traditional ultrasonic and chemical treatments need a lot more care.
- When the biochar reaches its saturation point, we can use the phosphorus filled biochar as a fertilizer.

## **Negative Consequence**

- The BIFI might be susceptible to birds and small water prairie animals to make its habitat on the island.
- They also could eat away some of the plants on our BIFI.

The first iteration of the BIFI





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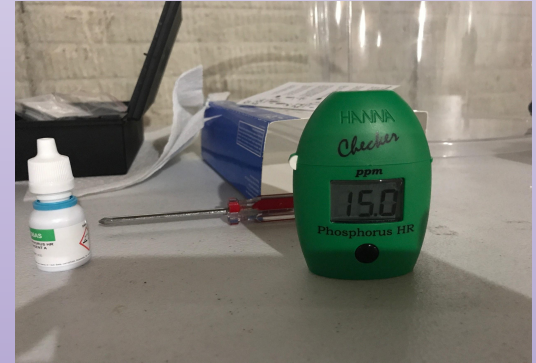
[Our Technology](#)

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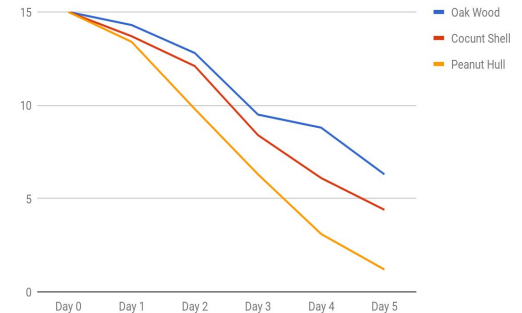
[Testing our  
Solution](#)

# Testing Our Solution

We needed to find the most efficient biochar, so we tested three different biochars, Peanut Shell, Coconut Shells, and Wood Chips. We had used the Hanna Instruments Phosphorus Kit, which was recommended from one of our team's experts. We mixed a phosphorus solution with water to create a control for us to test our biochar on. This control was a 15 ppm solution, which is more than twice the amount in Lake Erie. We mixed the biochar in an equal amount of the control in three different jars, representing the three different biochars. We used the Hanna Phosphorus Digital Checker and tested the phosphorus every 24 hours for 5 days. We filtered out the biochar, so it doesn't read the biochar retained phosphorus as well. Through our experiment we figured out that the Peanut Shell biochar was the most efficient and it reduced 92 percent. From this we decided to use the Peanut Shell biochar in the BIFI.



Biochar Phosphorus Absorption Chart





## *Harmful Algae Bloom (HAB) Project*

### *The Under Control Team #32140*





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### **Introduction to Harmful Algae Bloom (HAB)**

We are the Under Control team and we are here to present our solution. Our solution was an invention to help detect/monitor, prevent and mitigate harmful algae bloom.



Harmful algal blooms are a major environmental problem not only in the United States but globally. As of 2017, all 50 states in the United States have been impacted by harmful algal blooms. Known as red tides, blue-green algae or cyanobacteria, harmful algal blooms have severe impacts on human health, aquatic ecosystems and the economy. Algal blooms can be toxic.

## Hydrodynamics: Harmful Algae Bloom (HAB)

Algal blooms are the result of an excess of nutrients (particularly phosphorus and nitrogen) into waters and higher concentrations of these nutrients in water cause increased growth of algae. Since the problem is naturally occurring, widespread and frequent, we decided to attack the problem from all angles i.e. detect/monitor, prevent and mitigate.

Our solution consists of:

- An eco-friendly mixture with strong adsorption ability that bonds with phosphorus and helps with the biological treatment of algae. This is a prevention mechanism to limit the blooming of algae due to lack of nutrients.

### **Problem Summary**

#### *Harmful Algal Blooms – National Issue*

Harmful Algae Bloom (HAB) is a form of nutrient pollution and is one of America's most serious water pollution issues today. 50 out of 50 states are impacted by the nutrient pollution. States have identified about 15,000 water bodies in the United States with nutrient-related problems.

We asked our experts about where do the nutrients come from and cause pollution:

1. Fossil Fuels – 250 million cars and trucks in the United States release more than 7 million tons of nitrogen oxides into the atmosphere, contributing to pollution in air and water.
2. Agriculture – Animal manure, excess fertilizer applied to crops and fields, and soil erosion make agriculture a large source of nutrient pollution. Livestock production generates close to 1 billion tons of manure.
3. Urban Sources – About 10% of the nutrients flowing from the Gulf of Mexico come from urban storm water, waste water and sewage treatment plants.
4. Industry – In 2010, 592 industrial facilities released 100,000 tons of nitrate compounds, equal to 3,000 full railroad cars.

The Mississippi River Basin spans 31 states and ultimately drains into the Gulf of Mexico. Nutrient pollution from the Mississippi River Basin is causing a large “dead zone” in the Gulf of Mexico that cannot support aquatic life.

This is Lake Erie in 2011:



### *Harmful Algal Blooms – Worldwide Problem*

Lake Baikal, in Moscow, is undergoing its gravest crisis in recent history, experts say, as the government bans the catching of a signature fish that has lived in the world's deepest lake for centuries but is now under threat.

Holding one-fifth of the world's unfrozen fresh water, Baikal in Russia's Siberia is a natural wonder of "exceptional value to evolutionary science" meriting its listing as a World Heritage Site by UNESCO.

Baikal's high biodiversity includes over 3,600 plant and animal species, most of which are endemic to the lake.

Over the past several years, however, the lake, a major international tourist attraction, has been crippled by a series of detrimental phenomena, some of which remain a mystery to scientists. They include the disappearance of the omul fish, rapid growth of putrid algae and the death of endemic species of sponges across its vast 3.2 million-hectare (7.9 million-acre) area. Starting in October, the government introduced a ban on all commercial fishing of omul, a species of the salmon family only found in Baikal, fearing "irreversible consequences for its population", the Russian fisheries agency told AFP. "The total biomass of omul in Baikal has more than halved since 15 years ago" from 25 million tonnes to just 10 million, the agency said. Local fishery biologist Anatoly Mamontov said the decrease is likely caused by uncontrollable fish poaching, with extra pressure coming from the climate.

"Baikal water stock is tied to climate," he said. "Now there is a drought, rivers grow shallow, there are less nutrients. Baikal's surface heats up and omul does not like warm water."



*Some statistics about the harmful algal blooms*

1. 50 out of 50 states impacted by Harmful Algal Blooms.
2. 15,000 water bodies impacted in the US.
3. 250 million cars and trucks in the US release more than 7 million tons of nitrogen oxides into the atmosphere, contributing to pollution in air and water.
4. Animal manure, excess fertilizer applied to crops and fields, and soil erosion make agriculture a large source of pollution.
5. About 10% of the pollution flowing into the Gulf of Mexico comes from urban storm water and waste water treatment plants.

**Research and Analysis of Problems with Harmful Algal Blooms**

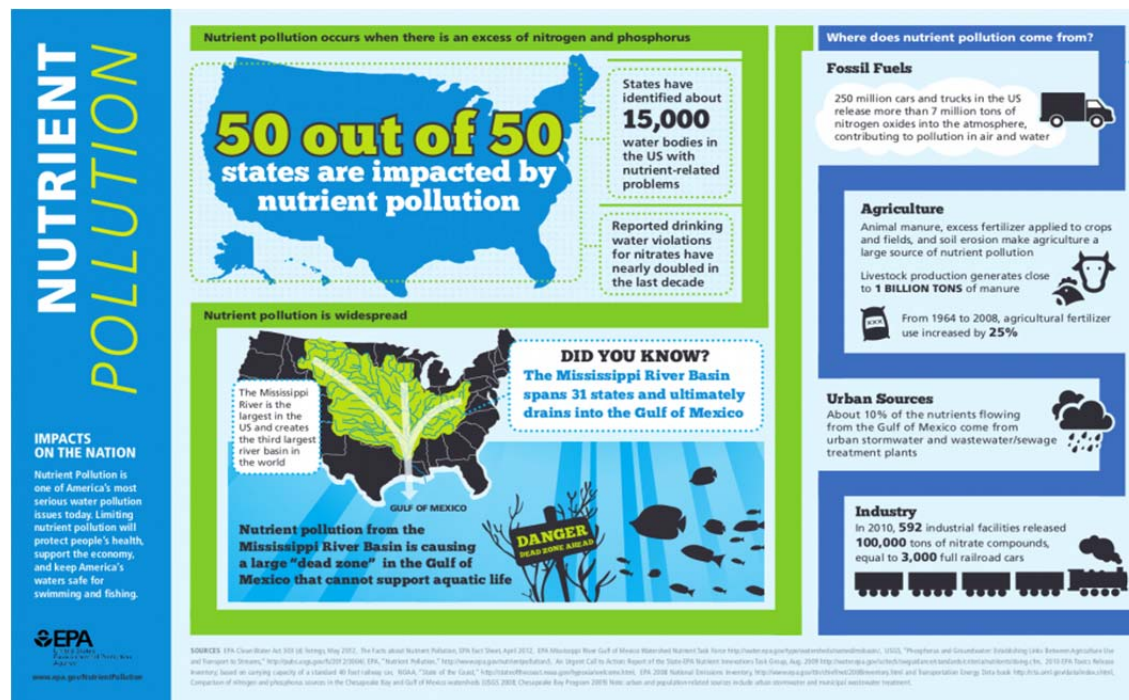
Following were some of the activities done as part of the researching the problem:

1. Online research
2. Reading articles and research papers
3. Field visits and talking to several experts
4. Survey the public
5. Talk to legislators

The below picture summarizes the problem very well:



## Hydrodynamics: Harmful Algae Bloom (HAB)



### Harmful Algal Bloom Impacts

HABs produce biotoxins which can bioaccumulate in the marine food web similar to mercury. Bioaccumulation happens when toxins build up in an organism at a rate faster than they can be broken down. Phytoplankton form the base of marine food webs and provide vital energy to each trophic level. When they bloom, any toxins they produce are consumed by, and can bioaccumulate in, higher level organisms like shellfish, copepods, krill, anchovies, and mackerel.



Sometimes organisms are not affected by the toxins themselves, but act as vectors and transport the toxins up the food web into higher level organisms—like fish, seabirds, manatees, sea lions, turtles, and dolphins. In addition to impacts of *single* HAB events, the effects of chronic

## Hydrodynamics: Harmful Algae Bloom (HAB)

exposure to HAB toxins on health, reproductive failure, and behavior are only beginning to be understood. Impacts from this type of exposure could be significant on protected and endangered species, as well as humans.

Human illness or death can also result from HABs when people consume contaminated fish and shellfish. Coastal state governments closely monitor select toxin-producing species of algae to provide as much advance notice to, and regulation of, the seafood industry as possible.

Other types of harmful algal blooms are not toxic but cause harm to marine life in other ways: by damaging or clogging fish gills or blocking sunlight for beneficial algae and seagrasses. Some HABs bloom so densely that the death and decay of the algae leads to oxygen depletion in the marine environment, suffocating animals or forcing them to migrate.

### Harmful Algal Bloom Article by CDC

#### What's the problem?

A harmful algal bloom (HAB) occurs when certain types of microscopic algae grow quickly in water, typically forming visible patches that may harm the health of the environment, plants, or animals. HABs can deplete the oxygen and block the sunlight that other organisms need to live, and some HABs produce toxins that are dangerous to animals, including people.

HABs can occur in marine, estuarine, and fresh waters and can impair drinking and recreational waters. In addition, HAB-associated toxins can contaminate seafood. HABs appear to be increasing in frequency along the coastlines and in the surface waters of the United States according to the National Oceanic and Atmospheric Administration (NOAA). These increases are likely responses to an overabundance of nutrients, such as nitrogen from fertilizers, and warmer temperatures associated with climate change.

#### Who's at risk?

Although scientists do not yet understand fully how many HABs might affect human health, health agencies in the United States and abroad are monitoring HABs and developing guidelines for HAB-related public health action. CDC works with public health agencies, universities, and federal partners to investigate how the following algae, which can cause HABs, may affect public health:

**Cyanobacteria**, also known as blue-green algae, can produce toxins that may taint drinking water and recreational water. Humans who drink or swim in water that contains high concentrations of cyanobacteria or cyanobacterial toxins may experience gastroenteritis, skin irritation, and allergic responses. People exposed to cyanobacterial toxins through dialysis water contamination may experience life-threatening liver damage.

## Hydrodynamics: Harmful Algae Bloom (HAB)

**Harmful marine algae** occur in the ocean and produce toxins that may harm or kill fish and marine animals. Humans who eat shellfish contaminated with HAB toxins may become sick with shellfish poisoning, such as neurotoxic shellfish poisoning, paralytic shellfish poisoning, or ciguatera fish poisoning. Inhaling marine aerosols containing toxins from Florida red tides may induce symptoms in people with asthma.

**Pfiesteria piscicida**, a single-celled organism that lives in estuaries, has been found near large quantities of dead fish. However, no toxin has been isolated from this organism, and studies supported by CDC have not identified any lasting symptoms associated with exposure to this organism.

How can you protect yourself from exposure to HABs?

To reduce your risk of adverse effects from HABs, you can:

Protect yourself, your family, and your pets from exposure to cyanobacterial HABs (CyanoHABs):

Don't swim, water ski, or boat in areas where the water is discolored or where you see foam, scum, or mats of algae on the water. If you do swim in water that might have a CyanoHAB, rinse off with fresh water as soon as possible.

Don't let pets or livestock swim in or drink from areas where the water is discolored or where you see foam, scum, or mats of algae on the water. If pets (especially dogs) swim in scummy water, rinse them off immediately—do not let them lick the algae (and toxins) off their fur.

Don't irrigate lawns or golf courses with pond water that looks scummy or smells bad.

Report any “musty” smell or taste in your drinking water to your local water utility. Respect any water-body closures announced by local public health authorities.

Reduce the occurrence of cyanoHABs:

Reduce the nutrient loading of local ponds and lakes by using only the recommended amounts of fertilizers and pesticides in the yard, properly maintaining a household septic system, and maintaining a buffer of natural vegetation around ponds and lakes to filter incoming water.

Stay informed about HABs:

Red tide events are tracked by the Florida Marine Institute and information is posted online to indicate which beaches and recreational areas should be avoided. ([www.floridamarine.org](http://www.floridamarine.org))



## Hydrodynamics: Harmful Algae Bloom (HAB)

Information about HABs is also available from other federal agencies, including the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA).

Additionally, the U.S. Environmental Protection Agency (EPA) has added certain algae associated with HABs to its Drinking Water Contaminant Candidate List. This list identifies organisms and toxins that EPA believes are priorities for investigation. The public should be aware of the potential threat that algal blooms pose so they can prevent becoming a victim to their effects.

### The Bottom Line

Harmful algal blooms can produce potent toxins resulting in skin irritation, allergies and gastroenteritis. They are typically associated with warm periods and overabundance of nutrients, for example, the excessive use of fertilizers on lawns and golf courses. They also produce toxins that can be ingested by eating contaminated shellfish.

There are various types of algal blooms that pose a potential risk to humans and animals:

**Cyanobacteria**, also known as blue-green algae, can produce toxins that may taint drinking water and recreational water.

**Harmful marine algae**, such as those associated with **red tides**, occur in the ocean and can produce toxins that may harm or kill fish and marine animals. Humans who eat shellfish containing toxins produced by these algae may experience neurologic symptoms (such as tingling fingers or toes) and gastrointestinal symptoms.

**Pfiesteria piscicida**, a single-celled organism that lives in estuaries, has been found near large quantities of dead fish.

Protecting against HABs includes avoiding high risk areas and times of the year when there are a larger number of HABs present and rinsing thoroughly with clean water if contact is made with HABs.

### Harmful Algal Bloom (HAB)-Associated Illness

#### Illness & Symptoms

Harmful algal blooms (HABs) can produce toxins that can cause illness in people, companion animals (dogs, cats), livestock (sheep, cattle), and wildlife (including birds and mammals). Exposures to the toxins can occur when people or animals have direct contact with contaminated water by:

#### Swimming

## Hydrodynamics: Harmful Algae Bloom (HAB)

Breathing in aerosols (tiny airborne droplets or mist that contain toxins) from recreational activities or wind-blown sea spray 1,2

Swallowing toxins by drinking contaminated water or eating contaminated fish or shellfish 3.

Human and animal illnesses and symptoms can vary depending on the how they were exposed, how long they were exposed, and the particular HAB toxin involved.

### Routes of Exposure



Boating in a lake with a HAB. Credit: Photo courtesy of Andy Reich.

A harmful algal bloom (HAB) can occur in water bodies around the world and can affect those who use these water bodies for recreation, agricultural, or drinking 1-4. People can be exposed to a HAB or HAB toxins when they swim, wade, or play in or near contaminated water; eat contaminated fish or shellfish; or use contaminated drinking water. The severity of illness and symptoms can vary depending on the type of exposure and the type of HAB toxin.

The main routes of exposure to HAB toxins are 5:

- Skin contact (through activities like swimming)
- Inhalation (by breathing in tiny airborne droplets or mist contaminated with HAB toxins)
- Ingestion (by eating or drinking food or water contaminated with HAB toxins)

How to Reduce Exposures and Prevent Illness

## Hydrodynamics: Harmful Algae Bloom (HAB)



Permanent HAB health advisory sign in Oregon. Credit: Photo courtesy of Oregon Public Health.

It is not possible to know if an algal bloom is harmful just by looking at it. Additionally, toxins can be present even when an algal bloom is not visible.

Protect yourself and your pets from harmful algal blooms (HABs):

Avoid entering or playing in bodies of water that:

- smell bad
- look discolored
- have foam, scum, or algal mats on the surface
- contain or are near dead fish or other dead animals (for example, do not enter a body of water if dead fish have washed up on its shore or beach)

Follow local or state guidance if you are notified that your tap water contains algal toxins. Boiling water does not remove algal toxins and can increase the amount of toxin in the water. Be aware of advisories and health risks related to consuming contaminated fish and shellfish.

### **Product and Solution**

#### *Summary of the solution and product*

Our solution is an eco-friendly mixture with strong adsorption ability that bonds with phosphorus and helps with the biological treatment of algae. This is a prevention, mitigation and control mechanism to limit the blooming of algae due to lack of nutrients.

The mixture is a combination of highly adsorbent biochars.



*What is biochar and how is it made?*

Biochar is defined as carbonised biomass obtained from sustainable sources and sequestered in soils to sustainably enhance their agricultural and environmental value. This distinguishes it from charcoal. Biochar, is a porous material, can help retain water and nutrients.

Due to its adsorption ability, some biochars have the potential to immobilise heavy metals, pesticides, herbicides, and hormones; prevent nitrate leaching and faecal bacteria into waterways; and reduce  $N_2O$  and  $CH_4$  emissions.

Biochar is made using a process called pyrolysis. The porous charcoal like biochar was once any kind of organic biomass. Pyrolysis involves placing the biomass into a special oven before heating in the presence of little or no oxygen. The result is a stable solid material rich in carbon content that can effectively capture carbon and lock the carbon into the soil. Temperatures required by this process vary and a different type of biochar is produced depending on the feed biomass used and the temperature reached in the pyrolysis process.

*Using Biochar to Battle Climate Change*

Carbon containing materials such as plants are made from carbon that is sourced from the air. While alive and whole that organic matter holds the carbon in place but when it burns, or decomposes the carbon is released back into the atmosphere in gases like carbon dioxide. These

gases then contribute to climate change and global warming. If the organic material undergoes pyrolysis, then the carbon largely remains locked as a solid in the biochar and can remain in this stable form for hundreds or thousands of years. Other byproducts of the pyrolysis process include oils and methane that can be captured and used as an environmentally friendly fuel.

### *Other Environmental Benefits of Biochar*

While reducing the amount of greenhouse gases in the atmosphere, biochar can have other environmental benefits. While in the ground it can remediate soils, improve water quality, increase fertility of the soil and increase agricultural productivity.

### Types of Biochar

Not all biochar is the same. The raw materials used and the temperature the feed material was heated to changes the chemical composition of biochar. As an example, biochar made from manure will have a greater nutrient content than that formed from wood chips. A wood based biochar, on the other hand, will remain more stable for a longer time. Higher firing temperatures will result in a greater amount of microporosity and adsorptive capacity, therefore a better potential for adsorption of toxic substances and soil rehabilitation.

### **Biochar Do it Yourself Process**

We read instructions and go the following material to make the biochars at hom:

- Peanut shells
- Coconut shells
- Wood chips
- Tin cans to burn the above
- Material to crush the charred shells into powder

Under adult supervision, we make burned the shells and wood chips in separate containers. The thought was to make the biochars separately and test them separately for effectiveness and then combine them as necessary to make the mixture cost effective.





### **Solution Implementation**

The biochar got deployed in the water with the use of small floating islands. We used the proven concept of a floating island so that:

- We could increase the area of exposure of the biochar to the water.
- Keep our biochar secured in membranes and screens, so that it can be recovered for reuse.
- We could use it to grow cover crops like cabbage or squash, to help reduce nitrogen levels in the water.

Here is the final design of the prototype:

- We are using plants with roots inside the water so that the roots can feed on the nutrients.
- The bottom layer is biochar with a membrane. The membrane holds the biochar in place and does not let it in the water. This layer comes in contact with the water and adsorbs phosphorus day in day out.
- The prototype also has pouches on the side of the island. These pouches are filled with biochar. These come directly in contact with water. The pouches would be submerged in the water so they can be more effective. The pouches can be customized based on the size of the water body or based on the content of phosphorus in the water body.

## Hydrodynamics: Harmful Algae Bloom (HAB)



### **Stages on Invention**

Following were the stages of invention of our product for the mixture:

1. We started out with iron oxide but based on expert feedback discontinued it, since it's comparatively expensive and uses metal compounds.
2. We used just wood chip biochar with activated carbon to start with in our mixture. This made the water turn black. The carbon did not settle down even after 24 hours and so we decided to use on wood chip biochar and not activated carbon.
3. As we did more research we found out that not all types of biochars are equally effective.
4. Hence we used coconut biochar to make our product better.
5. Based on more research, we found peanut shell biochars are very effective. This is when we decided to make our product a mixture of a variety of biochars since there is still research going on about what is the most effectively material to use.

Following were the stages of invention of our prototype:

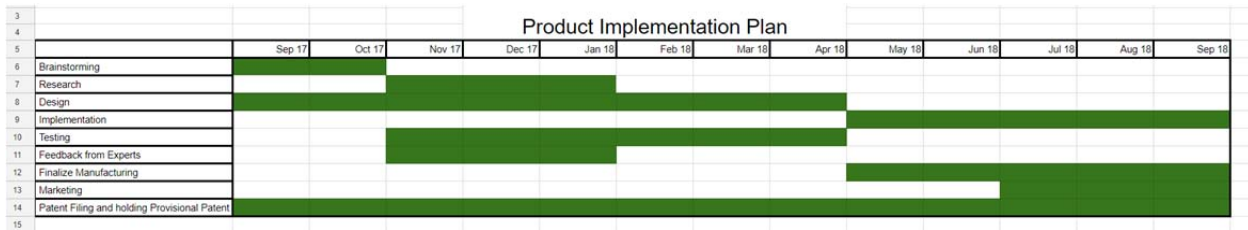
1. We started out designing a small bucket kind of floating island. The thought was we will have our mixture in the floating island and keep our concept simple.
2. We soon found out and even got expert feedback that as much water contact as possible is necessary for the biochars to adsorb phosphorus. So we added pouches on the side.
3. These pouches are customizable and can go deep into the water e.g. like 4-6 feet deep.
4. We then realized that just pouches will not work and there is a possibility of the biochar being let out and getting mixed with the water. So we added a membrane to the pouch which will hold the biochar in place and make it more effective.
5. We added cover crops to the island so that we could double attack the problem. Cover crops would absorb the nitrogen and also hold the soil mixed with the biochar in place.





## Hydrodynamics: Harmful Algae Bloom (HAB)

### Implementation Plan for our product



### Expert Feedback for our Solutions

We received feedback from several experts for our solution.

- 1) Following is the feedback from the EPA for our solution. We have incorporated some of the feedback comments in our revised solution implementation.

From: "Ruth.Briland@epa.ohio.gov" <Ruth.Briland@epa.ohio.gov>  
Date: December 7, 2017 at 12:46:47 PM EST  
To: "sohamjoshi@rocketmail.com" <sohamjoshi@rocketmail.com>  
Cc: "Amy.Klei@epa.ohio.gov" <Amy.Klei@epa.ohio.gov>  
Subject: Feedback for team Under Control

Hello Soham,

Please find the attached feedback on you team project. It was a pleasure to meet with you and the students last week, and let us know if you need additional help.

Good luck with the competition this weekend!  
Ruth

**Ruth Briland**  
HAB-Project  
Division of Drinking and Ground Waters  
Ohio Environmental Protection Agency  
Lazarus Government Center,  
PO Box 1049  
Columbus, Ohio 43216-1049  
Office: 614-369-4045  
Email: [Ruth.Briland@epa.ohio.gov](mailto:Ruth.Briland@epa.ohio.gov)

### Feedback for Team Under Control

Ohio EPA staff (Amy Klei, Ruth Briland, and Sarah Becker) met with the four student members and team leader of Under Control on 11/30/17 to discuss the team's project and solution for harmful algal blooms. The Ohio EPA staff were pleased and impressed with the team's concept and design that integrate two nutrient removal strategies, biochar with floating islands.

We strongly support the team's plan to evaluate the phosphorus removal capacity of several types of biochar (e.g., peanut, coconut, wood, and purchased product). One critique is to consider the particle size in addition to type (or source) of biochar. While reviewing the biochars, we noted that some types were very fine particles, like a powder, and other were in large chunks. The surface area of the particle will affect the sorption capacity of the biochar or ability to remove phosphorus from the test water. The group may consider testing the same type of char in two general size categories (fine powder or large chunks).

We also discussed the details of the floating island structure. We emphasized that the biochar particles should be separate from the soil and plant core of the island because the soil will occlude or block pores in the biochar that are intended to remove phosphorus from the water body. Their floating island is designed with biochar around the rim or perimeter of the island, to allow for water flow and phosphorus removal. We suggested other options, such as biochar bags attached to the island but lower in the water column and as additional or alternative placement. The mesh or material used to contain the biochar media is important to allow for water flow and interaction with biochar to achieve phosphorus removal. We noted that one past problem with floating islands is that geese and other animals are attracted to the islands and can cause problems (e.g., high nutrients, eat, disturb plants and structure).

The team mentioned that they had challenges determining phosphorus concentration in the test solution. Their phosphorus source is Roundup® to control for external sources of phosphorus. However, the actual phosphorus compound (phosphonate) may not interact in the same way as dissolved organic phosphorus. The team has already had problems with the test kit for phosphorus. We suggest using a low concentration of phosphoric acid as the test source. For issues with the test kit, we recommend contacting the kit manufacturers. We also recommended that they contact local drinking and wastewater treatment plants, as they commonly test for phosphorus and may be of more assistance with laboratory methods.

2) Following is the feedback from Battelle



January 4, 2018

Dear Kathir,

It was nice meeting you along with your project team members and know about your project on controlling harmful algal bloom (HAB). I was impressed with your team's ability on the fundamental understanding of the challenges associated with the HAB. The team did an excellent job on gathering the performance requirements and developed the prototype in a brief period. The selection of components to adsorb phosphorus and their integration into final product are novel. As I had mentioned during your field trip to Battelle, we have been working to solve this challenge for the last five years. As a subject matter expert, I believe your teams solution is unique and has high technical feasibility.

I have no doubt in my mind your team went over and beyond the expectation in building the prototype that resembles a commercial product. I strongly recommend conducting an economic feasibility analysis and protecting the intellectual property if you have not done earlier.

Please do not hesitate to reach out Battelle if you need any assistance in the future. Best wishes to you and your team members.

Regards

A handwritten signature in blue ink, appearing to read "Ram Lalgudi".

Ram Lalgudi, Ph.D.  
Sr Research Scientist

### **Bio-Char Infused Floating Island (BIFI) – Design Specifications**

#### **Inception**

We realized the Bio-char in its raw state would absorb Phosphorus from water, we ran some tests and proved that it is very effective in absorbing Phosphorus, which is the main cause for the

Harmful Algae Blooms (HABs). We were also thinking how to deploy these biochar in the lakes and ponds so that we can prevent Algae growth. An Idea came, what if we make a platform to float and have these bio-chars somehow packed with the platform. We started to work in that area and found out that Bio-Haven, a manufacturer does these floating Island concept in large scale like few hundred square feet. But their process is completely different than what we wanted to do.

### **Concept**

Our concept is very simple, infuse the biochar within the floating island and make them to expose in the water, increase as much contact as possible between the water and the biochar. Then what do we do with the absorbed nutrients, grow plants on top of the floating island to consume those nutrients. Simple concept, absorb the phosphorus and make algae deprived of the same nutrients and then consume those absorbed nutrients. The idea of having plants on top of the surface made us to call this product as floating Island. Adding biochar layer allowed us to call this product as Biochar Infused Floating Island, in short BIFI.

### **Summary**

There are three ways to absorb nutrients by deploying the Biochar Infused Floating Island,

- a) Interaction of Biochar layer (bottom layer of Floating Island) with the water
- b) Plants with roots in the water which can directly consume the nutrients
- c) The Biochar brisket, which will be attached to the floating Island and can be deployed in various depths to absorb the nutrients.

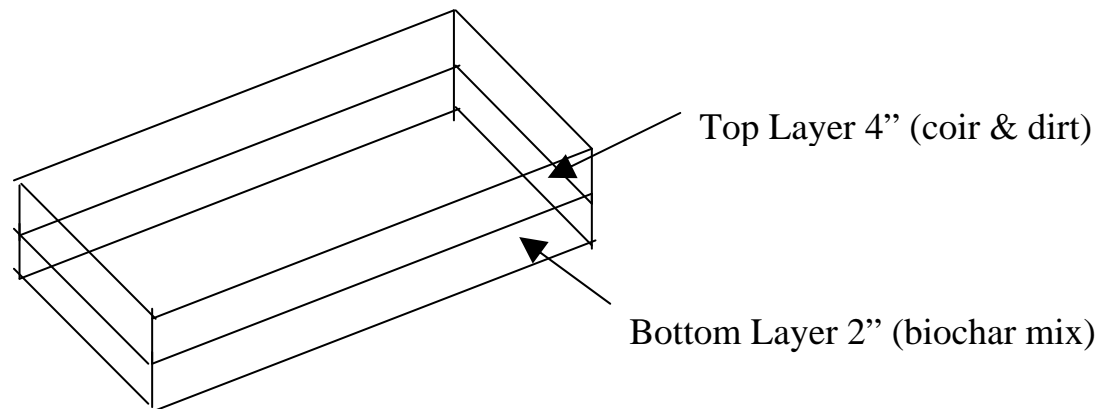
### **Detailed Design**

After thorough testing with various Bio-char, it was time to work on the implementation details of the floating island. We started to plan what materials we need, how to make the island float and how to infuse the biochars and what kind of plants to use to be more effective. Next few paragraphs details how the nutrients are absorbed

### **The Floating Island**

The Biochar Infused Floating Island will be in rectangular shape, 4 feet length and 2 feet width and it consists of 2 layers, the top layer will have depth of 4 inches and the bottom layer will be from anywhere between 2 to 4 inches. These will be anchored to the lake shores so that it doesn't drift around. Top layer will be partly submerged but the bottom layer will be fully submerged inside the water. We will add the kapok material around the BIFI at exact depth to make the floating island float at the appropriate depth. Top layer consists of coir mesh with dirt packed tightly and the bottom layer consists of biochar also packed tightly inside the special

membrane. This special membrane has tiny pores with which it will allow the water to pass through in and out but no other materials can escape. This way we will have the maximum contact area between the biochar layer and the water. As the bottom layer is submerged inside the lake or pond, the water interacts with the biochar and allows the biochar to absorb the Phosphorus.



### The Special Plants

Next comes the selection of plants, There are two types of plants which can grow on this Island, one with roots which is submerged inside the water and another is the regular type where the roots grow in the dirt. The plants with roots inside the water will absorb the nutrients like Phosphorus and Nitrogen from the water body directly. Their roots can grow in size from anywhere between 2 to 4 feet deep, and some can grow till 6 feet deep. This allows the BIFI to be more effective as it can tackle deeper problem. The other regular types of plants will grow in the top layer but the roots will grow into the biochar layer thus consuming the nutrients which biochar layer absorbed from the water. The idea of the Floating Island is to absorb the nutrients and provide it to the plants which grows on top of it, thus depriving nutrients to the HABs.

### Biochar Brisket

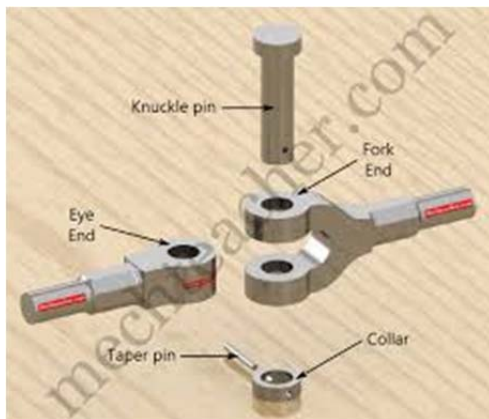
Next comes the Biochar Brisket deployment, these comes in various shapes and sizes and packed inside the special membrane which allows water to interact but no materials can go out. This will be tied or attached to the sides of the BIFI in various depths. If the problem areas are deep like 6 feet to 10 feet these come in handy. Correct amount of weight will be added so that it can submerge and tied to the BIFI at certain length depending on the depth of the problem area.



This is very effective in absorbing the phosphorus and then can be re-used in farming as fertilizer. They become the natural fertilizer with little or no further processing.

### Scalability

We need to talk about the scalability feature of this product, each BIFI unit can be attached to another BIFI unit very easily thus can grow both X and Y direction. These starts at 4 by 2s as a single unit and it can grow to any size. If the water body is big then these can be deployed as set of 3 or 4 according to the size. It all depends on the deployment site and concentration levels of phosphorus. Below shows the picture of type of joint we will be using, called knuckle joint.



### Potency

As described above, these are the 3 most effective ways we tackle the excess nutrients runoff problems in lakes and other local water bodies. These Biochar mix and the brisket should be potent enough for one single season (early spring to late summer where most of the cultivation happens). If there are more than one cultivation cycle in a year then we may have to re-deploy the biochar mixture once again. Most of the plants will be re-used but if biochar loses its potency then will be used as a fertilizer in farming land and new mixture needs to be added to the BIFI. New Briskets will be added to the BIFI as well.

### Pros of using First Generation BIFI

- a) Easy deployment, can be deployed in small to medium sized lakes
- b) Easily scalable as each BIFI unit can be attached to another BIFI unit.

## Hydrodynamics: Harmful Algae Bloom (HAB)

- c) Biochar is natural product and generated from the organic waste. So lower the cost of manufacturing
- d) 3 ways of effectiveness and the best part is these biochar brisket can be re-used as fertilizer in the farming land.
- e) Plants used in the BIFI can be re planted next season

### Cons of using First Generation BIFI

- a) In high phosphorus concentration water bodies, the potency of the biochar may be very dynamic and needs to re-fill the biochar mixture few times during one season and might need constant monitoring
- b) The process or adding biochar to BIFI is little complicated so not everyone can do it.
- c) After biochar has completely absorbed the phosphorus then it needs to be moved manually to another location to work effectively.

### Cost Analysis

Items	Quantity	Price in \$	Total Price
Plants with roots in water	4	\$3.00	\$12.00
Regular Plants	4	\$2.00	\$8.00
Bio Char Mix needed for Bottom Layer of BIFI in lbs	10 lbs	\$2.00	\$20.00
Dirt mixed with the choir mesh in lbs	15 lbs	\$1.00	\$15.00
Floating Island base with 2 layers 4' X 2'	1	\$10.00	\$10.00
Membrane covering bio char mixture in sq ft	35	\$0.10	\$3.50
Biochar Brisket	5	\$3.00	\$15.00
Manufacturing and assembling cost	1	\$10.00	\$10.00
Grand Total			\$93.50

### *Preparation of Bio-Chars*

Bio-Chars were prepared in the backyard in home environment so the quality and efficiency will be limited. Usually to get 100% efficiency we need manufacture these bio-chars in controlled environment. Any way we got the idea from internet on how to make the bio-chars in limited quantity. We bought few empty paint cans for each type of biochar, filled with oak wood pieces in one, coconut shell pieces in another and the last one with peanut shell. We poked a small hole in the top of the can and started to heat it up, see picture #1. The peanut hull, coconut shell were all manually prepared for this process.



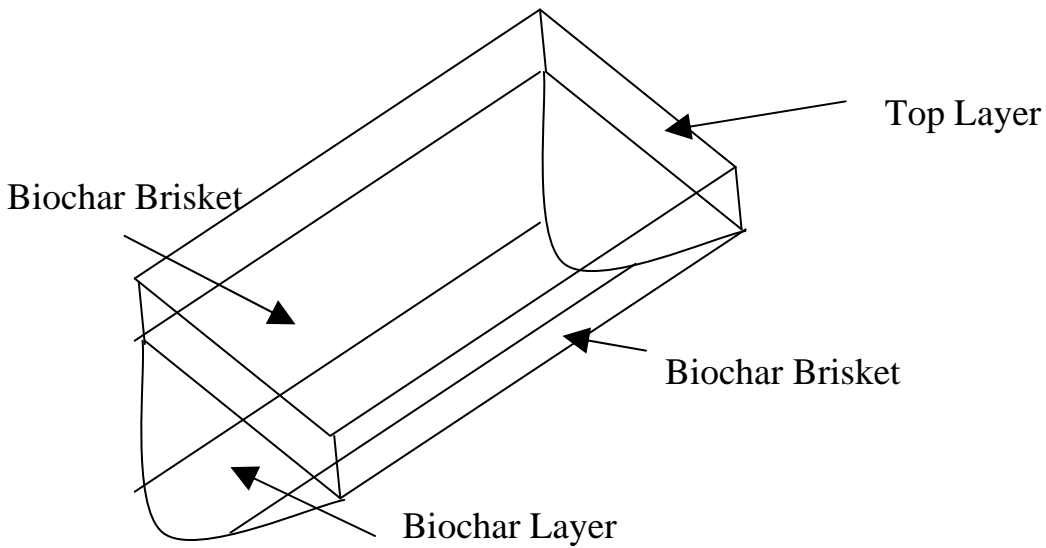




After certain amount of time the smoke starts to come out of the hole and then it stops. Once it stops, we moved the can out from the fire and let it cool down. We crushed with hand and with hammer to make it coarse, thus biochar is ready.

### **Future State of our Product**

Any product requires continuous improvement to be in the market, here are some of the ideas we are working on to tackle the cons of the first generation of BIFI and also make more effective in absorbing phosphorus as well as make it more potent for all year long even at high concentration phosphorus levels. Currently with 4 by 2, the minimal surface contact area is 8 sq. ft. and then with the different brisket size, we increase the surface contact area. What if, we go ahead and increase the contact surface area by 2 or 3 times thus increasing the effectiveness of BIFI. We will expand the bottom layer into a curved boat shaped layer under the top layer of the BIFI. On the bottom layer we will add Biochar brisket on both sides thus increasing by another 16 sq. ft. of contact area. These briskets can be re-used as fertilizers in the farming lands. Thus recouping the money that was spent on adding more biochar layers.



This doesn't change any pros from the previous model but fixes some of the cons for sure. This can be used for long time like 3 to 4 years, thus reducing the cost. The lake owners doesn't have to buy the whole unit every time, they need to buy the Biochar Brisket and sell those back to the farmers thus keeping the maintenance cost low. The plants are reusable, the BIFI unit is reusable, the coir mesh with dirt can able also be reused. This is very much cost effective, other than the initial cost increase. The other change we are proposing is to have mechanical paddle attached which will be operated by solar panel. Paddling helps with water circulation thus moving the water against the Biochar thus increasing the effectiveness. Next Gen BIFI should also be able to detect the phosphorus concentration on the water body and move automatically to those location with high concentration thus more effective.

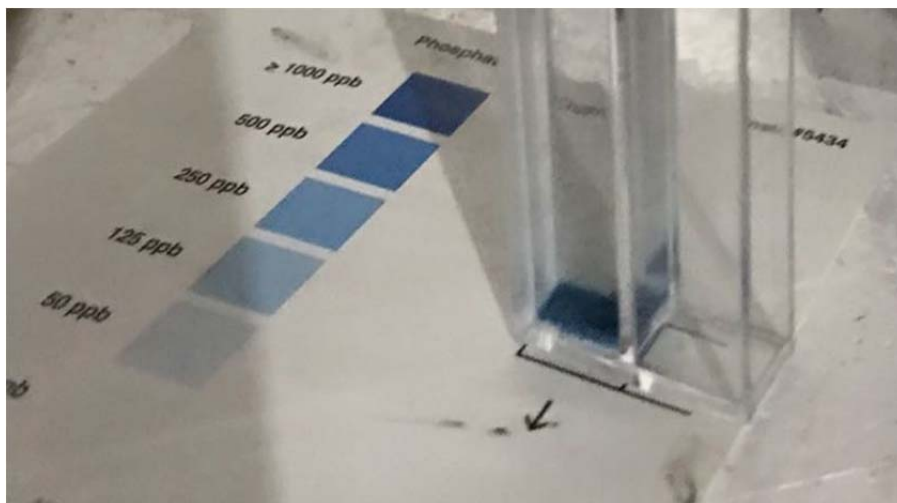
## Controlled Testing Our Solution

We bought a phosphate kit that can measure phosphorus content in PPB (parts per billion). We got some commercial grade fertilizer that was rich in phosphorus.

Using the commercial grade fertilizers helped us simulate a real world scenario.

Using the commercial grade fertilizers helped us perform controlled testing (by adding the same amount of fertilizer to all our test samples).





## Bio-Char Phosphorus Absorption Testing Summary and Results

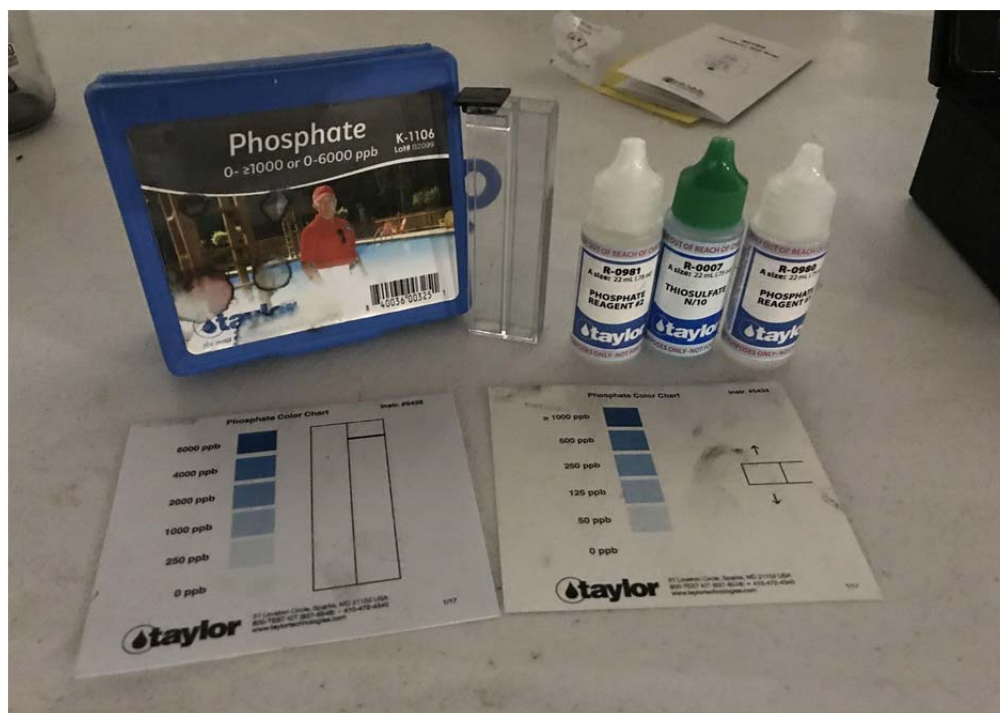
### *Summary*

This document provides information on our testing process and its results. These tests were performed at home with available testing kit. We are looking forward to do some testing at the laboratory level even though there are many thesis and research suggesting high absorption potential of Peanut Shells/Hulls biochar.

The typical amount of phosphorus in the lake water for the harmful algae to bloom is 0.03 mg/L (parts per million). So the idea is to have this Biochar Infused Floating Island to absorb as much phosphorus and nitrogen to keep it under 0.03 mg/L.

### *Testing Kit #1 - by Taylor Laboratories*

We initially worked with the Taylor Phosphate Testing kit which measures the phosphorus with the color coordination, darker the solution higher the content of phosphorus. This is based on the visibility and vaguely accurate, gets the range but not specific number of mg per Liter.



### *Testing Kit #2 - by Hanna Instruments*

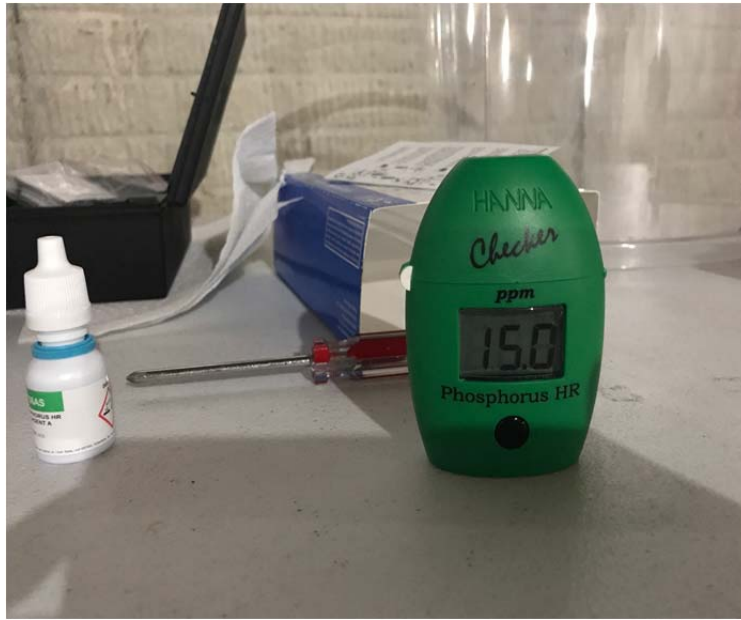
As we progressed we wanted to do find out a better measuring kit, so we ended up buying the Hanna Checker Phosphorus HR which measures in Parts Per Million (mg/L). Below is the picture which shows all the items came with the kit.





### *Testing Results of Various Bio-Chars*

We needed to prepare a solution with specific phosphorus content so that we can test for the same solution for all the different types of biochar. We started with 15 PPM (15 mg/L) measurement. We achieved by different iteration to get to this level. Thanks to Batalle for providing the fertilizer which is currently being used by the farmers. Please see the measurement and also the tested solution, the darker means more phosphorus content.

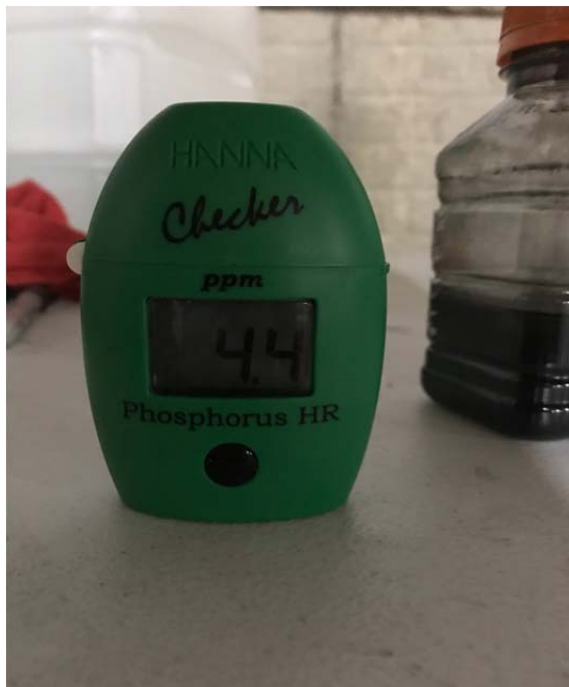


We took 15 fl oz. bottle, filled 12 fl oz of test fluid for the 3-different bio-char testing. We mixed 2 teaspoons of biochar mixed with the 12 fl oz of test fluid for each biochar and shake for few minutes, repeat it frequently. All these solutions were left to work for 24 hours. We filtered the solution to get just the water and leaving the biochar in the test bottle. We took only limited amount of water which is required to do the testing. We were testing every 24 hours for around 5 days continuously and mapped the graph with content in mg/L to the days.

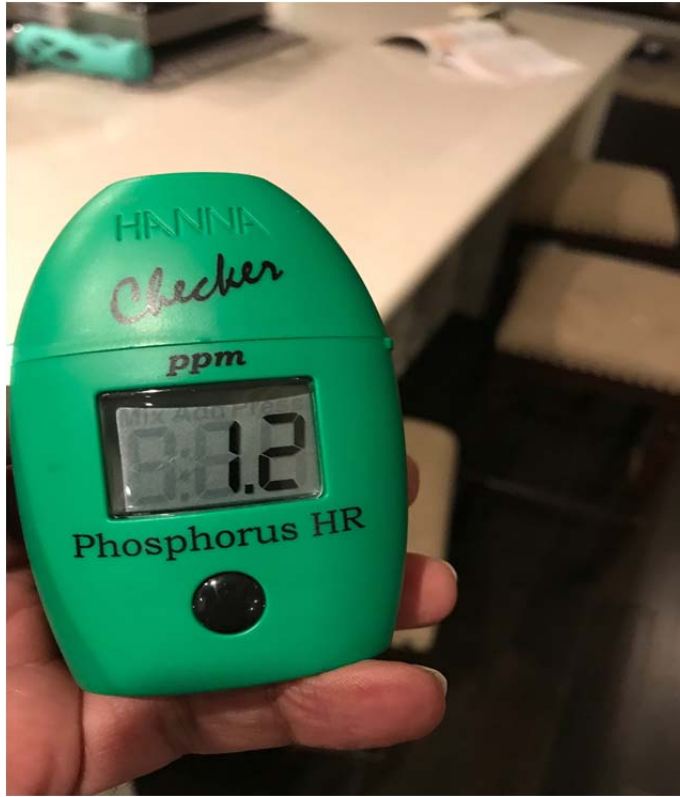
*Result of Oakwood Biochar after 5 days - 6.3 mg/L (58% reduction)*



*Result of Coconut Shell Biochar after 5 days - 4.4 mg / L (70.67% of reduction)*



*Result for Peanut Hull Biochar after 5 days - 1.2 mg/L (reduction of 92%)*

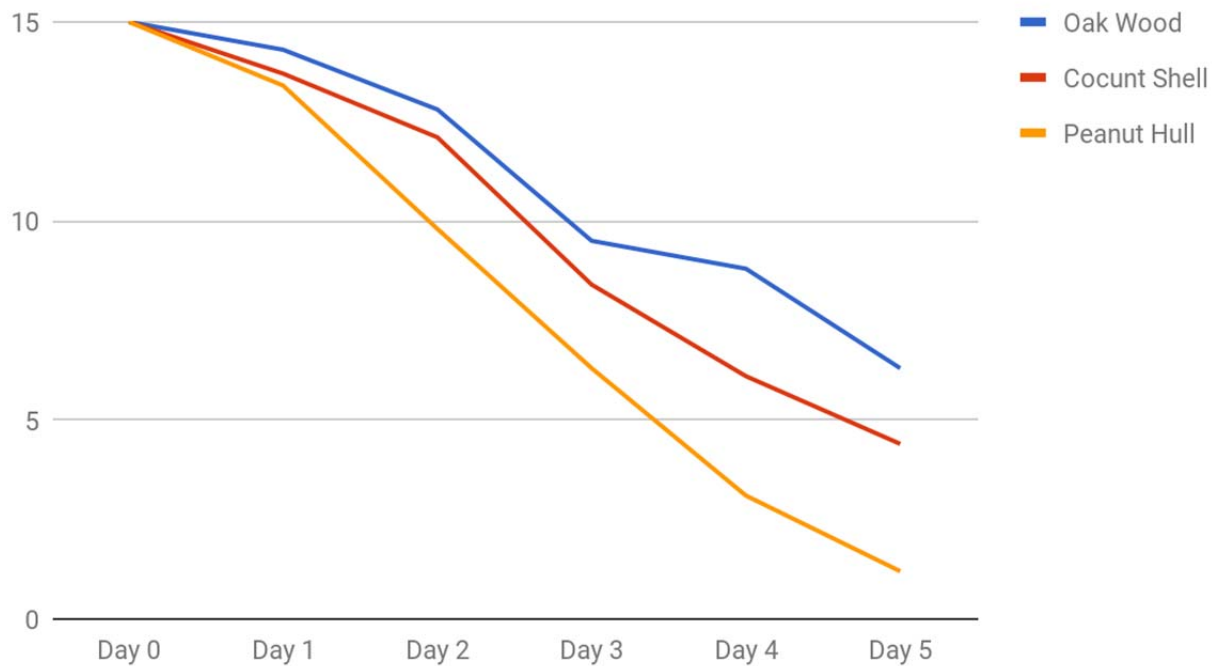


Note: Peanut hull is widely available and it is very cheap, costs between 15\$ to 23\$ per ton.

## Test 1: Testing different Biochar Phosphorus Adsorption Capacity (PAC).

We tested the Phosphorus Adsorption Capacity of different Biochars to find which Biochar is the most effective. We tested three different biochars, which were Peanut Hull, Coconut Shell, and Oak Wood Biochar. The following is a graph representing the three different Biochar Phosphorus Adsorption Capacity.

Biochar Phosphorus Absorption Chart





The results from the graph show that the Peanut Hull Biochar is the most effective in adsorbing the phosphorus. Down below shows a data table representing the exact measurements from each day.

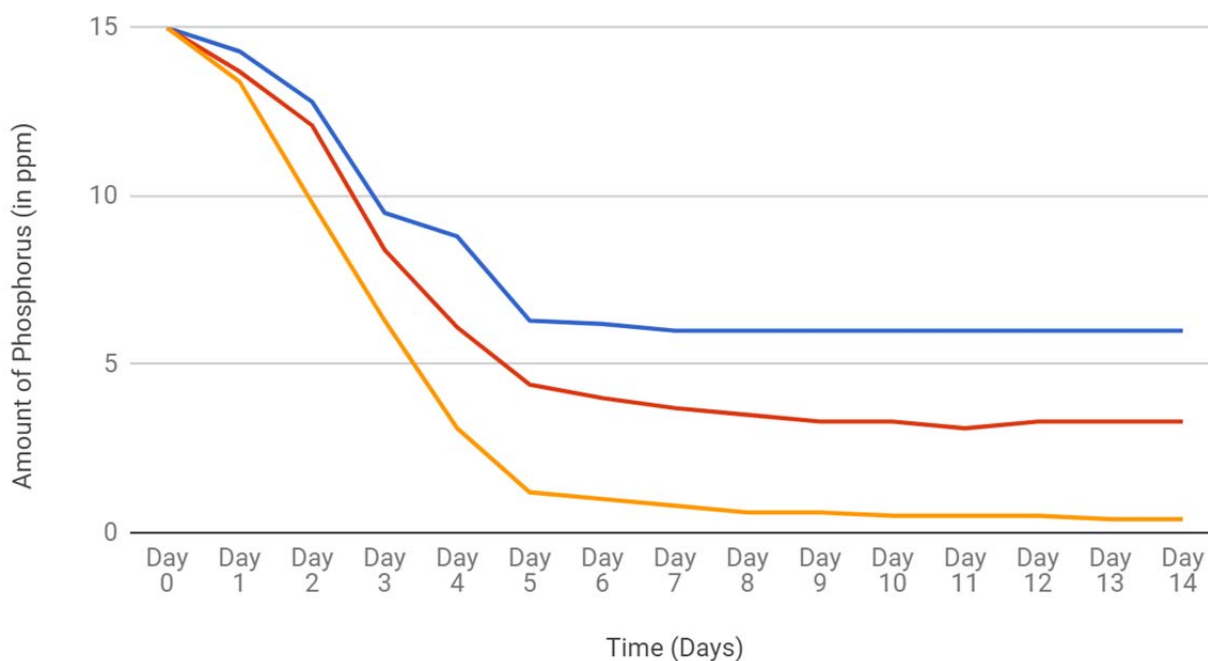
Types of Biochar	Oak Wood Biochar	Coconut Shell Biochar	Peanut Hull Biochar
Day 0	15.0 ppm	15.0 ppm	15.0 ppm
Day 1	14.3 ppm	13.7 ppm	13.4 ppm
Day 2	12.8 ppm	12.1 ppm	9.8 ppm
Day 3	9.5 ppm	8.4 ppm	6.3 ppm
Day 4	8.8 ppm	6.1 ppm	3.1 ppm
Day 5	6.3 ppm	4.4 ppm	1.2 ppm

From these results we see that Peanut Hull Biochar adsorbs exactly 92 percent of the phosphorus over five days, which achieves one of our breakthroughs of having close to a 95 percent Phosphorus Adsorption Capacity.

## Test 2: Measuring the Saturation Capacity of different Biochars

Also, we tested the Saturation Capacity of different biochars to see how long they could last in the water and not oversaturate. We tested the same biochars (Oak Wood, Peanut Hull, and Coconut Shell Biochar). Down below, is a graph representing the Saturation Capacity of each Biochar.

Different Biochar Saturation Capacities



The results from the graph show that the Peanut Hull Biochar also has the highest saturation capacity, meaning that it can stay in the water for the longest, while still absorbing phosphorus. Down below shows a table representing the exact measurements for each day.

Types of Biochar	Oak Wood Biochar	Coconut Shell Biochar	Peanut Hull
Day 0	15.0 ppm	15.0 ppm	15.0 ppm
Day 1	14.3 ppm	13.7 ppm	13.4 ppm
Day 2	12.8 ppm	12.1 ppm	9.8 ppm
Day 3	9.5 ppm	8.4 ppm	6.3 ppm
Day 4	8.8 ppm	6.1	3.1 ppm
Day 5	6.3 ppm	4.4 ppm	1.2 ppm
Day 6	6.2 ppm	4 ppm	1 ppm
Day 7	6 ppm	3.7 ppm	.8 ppm
Day 8	6 ppm	3.5 ppm	.6 ppm
Day 9	6 ppm	3.3 ppm	.6 ppm
Day 10	6 ppm	3.3 ppm	.5 ppm
Day 11	6 ppm	3.3 ppm	.5 ppm
Day 12	6 ppm	3.3 ppm	.5 ppm
Day 13	6 ppm	3.3 ppm	.4 ppm
Day 14	6 ppm	3.3 ppm	.4 ppm

From these results, we can see that the Peanut Shell Biochar had the highest Saturation Capacity and it achieved a 97 percent Phosphorus Adsorption after interacting with it for a longer time. The Peanut Hull Biochar also achieved another breakthrough of having a high saturation point.

## **Problem: Describe what you learned in your research.**

### **Research on the Algae and Harmful Algal Blooms problem:**

Our research was centered on the causes and effects of Algae and HABs (Harmful Algal Blooms). We talked with many experts in the field of algae and we found that algae is caused by three things. Algae can be caused by

- High Nitrogen and Phosphorus content in Agricultural, Residential, and Industrial runoff to waterways.
- Stagnant water in Lakes and Ponds.
- Excess of cyanobacteria in water.

We also found the effects of Harmful Algal Blooms to the environment. Algae had many negative effects to the environment and the organisms living there. Effects that Algae can have are

- Creating dead zones in the water. These zones are places in the water, which cannot support any life.
- It is a big contributor to the animal and plant death problem. 50% of unusual marine mortality deaths are associated with algae and HABs.
- Algae deprives oxygen and sunlight from aquatic plants living in the water, which also contributes to the aquatic mortality problem.
- Algae releases a cyanotoxin, which is very harmful to the environment.
- It also has infected many people's water supplies. In fact, in Toledo, Ohio more than 500 thousand people's water supply was cut off just because of HABs.
- It is also very expensive to handle. The U.S. has spent over \$29 billion on dealing with algae since 2009.

Harmful Algal Blooms are a severe environmental problem in all 50 states. In 2013, only 16 states were affected by HABs, but in 2017 all 50 states in the US have been affected. Over 15,000 lakes worldwide are impacted by Harmful Algal Blooms.

## **Research on Existing Solutions for this problem:**

This problem has been getting larger and larger each year and they don't have a solution that can fix it large scale yet. They have created many chemical treatments to fight off this problem in larger waterways, but

- They are very expensive. They can be up to thousand dollars every season in smaller lakes.
- They are as much of a harm to aquatic life as algae is. The chemicals can raise and lower the pH of the water, which makes it very harmful for aquatic life.
- Finally, these chemical treatments are not very effective in reducing the nutrients and algae in the water.

Now in recent years, they have created ultrasonic treatments, where they send out ultrasonic waves, which are at a certain frequency to break the algae's cell wall and ultimately kill the algae, but

- These treatments are even more expensive, where the cheapest one you can usually buy is \$2500 and you have to have maintenance done on it every year, which is also a lot of money.
- These treatments are only effective in smaller scale lakes and ponds. In larger scale lakes and ponds, you would have to buy more than one for it to be effective, but in places like Lake Erie, this treatment wouldn't be practical to use.
- These treatments break the cell wall of algae, which by doing so, releases a cyanotoxin. This toxin is very harmful to the environment and it contributes to aquatic mortality problem, like the algae.

From this research, we decided to create an eco-friendly, cheap, and effective solution to reduce nutrients, like Phosphorus and Nitrogen, in the water.



## **Research on tools that could help us build the BIFI:**

Now that we have decided we wanted to build a device to reduce Phosphorus and Nitrogen from the water, we needed to research materials for our prototype. We needed to find light, affordable, and strong material to build the outer frame of our prototype. We got feedback from some of our experts on what materials. For example, we got the idea of using water resistant woods, like Bamboo and Treated Lumber from Ram Lalgudi from the Battelle Research Center.

We also, needed to find plants for our BIFI. We talked with some biologists, like Douglas D. Kane, who is a biologist from Defiance University in Ohio. We got feedback to use hydroponic plants, because their roots are strong and long and don't need any soil to grow.

Finally, we needed to decide what materials to build the membrane. We called many membrane manufacturers to see, which was the best material for an impermeable membrane other than letting water bypass through. From this research we decided to use a nylon membrane.

.

## **Step 1: Making The Biochar**



**Preparing the materials to go into Pyrolysis.**



**Materials going through Pyrolysis**

## **Step 2: Make base for the model**



**This is the our base for our prototype. In our prototype we have a sturdy styrofoam base, but in our final product we decided to have treated bamboo lumber as our base. We had a styrofoam block, which we cut large holes into, so we can insert the soil and biochar.**

### **Step 3: Insert Biochar and Soil into the base**



**We placed our newly-made biochar and soil into our base. In the top layer, we placed our soil in the holes. In the bottom layer, we placed our peanut shell biochar and soil mixture. The plants feed of these nutrients that the soil and biochar adsorb.**

#### **Step 4: Place plants in the model and make the membrane**



**We created holes to place our plants in the top layer of soil (For the model, the plants are just a small representation of the actual plants). We added tape around all the layers to represent a water permeable membrane, which will let water in to interact with the soil and biochar, but not let fine particles, like biochar out into the water.**



## **Step 5: Make and Add Biochar Briskets**



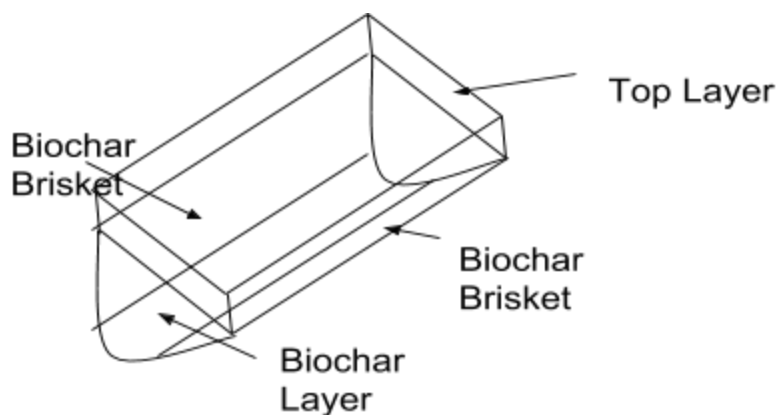
We created biochar briskets on the side to maximize the biochar interaction with the water. For the model we had bags filled with biochars, which were covered with “membrane”(Tape). In the final product they will be a rectangular shaped brisket, which is made from treated lumber and is filled with biochar.

## Step 6: Finished Model



This is our finished model. Our final product will be 4' by 2' and will include bigger plants, wooden biochar briskets, and a treated bamboo wood base. Also, our final product will be more curved shape to increase buoyancy and maximize the interaction between the water and the biochar.

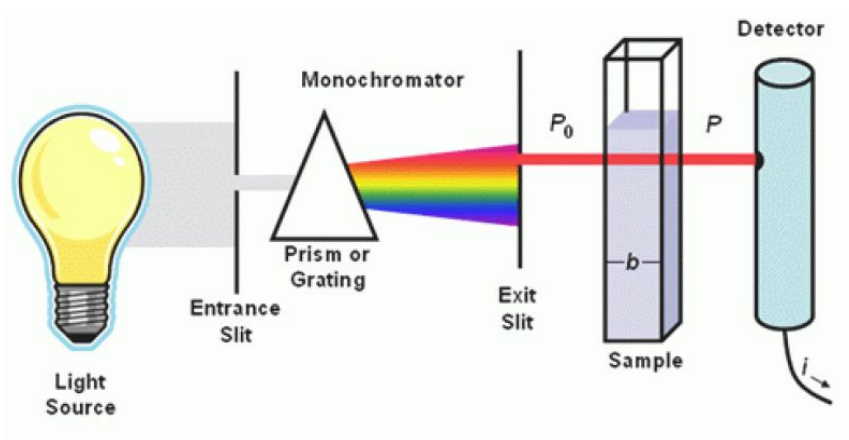
Picture of Final design





## Variables that are going to be being tested:

What Test	Types of Variable	What was used to Measure it	Units of Measurement
Phosphorus Adsorption Capacity Test	How much Phosphorus each biochar adsorbed.	Hanna Instruments Digital Phosphorus Checker	Parts Per Million (ppm)
Saturation Capacity Test	How high the saturation point was for each biochar.	Hanna Instruments Digital Phosphorus Checker	Parts Per Million (ppm)



Color spectrometer that Hanna Instruments Digital Checker uses to measure the ppm.

This was the Hanna Instruments Digital Phosphorus Checker that we used to perform our two tests. This testing kit was recommended by one of our experts (Mr. Ram Lalgudi from the Battelle Research Center). This kit is used in many commercial lakes and ponds to test Phosphorus Levels. To test it you have to take a sample and test it. The instrument takes this as the first content to compare to. Then, you will add a reagent to the sample you take. This changes the color of the sample to a type of blue (darker it is, more phosphorus, and vice versa). The instrument takes this as content number 2 when you test it. This device is built with a color spectrometer and it compares both contents colors and gives out a Phosphorus Reading based on that.

We needed to test two variables to determine if our product was going to be practical and effective. The two variables that we needed to test were the Phosphorus Adsorption Capacity and the Saturation Capacity. We will test both of these with the Hanna Instruments Digital Phosphorus Checker.

### **Phosphorus Adsorption Capacity Test:**

For the first test we were going to test the Phosphorus Adsorption Capacity (PAC). We were going to test the PAC by letting each of our three biochars to interact with the Phosphorus test sample we created, over the course of five days. Each day we would filter out the biochar and test the sample after it was filtered. We did this because we would see how much the phosphorus reduced from the sample, which would tell us how much phosphorus each biochar adsorbed, thus giving each biochar's PAC.

### **Saturation Capacity Test:**

For the second test we were going to test the Saturation Capacity of each biochar. We were going to test the Saturation Capacity by letting the biochars interact with the Phosphorus test sample, over the course of two weeks. We would do the same test as the PAC test, but we left it out for two weeks. When it gave us the same phosphorus amount, for more than 2-3 days we knew the biochar was at its saturation point and it wouldn't absorb any more phosphorus.

The problem of our research project is about Harmful Algal Blooms (HAB) which occur when colonies of algae—simple plants that live in the sea and freshwater—grow out of control while producing toxic or harmful effects on people, marine life, and birds. The human illnesses caused by HABs can be debilitating or even fatal.

HABs can:

1. Create dead zones in the water.
2. Raise treatment costs for drinking water.
3. Hurt industries that depend on clean water.

HABs are a major environmental problem in all 50 states. In 2013, only 16 states were affected by HABs, but in 2017 all 50 states in the US have been affected. Over 15,000 lakes are impacted by Harmful Algal Blooms.

Many HABs are increasing in severity and frequency, and biogeographical range. HABs are a worldwide phenomenon requiring international understanding leading ultimately to local and regional solutions.

HABs are caused by nutrient runoff. The two main nutrients that contribute to the growth of HABs are phosphorus and nitrogen. They come from agricultural, industrial and residential runoff of which, agricultural runoff is the biggest contributor.

The U.S. has spent over \$29 billion on dealing with algae since 2009. Currently, there is no stringent legislation that restricts the use of fertilizers and control of runoff. A legislation sponsored by Sen. Bill Nelson, D-Florida, could make toxic algal blooms “an event of national significance”.

Agricultural is the main cause of HABs. There are two reasons why HABs have not been stopped:

1. Most fertilizers these days contain high phosphorus and there are few fertilizers with limited phosphorus.
2. There aren't many regulations limiting the fertilizer and manure that can be placed on fields.

Nitrogen is more commonly found in salty waters like seas and oceans and Phosphorus is more commonly found in freshwater bodies. Harmful algal blooms are one the biggest causes of aquatics and marine life deaths. There are many different types of algae such as red-tides, brown-tides, and blue-green algae.

HABs produce and release something called a cyanotoxin which is extremely harmful. The key bonded elements in cyanotoxin are carbon and nitrogen. The chemical instantly kills fishes and humans exposed to it can develop legionnaires disease. The algae also create dead zones in the waters where fish and plants can not live there, and existing animals are killed off by the toxins.



The algae can build up all over the lake and block sunlight for plants and animals underneath, also killing them. To add to that, algae can adjust to its environment in certain circumstances. For example, algae grow from spring to fall in warm conditions. If it gets too hot, algae can go underwater to protect itself.

There are no efficient and cost-effective solutions to prevent, control and mitigation HABs, although a lot of research is being at an international level. The solutions that exist today are cost prohibitive and cannot be used for small to medium-sized water bodies.

HABs are predicted to increase and cause more harm in the coming years.



picture 1



picture 2

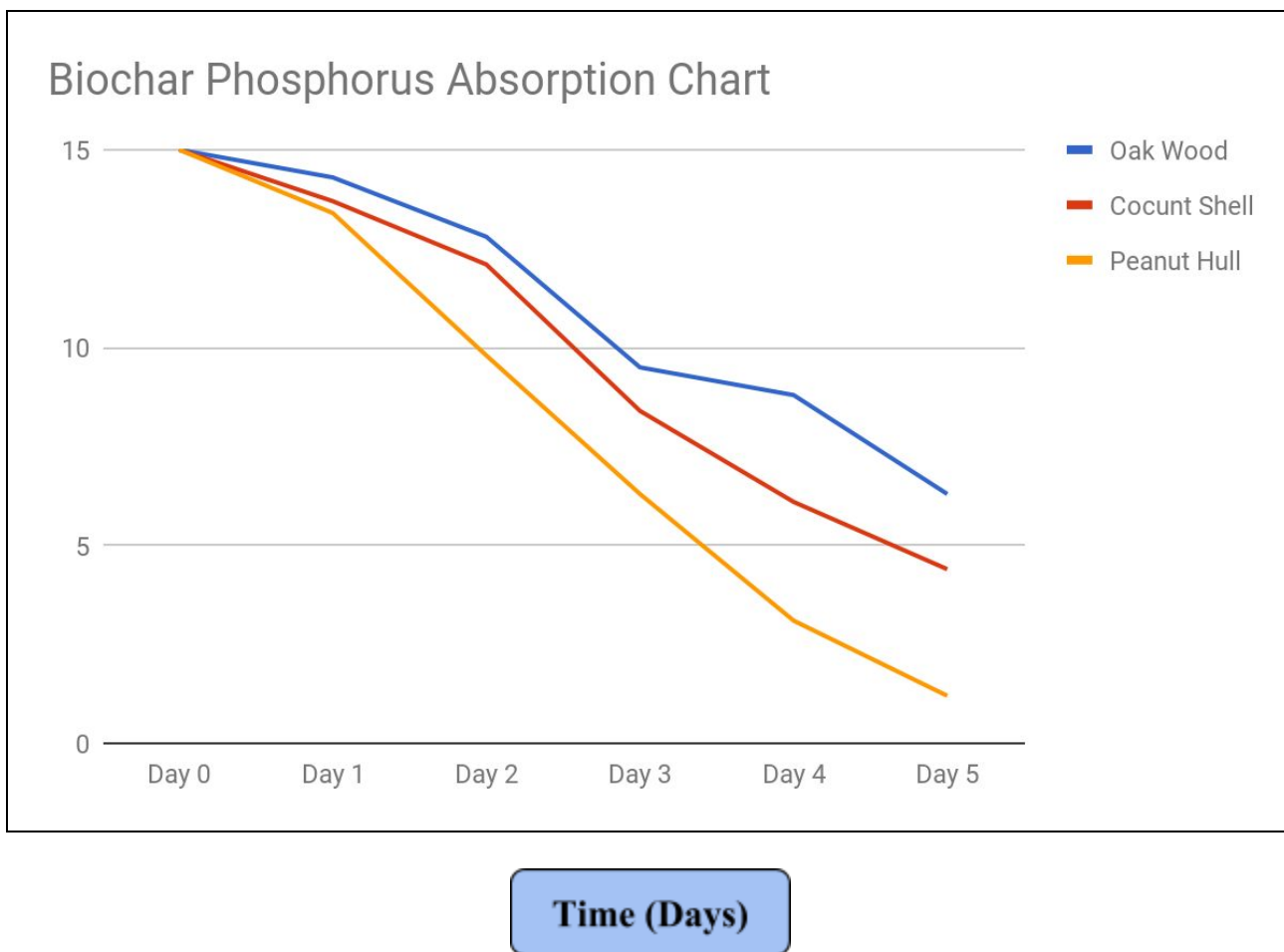


picture 3

Present the data you collected and observed in your testing. The use of data tables, charts and/or graphs is encouraged.

### Test 1: Testing different Biochar Phosphorus Adsorption Capacity (PAC).

We tested the Phosphorus Adsorption Capacity of different Biochars to find which Biochar is the most effective. We tested three different biochars, which were Peanut Hull, Coconut Shell, and Oak Wood Biochar. The following is a graph representing the three different Biochar Phosphorus Adsorption Capacity.



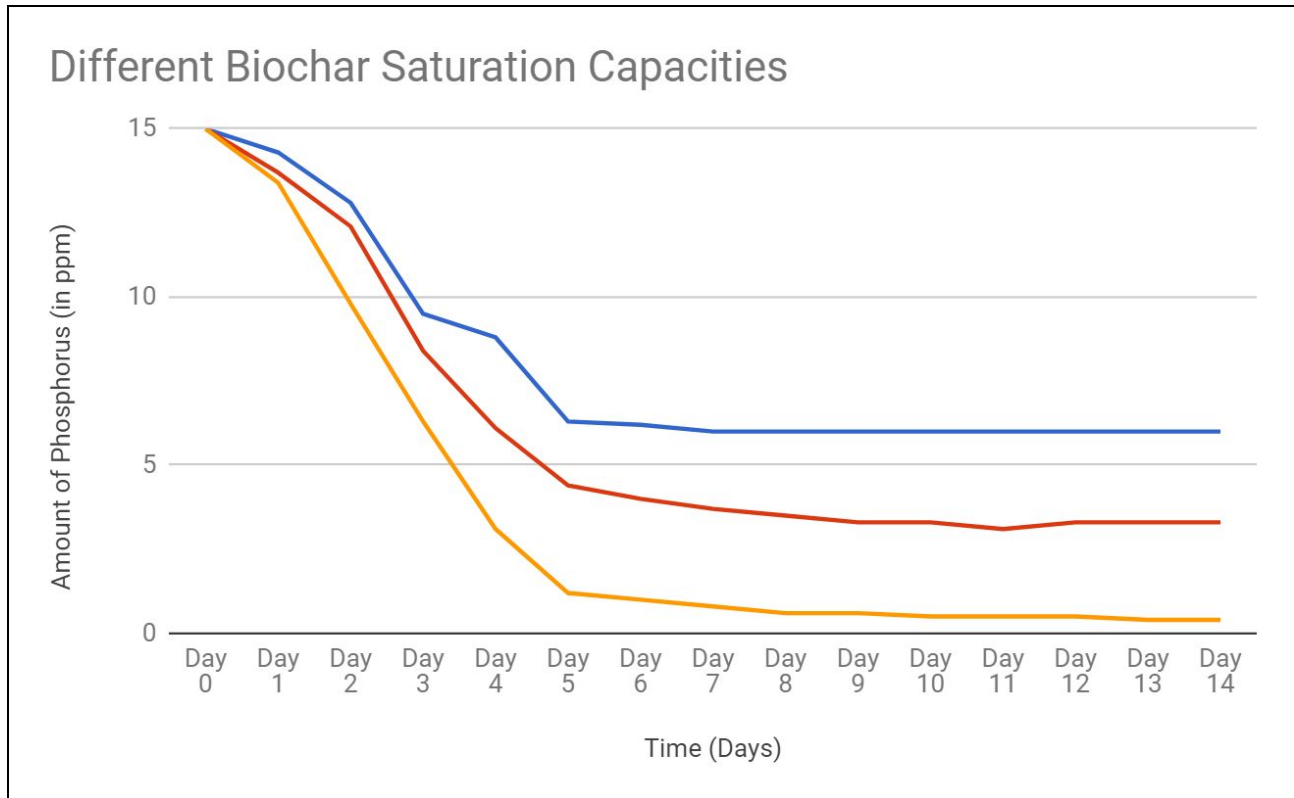
The results from the graph show that the Peanut Hull Biochar is the most effective in adsorbing the phosphorus. Down below shows a data table representing the exact measurements from each day.

<b>Types of Biochar</b>	<b>Oak Wood Biochar</b>	<b>Coconut Shell Biochar</b>	<b>Peanut Hull Biochar</b>
<b>Day 0</b>	<b>15.0 ppm</b>	<b>15.0 ppm</b>	<b>15.0 ppm</b>
<b>Day 1</b>	<b>14.3 ppm</b>	<b>13.7 ppm</b>	<b>13.4 ppm</b>
<b>Day 2</b>	<b>12.8 ppm</b>	<b>12.1 ppm</b>	<b>9.8 ppm</b>
<b>Day 3</b>	<b>9.5 ppm</b>	<b>8.4 ppm</b>	<b>6.3 ppm</b>
<b>Day 4</b>	<b>8.8 ppm</b>	<b>6.1 ppm</b>	<b>3.1 ppm</b>
<b>Day 5</b>	<b>6.3 ppm</b>	<b>4.4 ppm</b>	<b>1.2 ppm</b>

From these results we see that Peanut Hull Biochar adsorbs exactly 92 percent of the phosphorus over five days, which achieves one of our breakthroughs of having close to a 95 percent Phosphorus Adsorption Capacity.

## **Test 2: Measuring the Saturation Capacity of different Biochars**

Also, we tested the Saturation Capacity of different biochars to see how long they could last in the water and not oversaturate. We tested the same biochars (Oak Wood, Peanut Hull, and Coconut Shell Biochar). Down below, is a graph representing the Saturation Capacity of each Biochar.



**The results from the graph show that the Peanut Hull Biochar also has the highest saturation capacity, meaning that it can stay in the water for the longest, while still absorbing phosphorus. Down below shows a table representing the exact measurements for each day.**

<b>Types of Biochar</b>	<b>Oak Wood Biochar</b>	<b>Coconut Shell Biochar</b>	<b>Peanut Hull</b>
<b>Day 0</b>	<b>15.0 ppm</b>	<b>15.0 ppm</b>	<b>15.0 ppm</b>
<b>Day 1</b>	<b>14.3 ppm</b>	<b>13.7 ppm</b>	<b>13.4 ppm</b>
<b>Day 2</b>	<b>12.8 ppm</b>	<b>12.1 ppm</b>	<b>9.8 ppm</b>
<b>Day 3</b>	<b>9.5 ppm</b>	<b>8.4 ppm</b>	<b>6.3 ppm</b>
<b>Day 4</b>	<b>8.8 ppm</b>	<b>6.1</b>	<b>3.1 ppm</b>
<b>Day 5</b>	<b>6.3 ppm</b>	<b>4.4 ppm</b>	<b>1.2 ppm</b>
<b>Day 6</b>	<b>6.2 ppm</b>	<b>4 ppm</b>	<b>1 ppm</b>
<b>Day 7</b>	<b>6 ppm</b>	<b>3.7 ppm</b>	<b>.8 ppm</b>
<b>Day 8</b>	<b>6 ppm</b>	<b>3.5 ppm</b>	<b>.6 ppm</b>
<b>Day 9</b>	<b>6 ppm</b>	<b>3.3 ppm</b>	<b>.6 ppm</b>
<b>Day 10</b>	<b>6 ppm</b>	<b>3.3 ppm</b>	<b>.5 ppm</b>
<b>Day 11</b>	<b>6 ppm</b>	<b>3.3 ppm</b>	<b>.5 ppm</b>
<b>Day 12</b>	<b>6 ppm</b>	<b>3.3 ppm</b>	<b>.5 ppm</b>
<b>Day 13</b>	<b>6 ppm</b>	<b>3.3 ppm</b>	<b>.4 ppm</b>
<b>Day 14</b>	<b>6 ppm</b>	<b>3.3 ppm</b>	<b>.4 ppm</b>

From these results, we can see that the Peanut Shell Biochar had the highest Saturation Capacity and it achieved a 97 percent Phosphorus Adsorption after interacting with it for a longer time. The Peanut Hull Biochar also achieved another breakthrough of having a high saturation point.

## **The Design of Our Product:**

The design of our product, The BIFI (Biochar Infused Floating Island) is based around our Peanut Hull Biochar. The Biochar Infused Floating Island will be in rectangular shape, 4 feet length and 2 feet width and it consists of 2 layers, the top layer will have depth of 8 inches and the bottom layer will be from anywhere between 4 to 8 inches. These will be anchored to the lake shores so that it doesn't drift around. The frame of the BIFI will be made of a Treated Bamboo Lumber. Top layer will be partly submerged but the bottom layer will be fully submerged inside the water. Top layer consists of coir mesh with soil packed tightly and the bottom layer consists of biochar also packed tightly inside the special membrane. This special membrane has tiny pores with which it will allow the water to pass through in and out but no other materials can escape. This way we will have the maximum contact area between the biochar layer and the water. As the bottom layer is submerged inside the lake or pond, the water interacts with the biochar and allows the biochar to absorb the Phosphorus.

## **List of Materials Used:**

- **Treated Bamboo Lumber Wood**

[https://www.calibamboo.com/product-denali-dark-brown-deck-7502004401.html?utm\\_source=connextity&utm\\_term=7502004401&utm\\_medium=cpc&utm\\_campaign=Flooring+Supplies](https://www.calibamboo.com/product-denali-dark-brown-deck-7502004401.html?utm_source=connextity&utm_term=7502004401&utm_medium=cpc&utm_campaign=Flooring+Supplies)

- **Peanut Hull Biochar**

(We made it on our own, by a process called pyrolysis)

- **Sedges (Plants)**

[https://www.google.com/search?q=sedges&tbm=shop&source=lnms&sa=X&ved=0ahUKEwiPmN3rzszHZAUhUBzFMKHXB88Q\\_AUICygC&biw=1045&bih=527&dpr=3.06#spd=908129580512216211](https://www.google.com/search?q=sedges&tbm=shop&source=lnms&sa=X&ved=0ahUKEwiPmN3rzszHZAUhUBzFMKHXB88Q_AUICygC&biw=1045&bih=527&dpr=3.06#spd=908129580512216211)

- **Small Succulents (Plants)**

<https://www.etsy.com/listing/280362500/succulent-plants-30-plant-assortment?ref=related-7>

- **Soil**

[https://www.farmandfleet.com/products/710790-green-gro-potting-soil.html?feedsource=3&gclid=Cj0KCQiA2snUBRDfARIsAIGfpqGf5c9UYhSj\\_sdRUyV9FKDbojPzG62I6eHFItfOqA9nS7tlSPdGd1saAtfHEALw\\_wcB](https://www.farmandfleet.com/products/710790-green-gro-potting-soil.html?feedsource=3&gclid=Cj0KCQiA2snUBRDfARIsAIGfpqGf5c9UYhSj_sdRUyV9FKDbojPzG62I6eHFItfOqA9nS7tlSPdGd1saAtfHEALw_wcB)

- **Nylon Membrane**

<http://www.monarflex.com/Product%20Guide/Building%20membranes/Roofing%20underlay/High%20performance%20breather%20membranes.aspx>







## *Harmful Algae Bloom (HAB) Project*

### *The Under Control Team #32140*



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### **Legislative Solution Summary by the Under Control Team**

## Hydrodynamics: Harmful Algae Bloom (HAB)

The team researched about existing bills and laws to explore what kinds of mandates and provisions exist today.

In our discussions with our experts, we found the following:

1. A lot of the provisions that exist today are for farmers and industries.
2. Some bills have laws which need mandatory adherence like the example below.
3. Some bills are more training and education focused.
4. Any bill that deals with subsidies is hard to pass since it increases cost of other tax payers.
5. Bills have to be economically viable to be able to put forward. Proposal that would take a lot of dollars to implement and that do not have tangible way to measure effectiveness are hard to pass.

Example of an existing law:

Ohio's newest legislation addressing water quality concerns became effective on July 3, 2015. The new law, enacted by the Ohio legislature earlier this year as [Senate Bill 1](#), affects Ohio agriculture with the following provisions:

**1. Fertilizer application restrictions in the western basin.** In the western basin of Lake Erie, a person may not apply fertilizer (defined as nitrogen or phosphorous) under these conditions:

- a. On snow-covered or frozen soil
- b. When the top two inches of soil are saturated from precipitation
- c. In a granular form when the local weather forecast for the application area contains greater than a 50% chance of precipitation exceeding one inch in a twelve-hour period

Exceptions—the above restrictions do not apply if the fertilizer is:

- a. Injected into the ground
- b. Incorporated within 24 hours of surface application
- c. Applied onto a growing crop

**2. Manure application restrictions in the western basin.** In the western basin of Lake Erie, a person may not surface apply manure (defined as animal excreta) under these conditions:

- a. On snow-covered or frozen soil
- b. When the top two inches of soil are saturated from precipitation
- c. When the local weather forecast for the application area contains greater than a 50% chance of precipitation exceeding 1/2 inch in a 24 hour period

Exceptions—the above restrictions do not apply if the manure is:

- a. Injected into the ground
- b. Incorporated within 24 hours of surface application
- c. Applied onto a growing crop
- d. Or if, in the event of an emergency, the chief of the division of soil and water resources provides written consent and the application is in accordance with NRCS practice standard code 590.

**Complying with the new law**

To ensure compliance with Senate Bill 1's fertilizer and manure restrictions that are now effective in Ohio, producers should consider these questions before making an application of manure or fertilizer:

**1. Will the application of fertilizer or manure occur in the western basin of Lake Erie?** If so, the new restrictions may apply to the application. A map that outlines the 11 watersheds and all or parts of 25 counties that comprise the western basin is available [here](#).

- **Does the application involve a restricted nutrient?** The new restrictions apply to any application that involves nitrogen, phosphorous or any type of animal manure.
- **Will the restricted nutrient be injected into the ground, incorporated within 24 hours, applied onto a growing crop or made with permission of the chief of soil and water resources due to an emergency involving manure applications?** If so, the application is permissible as an exception to the restrictions.
- **If one of the above exceptions does not apply to the application, do weather conditions prohibit the application?**
- **Is the ground frozen, snow covered or saturated two inches deep or more?** If so, the application is prohibited.
- **Is there a greater than 50% chance that precipitation will exceed one inch in the next 12 hours for the area where the application will occur?** If so, an application of granular fertilizer is prohibited.
- **Is there a greater than 50% chance that precipitation will exceed one-half inch in the next 24 hours for the area where the application will occur?** If so, an application of manure is prohibited.
- **Refer to OSU Extension's C.O.R.N. newsletter** for guidance on how to obtain important precipitation information prior to an application.

**2. Is a temporary exemption from the manure restrictions available?** If manure applications will be made by a "small" or "medium" animal feeding facility in the western basin, the facility may request the temporary exemption from the restrictions. Refer to ODA's explanation of what qualifies as a small or medium animal feeding facility on its website, [here](#).

**3. Is the manure or fertilizer obtained from a confined animal feeding facility regulated by ODA's Division of Livestock Environmental Permitting and to be applied on more than 50 acres of land in agricultural production anywhere in Ohio?** If so, the person applying the manure or fertilizer must be certified by ODA as a Certified Livestock Manager or agricultural fertilizer applicator. A tool to search for concentrated animal feeding facilities operating under permit is available on ODA's website, [here](#), as is information about CLM certification and the agricultural fertilizer certification program.

**Non-compliance risk**

ODA has authority to investigate potential violations of the new fertilizer application restrictions and the Division of Soil and Water Resources has similar authority over potential violations of manure application restrictions. The agencies may investigate upon receiving a complaint from any person or receiving any information that suggests a potential violation. If a violation has occurred or is occurring, the law grants the agencies rulemaking authority to establish penalty amounts for violations, which may not exceed \$10,000 per separate violation. To date, the agencies have not yet initiated proposed rules for the penalty amounts. The agencies may not assess penalties until after providing an alleged violator opportunity for a hearing.

Due to the risk of non-compliance with the new law, producers should review insurance policies and determine whether insurance coverage exists or is available for a mishap under the new law.

Our team narrowed down on the following two ideas for drafting a bill:



## Hydrodynamics: Harmful Algae Bloom (HAB)

1. HAB-PAP (Harmful Algal Bloom – Public Awareness Program)
2. HAB-MMP (Harmful Algal Bloom – Manure Management Plan)

As we contacted legislator offices, we were told that there were bills already existing that addressed manure management.

So we narrowed down our final choice to HAB-PAP (Harmful Algal Bloom – Public Awareness Program)



We contacted all 132 legislators in Ohio. We got responses for several of them.



## Hydrodynamics: Harmful Algae Bloom (HAB)

We sought guidance from Senator Kris Jordan.

**Senator Kris Jordan** is a member of the [Ohio Senate](#) who has represented the 19th District since 2011.

He served in the [Ohio House of Representatives](#) from the 2nd District.

Senator Jordan liked our idea and advised us to pick one of two programs from our list of five options and expand those in more detail. He asked to lay out how the plan, benefits, implementation, cost involved and how they could be applied to more states.

Below is a draft of our bill that we presented to Senator Kris Jordan. We plan to refine our bill based on his guidance and work with the legislative bill drafting commission to make it better.

# Hydrodynamics: Harmful Algae Bloom (HAB)

By: Under Control Team

House Bill # \_\_\_\_\_

## A BILL TO BE ENTITLED AN ACT

### Purpose:

To increase the public awareness about Harmful Algal Blooms (HAB), through a set of structured programs and initiatives, to create a community that can participate and contribute to fighting this national issue.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF OHIO:

### Harmful Algal Blooms:

HABs occur when environmental conditions promote the rapid growth of large numbers of single-celled algae in salt or fresh water. While not all algal blooms are harmful, a small percentage can produce toxins that negatively affect people, fish, shellfish, and other animals. These blooms often discolor the water and result in "red tides" or "brown tides" and may directly or indirectly cause illness in people.

Ingestion of these toxins can cause gastric distress, liver damage, and lung paralysis, and can lead to hospitalization or death. Swimming in or breathing the air near HABs can cause eye, nose, and throat irritation, as well as shortness of breath. In addition to producing toxins, HABs may clog or lacerate fish gills, decrease oxygen in the water (hypoxia), or block sunlight for aquatic plants. A National Oceanic and Atmospheric Administration (NOAA)-funded study by the Woods Hole Oceanographic Institute estimated that the annual economic impact of HABs in the United States is approximately \$50,000,000, including a cost of \$18,000,000 to commercial fishing industries, \$7,000,000 for recreation and tourism effects, and \$2,000,000 for monitoring and management.

Some statistics about the problem:

- 50 out of 50 states are impacted by Harmful Algal Blooms.
- States have identified about 15,000 water bodies in the US with HAB related problems.
- Reported drinking water violations for nitrates have nearly doubled in the last decade.
- About 10% of the nutrients that cause HABs and flow into the Gulf of Mexico come from urban storm water and wastewater/sewage treatment plants.
- An algal bloom contaminated with toxic bacteria shocked Toledo in August 2014, poisoning the city's Lake Erie drinking water and forcing the city of 400,000 people to drink bottled water for three days.

### Section 1: Short Title

This Act may be cited as the "Harmful Algal Bloom Public Awareness Program (HAB-PAP) Act of 2017/2018".

## Vehicles

### Washing Your Car

- Use a commercial car wash; commercial car washes are required to properly dispose of wastewater and many filter and recycle their water.
- If washing your car at home consider the following actions:
  - Wash your car on a pervious surface such as grass or gravel (not concrete or asphalt) so water is filtered before reaching a water body.
  - Use nontoxic, phosphate-free soaps.
  - Use soap sparingly.
  - Minimize runoff by reducing water use, using a spray nozzle to restrict water flow.
  - Wring out sponges and rags over the bucket or in a sink, not the ground.
  - Empty wash water into the sink or toilet, or the grass if you wish to dispose of it outside.
  - Use waterless car wash products for spot-cleaning or a car wash kit, which redirects water from storm drains.
- When conducting car wash fundraisers use a car wash kit; many cities will lend kits free of charge to groups conducting car washes for fundraising, or you can buy car wash kits.

### In the yard:

#### Lawn care:

- Apply fertilizers only when necessary and at the recommended amount.
- Don't apply fertilizer before windy or rainy days.
- Apply fertilizer as close as possible to the period of maximum uptake and growth for grass and other plants, which is usually spring and fall in cool climate, and early and late summer in warm climates.
- Avoid applying fertilizer close to waterways.
- Do not overwater lawns and garden; use a soaker hose, a porous hose that releases water directly to the ground, which can reduce overwatering that carries away fertilizers that would otherwise enrich lawns and gardens.
- Fill fertilizer spreaders on a hard surface so that any spills can be easily cleaned up.
- Properly store unused fertilizers and properly dispose of empty containers.
- Maintain your lawn mowers, snow blowers, chain saws, leaf vacuums and similar outdoor power equipment to reduce nitrogen oxide emissions.

#### Garden care:

- Plant a rain garden of native plants, shrubs and trees that reduce the amount of fertilizer needed and provide a way for water to soak into the ground.
- Install a rain barrel to collect rainwater; the rainwater can later be used to wash your car or water your plants and lawn.

## Section 2: Establishment of the program

Some of the programs and initiatives would include, but are not limited to:

- HAB awareness sessions in middle and high schools.
- HAB awareness advertisements on local television.
- Mobile application for public education (could be built via an application development competition to promote STEM). Send a text to registered users when there is a HAB warning around their area.
- HAB awareness flyers in public places like libraries, visitor centers, State buildings, etc.
- HAB awareness flyers in stores like Home Depot, Lowes, Menards and other that sell phosphorus rich products.

## Section 3: Details of the programs and initiatives

Following is some of the information that can be included in the above programs and initiatives:

### At home:

#### Cleaning Supplies-Detergents and Soaps

- Choose phosphate-free detergents, soaps, and household cleaners.
- Only run your clothes or dish washer when you have a full load.

#### Pet Waste

- Always pick up after your pet.
- Avoid walking your pet near streams and other waterways. Instead, walk them in grassy areas, parks or undeveloped areas.
- Inform other pet owners of why picking up pet waste is important and encourage them to do so.
- Take part in a storm drain marking program in your area to help make others aware of where pet waste and other runoff goes when not disposed of properly.
- Don't use toilets as trash cans. Excess solids can clog your drain field and necessitate more frequent pumping.
- Choose products which are high performing and water efficient.
- Use low-flow faucets, shower heads, reduced-flow toilet flushing equipment, and water-saving appliances such as dish- and clothes washers.
- Repair leaking faucets, toilets and pumps.
- Take short showers instead of baths and avoid letting faucets run unnecessarily.

- Adopt techniques that utilize natural processes to manage storm water runoff and reduce the impact of impervious surfaces on water quality.
- Use pervious pavers for walkways and low traffic areas to allow water to soak into the ground.
- Install a green roof on your home or business.
- Incorporate best management practices, such as grassed swales, filter strips, or buffer strips on your property to control and temporarily store storm water runoff.
- Use yard waste, which includes grass clippings and leaves, in mulch or compost for your garden. If this is not an option, prepare all clippings and leaves for community composting, or in barrels or secured paper bags for disposal, which keeps them from washing into streams.

### In the community and classroom:

#### Get Involved

- [Monitoring and Assessing Water Quality - Volunteer Monitoring](#)  
This page has EPA resources and links to information about volunteer water quality monitoring.

#### Spread the Word

#### Resources:

<https://www.epa.gov/nutrientpollution/harmful-algal-blooms>

<http://theoce.org/campaign/harmful-algal-blooms>

<http://lakeeriealgaee.com/>

<https://ohioseagrant.osu.edu/research/issues/habs>

<http://epa.ohio.gov/ddaww/HAB.aspx>

<https://www.congress.gov/bills/115th-congress/senate-bill/1057>

<https://www.portman.senate.gov/public/index.cfm/press-releases?iD=3804D2C0-4F51-4FE8-B677-2D091A05F011>

<https://mast.house.gov/algaee>

### Expanded Bill based on the feedback from Senator Kris Jordan

#### Section 2: Establishment of the program

Where our program will be implemented in:  
Middle and High schools

Why we chose this location:

Middle school and High schoolers are already learning about things in school. It will be more effective if we inform kids about it. There are about 950,000 middle and high schoolers in Ohio. This is about 8.4% of the Ohio population.

We can easily spark attention and interest in kids about the program. In fact, the age group is just perfect; they are not too young to understand or too old to not care. Our message will clearly be stated as kids will learn about the awareness in harmful algal blooms.

What the program includes:

STEM experts and companies can make guest visits to schools and use various methods such as hands-on interactive activities to engage kids to stop the rising problem of harmful algal blooms. We could have one mandatory day of the year to learn about the harmful algal blooms, similar to "The Hour of Code". Making algal blooms something that is taught in school, even for a day can be helpful to spread the word.

"Hour of code" is a program where for an hour of the day, everybody in the school coded. This happened during just one day of the year

Overall significance:

This program raises awareness for algae using a strategic method. We teach kids about the problems with algae. The next generation will be more aware and people will take precautions to put algae to an end

#### Section 3: Implementation

This is how we will implement the program:

Potential speakers and people who can teach about algae but not limited to

- Government agencies
- STEM companies
- Biologists
- Chemists

Companies that can educate kids on algae are to be contacted to see if they are willing to go to schools in their city to educate kids. If they are willing to volunteer, that is fine, or else they can be paid \$30 or less to go. About \$1500 will need to be spent on companies preparing and training. About \$5000 will be spent on supplies needed by the companies.

In the school end of things, they can spend an hour during one day of the year as stated in section 2 to welcome scientists into their school to educate students.

Contacting the superintendent and principal would be necessary to convince them into allowing this to happen.

#### Section 4: Further goals

Here is what we can do if the program succeeds:

The whole purpose for the bill is to inform students on the growing algae problem. If this program is a success, a possible improvement is to add a fundraiser. People could donate money or the fundraiser money could go to scientists' research into harmful algal blooms.

This would make the public happy. We predict that students would tell their parents about the problem and it will soon spark awareness. This is when the fundraisers can come in.

#### Section 5: Consultation

Here is where the public can contact if they want to learn more:

If the public wants to learn more about the program, they can contact the EPA to get more information. This will increase the effectiveness of our program because people would want to fact check what they are learning.

### Field Trips to Investigate Harmful Algal Blooms

#### *Delaware Water Treatment Plant and Waste Water Treatment Plant by Soham Joshi*

Delaware water treatment plant handles all of Delaware's home and businesses and they process about 7.2 million gallons per day. We met with Jaccion a operator at the plant.

## Hydrodynamics: Harmful Algae Bloom (HAB)



Q and A:

Why are there 2 plants?

There are 2 plants because one is to filter the wastewater or sewage from houses and industrial buildings. One of the plants is to filter water from the olentangy river and wells for drinking and other household purposes.

Is the industrial and residential wastewater treated the same with chemicals?

Wastewater goes through the a pretreatment phase and then the water is treated the same. The industrial water has chemicals and other sludge that is harder to remove. The pretreatment process cleans the water until it is similar to the residential water. This is the most effective way to treat the different types of water.

How modern are there processes?

The processes were placed in 2014. Every 10 years a new machine is put in for more effective treatment. We changed our heater to a more effective on and saved 23,000 dollars every month on electricity. Any way to save energy in our plant can save a lot of money.

How is the water quality checked?

It is checked every 4 hours at each stage. An operator takes a sample and runs tests to make sure the water quality is regular. The operator test the turbidity, pH, and hardness.

## Hydrodynamics: Harmful Algae Bloom (HAB)

The water released into the river is cleaner than the river. Our processes are helping clean the river.

### *Delaware Water Treatment Plant and Waste Water Treatment Plant by Kathir MaariKarthikeyan*

First, we went to the Delaware water plant and the Delaware wastewater plant. We got to learn the processes that are specific to these plants. Also, we got to see in detail every single processes. We also got to test Olentangy River water in their lab.



We got the idea to increase efficiency of some very non-energy efficient processes and use some of these processes to solve other water problems (ex; Aeration Tanks in neighborhoods and “Ram pumps” to make pumping water up energy efficient. These were previous ideas we took into account.

Q and A:

How long does the water treatment processes take?

Groundwater- 4 hours, Surface water- 6 hours

What would happen if rainwater came into the open tanks?

I would have to keep the excess water in a different tank and change the oxygen levels.

Does methane power your plant?

No, it doesn't. More bigger plants use some methane to power the plant, but not ours.

Which process is more biological?

Wastewater, because we use life to clean the water and we only add one chemical. Water treatment adds a lot of chemicals and isn't biological.



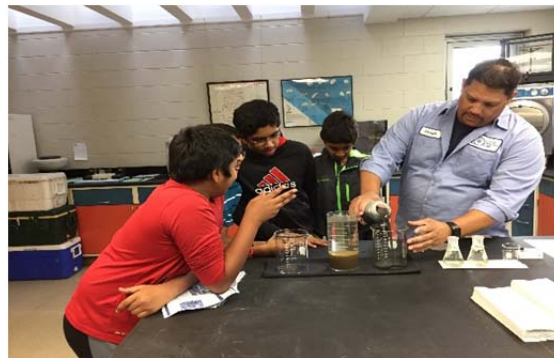
## Hydrodynamics: Harmful Algae Bloom (HAB)

What scientific principles do u use for your plant?

For the water treatment plant they didn't use that many scientific principles, they added many chemicals to bind with other particles and take them out of the water. For the wastewater treatment plant they used some scientific principles such as, gravity because that's how the water flows to them, speed and velocity in relation of hydrodynamics because they set the water at a velocity and speed to accommodate what they are doing (for example when they want some solids to settle down from the water they put the water in a certain speed and a certain direction, so that the solid can settle down), and density principle because they take out solids by density, they do this by having the water going in a circular direction and then over time the solids that are more dense settle down.

### *Delaware Water Treatment Plant and Waste Water Treatment Plant by Pranav Krishnamoorthy*

I went to a filtration plant and a waster water treatment plant. At the filtration plant the manager took us on a tour of the plant. First, we saw the computer the operators use to see what is going on with the pipes and the system. Then we learned about the process as we took a look at the pipes. There were cleaners, pressure filters and chambers.



The second trip was to the waste water treatment plant. The person named Jacion took us around the plant. First was the place where the water goes up the pipe to the chamber where the grit and heavy solids are removed. Then they go through a pipe to remove solids in the water. Next, a pipe is rotated to remove solids floating on the water. The water proceeds to the aeration tanks where bugs feed on bacteria in the water. Then the water is spun and cleaned for the final time.

Q and A:

How are power plants powered by methane? What does it do?



## Hydrodynamics: Harmful Algae Bloom (HAB)

The sludge from wastewater is broken down so that it can be burned to make methane. It takes a long time to make enough methane and it pollutes the environment a very small amount

Do treatment plants pull water from Earth? How?

Water on the surface and water in lakes is pulled and put through the filtration process. Ground water, coming from the ground, is already filtered a bit allowing it to skip steps like ultrafiltration

What chemicals are used in purification?

Aluminum Chlorohydrate is used in a process called flocculation which removes the solids. Chlorine is used in ultrafiltration to clean out iron and manganese, common metals in water. Ortho phosphate is used to prevent the water to corrode stuff.

How can Bernoulli's principle apply?

Pressure tanks are wide and make the water flow slowly so there is a lot of pressure in it. Little pipes allow the water to move quickly all while in low pressure so the pipes don't break.

### *Orange Pond (Collecting Algae) by Kathir Maarikarthikeyan*

#### Orange Pond Summary:

We went to our local pond and saw that it was affected by Algae, Duckweed, etc;. We went and collected many samples of Algae and water from different locations on the pond. We found that the water near the storm drain output was more turquoise, which indicated more Phosphorus and Nitrogen in the water. The water far away from the storm drain was much lighter blue, which indicated less Phosphorus and Nitrogen. This field trip gave us a picture of how algae are affecting us locally.



#### Orange Pond Observations:



- The water was much more blue/turquoise near the storm drain output. This showed more nutrients in this water.
- The water farther away was normal pond color. This showed less nutrients in the water.
- The Algae was always found mixed with other small aquatic plants, like Duckweed in the pond.
- More algae was found near the storm drain output and less was found far away.
- We collected three algae and water samples from different locations in the pond.
- Not many fish or other sea life found near the algae. Probably indicating that the sea life cannot live in algae-infested water.

### *Orange Pond (Collecting Algae) by Pranav Krishnamoorthy*

#### Orange Pond Summary:

Kathir and I went to the pond at the Orange Township Park to collect a sample of algae for our robotics project. First, we inspected the pond to see where the algae are and how we should take it out. At one side of the pond, there was a fountain. We knew there would be no algae there because the water is flowing and algae live in stagnant water. At the other side, there were several pockets of stagnant water. The pockets were near the ground because that's where the nutrients can come from. We found algae that were green and was floating at the edge of the pond. We scooped up the algae and put it in bags to take home, and analyze. We also took three samples of the water at the pond. One sample was from the fountain, one from near the runoff

## Hydrodynamics: Harmful Algae Bloom (HAB)

output (drain output), and one from 10-15 feet away from the drain output. My prediction is that the water near the fountain has fewer nutrients and is cleaner than the water from the other two location in the pond.

### Orange Pond Observations:

- We went to a small public pond near our houses.
- There was more algae near the stagnant water, than near the fountain.
- The sewer drain was located near the stagnant and more algae infested water.
- Near the fountain, there wasn't any algae due to moving water.

### *Ohio Environment Protection Agency (EPA) by Soham Joshi*

#### Field Trip 4: Ohio Environment Protection Agency by Soham Joshi

We met with Aimee Klei who works for the Ohio Epa.

Q and A:

Algae is a pressing problem. What is EPA's involvement in tackling this problem?

The ohio EPA has been involved in solving the algal bloom problem through targeted programs since 2009. The EPA did an assessment to test toxic levels for few Ohio lakes and found that one of the lakes, Grant St May had high levels of toxins. The EPA has a test strategy to handle this problem which gets updated every year and is available on their website. From 2016, special legislation has been passed to conduct routine tests for the surface drinking water where the phosphorus is coming from, sewer overflow, wastewater treatment plants.

What are some of the solutions that are being used today that help control the problem to some extent?

Some of the water plants, like City Of Toledo have deployed the ozone systems that destroy the toxins. Different chemicals are used, then there's copper formula, bubblers in the lake, solar beads that circulate water, innovative technologies are used in farming. New tractors that help reduce phosphorus runoff, using fertilizer techniques to stop run - off, running it through treatment basins. There are innovative solutions like, datasun that tells what water and algal PH levels are through computer and data is then analysed.

## Hydrodynamics: Harmful Algae Bloom (HAB)

Is there a challenge our team can assist EPA with to help with harmful algae bloom? We would like to be engaged in some way if possible.

Solving an algal problem for Lake Erie involves consulting with different countries and states for the solution which is pretty complicated. City of Columbus has water protection problems. Lot of solutions cost lot of money, so there are budget constraints. There are political issues, typically the farms fields are owned by individuals so EPA doesn't own the property so it becomes difficult to prevent. Trying new equipment and technologies is a challenge.

Are there any bills or legislations that exist today or are being thought of or being proposed to mitigate the blooming of algae?

2015 legislation was passed, Ohio had to protect drinking water from toxins. People have to test for toxins, for Lake Erie applying manure to frozen ground to help reduce runoff. Hard to regulate what farmers can do.

Are there any ways to detect where they will happen?

We are starting to get closer to predict, harder to predict after more research

600 miles of Ohio river had harmful algal blooms, typical lakes always happen, hard to predict, changing weather patterns, bigger rain event can cause it, too many factors to predict.

### *Ohio Environment Protection Agency by Pranav Krishnamoorthy*

- We had a conference call with Ms Aimee Klei who works for the Ohio EPA
- We all settled and introduced ourselves
- We started to each ask our questions and write down our answers
- We also took notes as she described the processes and solutions used

In this phone call we learned a lot about the tools and processes used at the EPA. First, we learned about their standards which told us about what they expect when making solutions. Then, the speaker told us about what solutions there are to stop algae and what solutions are being developed so algae can be stopped. Then we asked about our concepts and then we analyzed the info we got after we were done.

Q and A:

What are some effects of algae??

## Hydrodynamics: Harmful Algae Bloom (HAB)

Algae emits harmful toxins into the air. It destroys drinking water by putting toxins in it to. It has made people very sick with legionnaires disease and has killed many dogs. The 2 main nutrients for it are phosphorus and nitrogen. Overall, algae is a very underrated issue and it is something that needs to be stopped.

How can other plants help kill algae?

People are using a thing called cover crops to cut down the nutrients that go in water and help the algae. The cover crops are planted in the winter to absorb some nutrients so during planting season, there will be less runoff going into rivers, ponds, and lakes. This goes to the fact that agriculture is the #1 cause of harmful algal blooms. This method will be a way to stop agriculture from doing this.

How has this problem been tackled at the EPA?

Various solutions have been tested. They have tried stopping fertilizers from giving off runoff. Fertilizers contain nitrogen and phosphorus. The 2 nutrients algae needs to survive. They have also tried ozone systems to kill the algae. Ozone is a greenhouse gas and is in the stratosphere protecting us from the sun's harmful rays. Ozone is also very poisonous which shows how it can be use full. Multiple metals have also been used to bond with and remove the phosphorus.

*Ohio Environment Protection Agency by Kathir MaariKarthikeyan*

Ohio EPA Conference Call Summary:

We got ahold of a representative of the Ohio EPA and asked her many questions and got a lot of information back from her. She explained their involvement with this problem and solutions they already use to help. She also explained some problems that we could try to find a solution to fix that problem. For example, she said that a drone or a robot to take pictures would be much easier to them. Which sparked an idea to have a robot to detect phosphorus levels and take pictures of that area.

Additional Information:

- In Ohio 150 million dollars are spent on the Algae problem.
- 50 out of 50 states are affected by algae or HABs in some way.
- In lakes like our own Grant Lake St. Mary, they are using Alum to bond with the phosphorus, but it isn't effective.
- In Toledo 500,00 people were cut off of their water supply because of algae infesting their water.

Ohio EPA Conference Call Questions:

What do they already use to clean or kill algae?

Answer: They use Alum right now to kill Algae. They are experimenting with Iron Oxide and many other coagulants to bond with phosphorus, but the problem is that how will it react with sea life.

## Hydrodynamics: Harmful Algae Bloom (HAB)

What innovations could be used to help the process of facing this problem?

Answer: Something, like a drone that could take closer pictures of Algae, to record where they are the most. This could help us identify the source of the algae before it gets to be too much algae for the water body and could help scientists identify the type of algae it is, instead of manually doing it.

*Doug Kane, Professor of Biology, Defiance College by Pranav Krishnamoorthy*

Question :How can focused solar rays kill algae?

Answer :When the rays are focused, the intensity can damage the algae making it die. Algae can die at a certain luminosity of light. Algae has a weak photochrome layer so if the light from the sun is intensified, it can kill the algae. The algae will start to bleach by turning white from the light. Then it can die. A problem with this is that the algae can be “smart”. It can sink in the water a couple inches so the water protects the algae from the sun’s rays. The algae can also change its pigment so that it can withstand the sun.

Question :How can ultrasonic kill algae?

Answer : Ultrasonic can kill algae by breaking cell walls. Using ultrasonic has been tested at the EPA and works only sometimes. The frequency can’t be heard by humans which is good. It will destroy the cell wall of the algae which will kill the cells of the algae. A big problem with the cell lysis is that it will start emitting more toxins. When the cell wall is broken, the toxins in it all get released out which will create more harm than help.

Question :What process are there to detect nutrients that algae uses?

Answer : There is no current device to detect the phosphorus in water with algae but the process used to detect nitrogen is very hard to use. A device which can detect phosphorus would be great and can really put an end to algae. Cheaper solutions to the algae problem would also be better.

Doug Kane, Professor of Biology, Defiance College by Soham Joshi

We met with biologist Douglas D. Kane to research about algae. Mr. Kane is a professor at Defiance college and offered some insight and expertise on algae. He told us about what he works with and what research he has done.



## Hydrodynamics: Harmful Algae Bloom (HAB)

Question : What mitigation or research is being with organic materials?

Answer: Some iron bonding experiments after resulted in algae growth. AMny sources also have said that iron bonds with phosphorus really well.

The best materials to use are iron oxide and phoslock. Almin can be used as it is a coagulant and removes phosphorus, can be done in smaller lakes but not big lakes.

Question :What has been invented to reduce algae?

Answer :I do not know of anything, but blue green algae has been used for biofuel, used for cattle food. The issue is they are not scalable and are very hard to manufacture. Any product to reduce phosphorus and prevent algae growth would be a great invention.

Question : What have you invented?

Answer :Crop insurance, for bad year or drought you get a certain payment no matter what happens, phosphorus moratorium in the watershed, get a payment of your average yield,

### Additional Information -

Current there are no direct sensors for phosphorus, but there are sensors for nitrogen.

The problem with algae is that it sucks up all the nutrients, blue green algae or cyanobacteria affects water sources everywhere.

Many people are trying the 4 r's for fertilizer.

### Additional Resources -

- lake erie algae heidelberg university
- noaa and lake erie habs forecast
- great lakes observing systems
- central ohio stone labs

*Doug Kane, Professor of Biology, Defiance College by Kathir MaariKarthikeyan*

We got ahold of a biologist from OSU and he helped learn the more biological effect of algae, and how it is caused. We learned where algae is most vulnerable to kill and how we can prevent it. It gave us bigger knowledge of algae and helped us think of better solutions for the problem.

#5 Biologist Conference Call Questions:

Question: What would happen if the cells were broken in Algae?

Answer: It sometimes releases a toxin, but not usually.

*Ohio Environmental Council by Pranav Krishnamoorthy*

During this audio call we talked to Mrs. Kristy Meyer, from the OEC. She talked mostly about how agriculture contributes to algal blooms and ways in which farms are controlled. The main

thing in farms which helps algae is manure and fertilizer. She talked mostly about the manure. She also said that the OEC works more on taking actions as in talking with farmers and trying to stop algae with agreements and solutions that benefit for everyone.



**KRISTY MEYER**

*Vice President of Policy, Natural Resources*

Q and A:

What are more causes and prevention strategies for harmful algae?

Agriculture is the biggest cause of algae but a major part of it is manure from animals. Animals produce a lot of manure on farms and they contain a lot of phosphorus because the plants the animals eat contain phosphorus. The runoff from the manure enters the water so phosphorus gets in the water. They are trying to get farmers to inject the waste into the ground instead of just covering it. Many agreements are being made with farmers so they control the manure or use certain methods to hold water back so the runoff doesn't enter a pond or a lake.

What actions are the OEC taking in order to stop HAB?

Some actions are agreements with farmers. These include limiting chemicals and manure usage to prevent runoff. Many uses to hold water back are also used. Many legislators are being notified of algal blooms so they can make laws on preventing algae. Legislators can also generate awareness for algae. Back to the farmers, they are given crop insurance along with having to plant cover crops to control nutrients in the soil. Taxes are also being used to stop algae.

What are some good solutions to harmful algal blooms?

In the end, there is no magic solution or one solution that is far better than others.

Wetlands are one of the natural solutions on Earth. They rid the water of pollutants and are very important to the environment. In fact, just like cover crops, people are trying to restore wetlands and try to use buffer strips. Other good solutions are to prevent algae in the farms before it even reaches the water. Others are to stop algae and remove it once the nutrients reach the body of water.

*Ohio Environmental Council by Kathir MaariKarthikeyan*

## Hydrodynamics: Harmful Algae Bloom (HAB)

We got ahold of Mrs. Kristy Meyer from the OEC (Ohio Environmental Council) and she helped us learn more about the causes of algae and gave us some ideas we could find solutions to. She helped us learn that fertilizer runoff isn't the only cause of the algae and that animal manure is also high in phosphorus and that contributes to the algae too. She also gave us problems that we could find solutions to, such as a moving biodigester to solve the problem of moving manure from place to place cost-effectively. Mrs. Kristy Meyer was very helpful in giving us important information and good ideas for our project.

Q and A:

Where are scientists trying to stop the problem of algae? Preventing or Killing?

Answer: They are trying to prevent. They are targeting the amount of phosphorus is being used and are trying to reduce it. Plants need 40 parts per million of phosphorus to grow but manure and some fertilizer has more than 150 parts per million, which is a big difference. So they have no other choice than to dispose of it in the runoff.

What is the Ohio Environmental Council doing to help solve this problem of algae?

Answer: They talk to the public and legislators. They educate many voters on the problem of algae and they present their ideas to the public and get feedback from the public.

Does Ohio Environmental Council support any current solutions to this problem?

Answer: One solution they support is holding the water back from the tile drains, when there is heavy rain. This solution stops a release of high in phosphorus water to go and dump out in the waterbody. Also, cover crops are important, so that the soil can capture some phosphorus and nitrogen before the runoff goes into the water

*Ohio Environmental Council by Soham Joshi*

We met with Kristy Meyer who works for the Ohio Environmental Council. The Environmental Council is a non - profit organization that controls environmental issues such as enforcing environmental laws and looking for solutions to solve environmental problems.

Additional Information:

Manure releases phosphorus into the water, but transporting it farther than 10 mile radius makes it an unviable option.

Q and A:

What organic materials are being used to clean phosphorus?

Activated carbon is used in wastewater treatment plants to reduce algal toxins. Alum is also being used in smaller portions, but cannot be used in bigger water bodies. To prevent algae you need to stop phosphorus at its source. Phosphorus comes from animal manure, as well as human products. So it is difficult to prevent phosphorus from entering water bodies.

Are there any automated ways to test phosphorus?

Some universities have been developing sensors to put in the water. The sensors will be able to give a real time feed of phosphorus, nitrogen, and pH. Most of the testing happens in the lab and is laborious. There are very few options available for an automated test. Hence testing phosphorus levels in different parts of the lake is a challenge.

Are there any laws related to cover crops?

Yes, there are many laws including Conservation Laws, Clean Lake Initiative, Farm Bill, to name a few. Most laws are written keeping into account the cost to implement them. Subsidies given to farmers increase taxes for the middle class, which is undesirable. Hence there is emphasis on the education of the farmers and voluntary implementation of the education.

*Battelle Research Center by Kathir Maarikarthikeyan*

### **Battelle Research Center Summary:**

Our team contacted Mr. Ram Lalgudi and he invited us to Battelle Research Center to get information on Algae and how his team and other scientists are trying to solve the problem. He also gave us information on how to test our solution, so that we can know how much phosphorus got absorbed into our solution.



Furthermore, he told us the science behind the phosphorus bonding and showed us in a diagram. We also got many field trips to visit, if we wanted to further get feedback on our solution and if we wanted to go test our solution more in depth. He gave us feedback on our solution and said it was practical and if we have good test results, it could work. This field trip helped us test our solution and go into more depth of the science part of the idea.

## Hydrodynamics: Harmful Algae Bloom (HAB)



### Battelle Research Center Questions:

Q: What is your team (Battelle) doing to solve this problem?

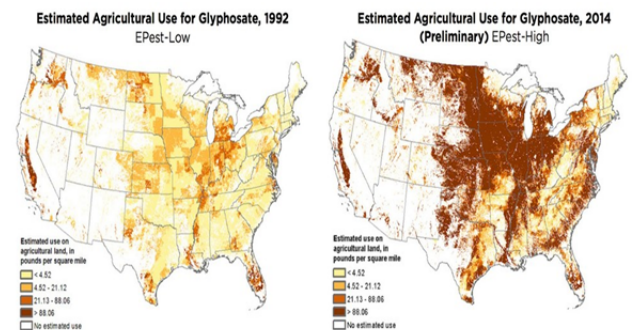
A: We actually found out that Soy hull can absorb phosphorus through testing. Now some farmers are using Soy hull to prevent phosphorus overgrowth in the waterbody the runoff leads to.

Q: How can we test our solution?

A: You can use glyphosate (Phosphorus compound) (Also found in Roundup a weed killer) and a water solution. First, you would measure the phosphorus levels of the solution. Then, you would add your solution (biochar and nanoparticle mixture). After that, wait an hour and take a phosphorus level reading. Finally, wait a full 24 hours and measure the phosphorus levels.

Q: Do you have any idea of a bill we could draft?

A: No, not really. There are so many bills that have been drafted, since this is a big problem. Maybe we can draft a bill on limiting phosphorus concentration in fertilizers, like have some amount that the fertilizer phosphorus concentration has to be under.



Q: What amount of phosphorus would be needed to make a good solution?

A: You don't have to absorb it all, but you need to get 40-75% of it absorbed to make a great solution. If you get 40-75% of the phosphorus absorbed, then your solution is practical for the real world.

*Battelle Research Center by Pranav Krishnamoorthy*

### **Battelle Research Center Summary:**

We went to the Battelle center where we talked to Mr. Ram Lalgudi. He is a scientist who has made 56 patents. He discussed a lot about his soybean hull and how it works to absorb phosphorus. He also talked about how they used carbon to absorb water that is 37 ppm. We learned a lot of new things from him including the fact that there is a ratio of the most abundant elements, so if we add more of one it makes the other elements less dominant in the ratio, which is what we are exactly trying to do to reduce phosphorus.

Battelle Research Center Questions:

Q: As technologies develop, what are some solutions become available?

A: Nowadays, people know more about the soil. High-tech tractors can show farmers and scientists everything about an area of soil. This can help them know where there might be lots of nutrients and what is occurring in the soil.

Q: How would our biochar solution work?

A: Biochars work because of the carbon content in them. In the ground there are 5 main elements that in a certain ratio, keep the earth in good shape. These elements are nitrogen, carbon, oxygen, silicon, and phosphorus. Algae needs phosphorus and nitrogen. If the ratio is disrupted, there could be more of this element found which will help the algae. This can offset by using the other elements like silicon and carbon. The biochar has carbon so it is able to offset the nutrient to stabilize and kill the algae. Our biochar idea was good but, it might not be the most stable. The carbon might not survive in more acidic or basic water. We were suggested to add more nitrogen in a mixture with the carbon. The nitrogen will actually not help the algae but stabilize the carbon so it can last in the water.



Q: What solutions are used at Battelle?

A: A solution used at Battelle is to use a soybean hull. This is used in a remediation process to rid the water of phosphorus. Soybeans contain a lot of protein which bonds with phosphorus really well. It also contains carbohydrates which absorb the water. Together, these characteristics make soybean hull really good at removing nutrients from the water.

Q: Do you work with other companies?

A: Yes. Battelle is very research based. They come up with solutions and patent them to solve problems. They send their machines and patents to other companies like the OEC who can work with them to implement them into places or can make agreements. They have made many research based solutions like the soybean biochar.

Q: Does the fact that phosphorus in water can be in a compound affect how it is treated?

A: Phosphorus cannot be broken down and released out of the water which is bad. Carbon can be released as CO<sub>2</sub>, methane, and many other substances. In the in your goal is to remove the phosphorus whether it is phosphorus or phosphate. In order to remove phosphate, trihybrid can be put in the water. This will bond and create phosphoric acid which can be removed easily.

### **Brainstorming Ideas and Solutions Prior to Selecting Harmful Algal Blooms**

*Metallic and Electrical treatment by Pranav Krishnamoorthy*

Water should not be wasted, and at the same time, we can't reuse bad or unclean water. Our water gets sent to the treatment plants where a lot of energy is used to clean the water. There are many ways to fix the problem of reusing water. Common drawback, they require lots of money and time or are really complicated and not efficient with easy resources.

#### **Observations**

- Electricity is a common thing in most houses
- Electricity can be deadly(no joke) and kill things
- Silver is used to purify, as before fridges existed, silver coins were put in milk
- Plastic is a very good insulator and is cheap

## Hydrodynamics: Harmful Algae Bloom (HAB)

- A charged(usually positive) item can pull water dues to the positive and negative side of water.

### Solution

Deep underground, there will be an “electric tank” In this tank, which is, underground, away from the house cables will be given electricity. The electricity will be able to kill bacteria as they will not survive the current and it will distill the water removing minerals like calcium carbonate. A silver lining will also be placed as it can further purify the water.

### More information

Plastic pipes that are commonly used can act as a good insulator to remove the charges that are in the water. The section with electricity will be placed in the pipe so that it stays away from power lines which can result in power outages. Other minerals in the water which are transition metals can be removed by using magnetism

### Benefits

This process will save water as it is being reused using resources that are common. Water won't have to travel all the way to the plant and back, especially if it is clean.

### Tech.

This process is using the science of conduction and insulation along with water travelling through the pipes. That much new technology is needed, Only electricity is being delivered into another location where water can be reused.

### In the world

A similar solution to this has been tested where cotton was used in pumps for purification. We can test this by putting unwanted bacteria in water and put electricity through them and record if they are still alive.

### Citation

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*Smart Pipes by Pranav Krishnamoorthy*

## Hydrodynamics: Harmful Algae Bloom (HAB)

### The thing

The idea is to create a pipe that can work better than your standard pipes that we have right now.

### Solution

It is to have the pipes running in a circle to spin a wheel which generates electricity. This electricity will be passed through the waste water.

### Process and Facts

Wastewater is more acidic than normal water and it need to be increased so it can be neutralized. The electricity will kill bacteria and remove certain minerals. The electricity will transfer electrons to water thus, raising the pH. This process even kills viruses making the water pretty safe to drink.

### Savings

This process will save energy as water has to move from your house to the plant and back. You are not wasting energy and electricity because the wheel will produce its own energy. The cost of the wheel/turbine is \$1000-\$5000

### Tech

As pipes are being renovated, this will further improve them.

### Cleaning Method by Pranav Krishnamoorthy

In order to clean water, people put chlorine water. This is a very efficient way to remove unwanted bacteria from the water. But a problem is Dechlorination. Although there are many ways to do it, many ways either cost a lot of money or are hard to pull off because of dangerous chemicals.

### Observations

- Sodium is the 6th most abundant element in the world and is cheap
- Sulfur costs \$24 for a hundred grams
- Sulfur is used in compounds to remove chlorine
- Polymers can filter water by separating salt from water

### Solution

The solution is a process which is cheaper to use than some other process with sulfur, which is poisonous or carbon, which is very expensive to use. Here is the process

1. Chlorinate water to disinfect it
2. Add sodium to the mixture to cancel out the chlorine and produce salts
3. Polymers can then be added to filter the salts out.

## Hydrodynamics: Harmful Algae Bloom (HAB)

### Helps

This problem is a very specific problem targeting chlorine, yet still important as water can't be left chlorinated but must be taken care of in an efficient way. This process will reduce some costs and time to clean water.

### Science/ Tech

A scientific concept used is pH as an acid and base are reacting and some chemistry. An equipment needed is that it should be a secured room as the sodium can react violently with the water.

### Market/ Test

Sodium and chloride is common in the market as it is a simple classic formula. Polymers are something that are slowly developing. We could test this by making/getting polymers and putting it in saltwater.

- [https://www.health.ny.gov/environmental/emergency/chemical\\_terrorism/chlorine\\_tech.htm](https://www.health.ny.gov/environmental/emergency/chemical_terrorism/chlorine_tech.htm)
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- <https://www.youtube.com/watch?v=oZdQJi-UwYs>

### *Using Sun to kill Algae by Pranav Krishnamoorthy*

#### Problem

Algae is creating problems. It is damaging the environment by growing in places with certain nutrients on the surface of water. This blocks out light and nutrients for plants and animals underneath. Algae also releases toxins into the atmosphere. Algae does have its weaknesses.

#### Observations

- Algae needs phosphorus and nitrogen to survive.
- Algae thrives on stagnant water because the hot water is at the surface because it is not mixed.
- Algae lives and uses sunlight at lux(lumens per square meter) from 1000-12000 lux
- Algae is a threat that needs to be removed.

#### My Solution

My solution is a stationary machine that is made of a motor, paddle, and a sheet of concave mirrors. The mirrors, which are concave, can focus the sun's rays into a point which increases the intensity of the light which kills the algae.

This machines will move the mirrors periodically as they shoots a point of light. They will not harm fishes swimming around unless they decide to sit in the ray for a long time.

## Hydrodynamics: Harmful Algae Bloom (HAB)

### How it works

This will be placed just outside the body of water and will be stationary unless moved manually. A motor will be at the bottom. This will hook to 2 paddles which can create waves to weaken the algae. The motor will also move the sheet of glass periodically to kill algae. The beams lose strength as the range is increased. It is moveable so a person can move it around. It can take 1-5 days to kill a patch of algae prices.

<https://docs.google.com/document/d/1ydjXfeH6nsljHRJ-kwwRmwLFqiyx27E2K0nHNRrJ2oY/edit>

### Notes

It will not kill fish. Fish can burn but they usually don't burn in normal daylight. You are just focusing energy. Sure, it is more intense but it is just 1 point. The sun shines 1000-2000 lux during sunrise/sunset/overcast. During midday of summer 20000-100000 lux. It doesn't kill algae because of the spread and because of the limited time it lasts.

### *Transporting Water by Pranav Krishnamoorthy*

Pipes require a way to move the water from the house to our plants or vice versa. The plants normally transport water downhill to reach our houses. Logically, the water has to travel uphill to reach the plant.

### Solution

A device which can store the energy from friction and waves from trains or packed highways. Unlike ram pumps, it won't waste water.

### Details

Two electrodes, a positive and a negative will be attached to a wire with a place to hold the energy. The electrodes will generate a charge which can be stored. This energy will be used to pump water through a pipe. Electrodes are 10-20 dollars. This system produces a high voltage and it is inexpensive unlike other vibration systems.

### Benefits

This will reduce the energy required to pump energy uphill and will not waste water like a ram pump. Even, if it doesn't produce much energy after a car or 2, there will be many cars or trains in their corresponding roads and can generate energy. Vibration travels better in solids than in air.

### Uniqueness in competition

Most people will probably try to purify or find water. They may even try to fix pipes. My idea is to transport water which is something that probably won't be touched on.

### Technology

We will need electrodes to make the vibrations will make them shake. The energy will be stored in a box which will pump water through the pipes.

## Hydrodynamics: Harmful Algae Bloom (HAB)

### Market

People are trying similar experiments, some with expensive material to create electricity from this method for use. My idea is to make it be able to be used to transport water.

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- <https://water.usgs.gov/edu/qa-home-uphill.html>
- [https://en.wikipedia.org/wiki/Hydraulic\\_ram](https://en.wikipedia.org/wiki/Hydraulic_ram)
- [https://www.google.com/search?source=hp&q=how+vibration+can+make+enrgy&oq=how+vibration+can+make+enrgy&gs\\_l=psy-ab.3..33i21k1.1539.6378.0.6596.29.22.0.0.0.432.3170.0j13j2j0j1.16.0..2..0...1.1.64.psy-ab..13.16.3162.0..0j35i39k1j0i67k1j0i131k1j0i227i67k1j0i227k1j0i22i30k1j0i22i10i30k1.0.Wfd6Z\\_M8hzk](https://www.google.com/search?source=hp&q=how+vibration+can+make+enrgy&oq=how+vibration+can+make+enrgy&gs_l=psy-ab.3..33i21k1.1539.6378.0.6596.29.22.0.0.0.432.3170.0j13j2j0j1.16.0..2..0...1.1.64.psy-ab..13.16.3162.0..0j35i39k1j0i67k1j0i131k1j0i227i67k1j0i227k1j0i22i30k1j0i22i10i30k1.0.Wfd6Z_M8hzk)
- <http://www.mitsubishielectric.com/company/environment/ecotopics/vibration/spring/index.html> <https://arxiv.org/ftp/arxiv/papers/1210/1210.5191.pdf>
- <http://www.homedepot.com/b/N-5yc1vZc8lh>

### *Using Organic Polymers for Water Filtration by Soham Joshi*

#### About polymer

A substance that has a molecular structure consisting chiefly or entirely of a large number of similar units bonded together, e.g., many synthetic organic materials used as plastics and resins.

#### Hydrogel structure -

The hydrogel you have used is a polymer of a type of substance called a carboxylic acid. The acid groups stick off the main chain of the polymer, as shown in the diagram below. When the hydrogel is put into water these acid groups react, the hydrogen atom comes off and the polymer chain is left with several negative charges along its length. (Note:  $\text{H}_3\text{O}^+$  is another way of writing  $\text{H}^+$  in solution and shows that an acid is present.)

Polymer can be used to:

- Desalinate water
- Help farmers with irrigation
- Make soil richer

[https://www.youtube.com/watch?v=otRU\\_xkQNJ&t=25s](https://www.youtube.com/watch?v=otRU_xkQNJ&t=25s)

<https://www.youtube.com/watch?v=0Dr587jEzBA>

<https://www.youtube.com/watch?v=FFrdZjIDwAU>



<https://www.youtube.com/watch?v=rIIgLIIm4lQ0>

#### Membrane

Without any input of energy, water molecules will naturally move from fresh solutions to saltier ones. The researchers developed a specially formulated solution that is saltier than seawater, drawing water molecules out of seawater across a porous membrane and leaving the sea salt residue behind. The resulting solution contains a mix of salt compounds that vaporize at much lower temperatures than seawater salts. That means the salty liquid can be made into freshwater by thermal desalination at only 122°F, a significant energy saving over traditional thermal desalination methods.

<https://www.nap.edu/read/18734/chapter/7#19>

#### Using fruit peels

One of the common ways that fruit peels are used to clean water is soaking the fruit peels in rubbing alcohol, washing them of and then soaking them in unclean water which has to be cleaned.

#### Soluble Polymer Filtration

- Cationic polyelectrolyte is a soluble water filtration polymer
- poly(diallyldimethylammonium chloride), or PDADMAC

#### What has been done(similar)

Trans Derma Prill Beads are made from magnesium oxide which is produced from naturally occurring salts of magnesium found in rich brine deposits located approximately 2,500 feet below ground. Although technically just water, the new prill water is far more vital and has smaller molecules than ordinary water. It resembles dew and is beautifully pH balanced at 7.4. Lower surface tension increases hydration. Living cells that are properly hydrated have excellent dynamics, while cells that are under-inflated (dehydrated) or perhaps even worse, over-inflated (edema), are extremely vulnerable, both to absorption of toxic energies and to attack from predators. Proper liquid stasis directly relates to cellular longevity and cellular longevity relates directly to longevity itself.

#### Polymers in a Jerry Can by Soham Joshi

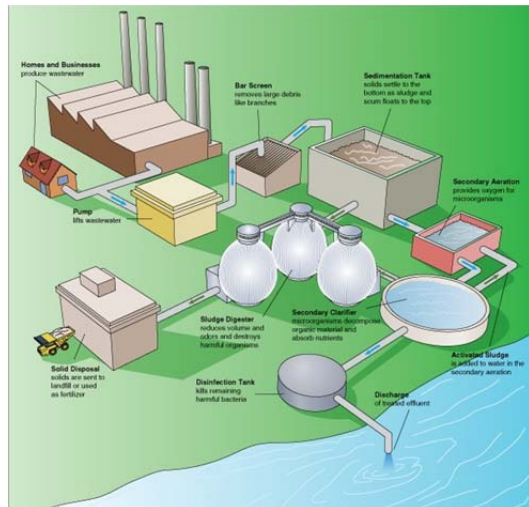
<https://www.youtube.com/watch?v=jKwVdZpscE0>

#### *Pump idea by Soham Joshi*

What is the problem you are trying to solve? Flow chart the process and the problem area.

## Hydrodynamics: Harmful Algae Bloom (HAB)

The problem I am trying to solve is the inefficient methods of transporting water to higher elevations.



Who is the problem solution helping?

My solution is helping wastewater and water treatment plants have more efficient systems.

How big is the problem? Use statistical numbers to quantify. Is it a universal problem or specific problem.

There are 10 or 12 pumps per plant.

What are potential benefits? Cost savings, water savings, environmental benefits, etc.

The benefit of my invention is that water may be moved quicker and the cost to run the pump will be cheaper.

Does the solution help any communities or sections of the society like elderly people.

No

What scientific concepts are being used in the solution?

What is happening is air pressure is building up inside the bottle, and when more pressure builds up the water will try to equalize with the outside world it shoots out the straw. This same concept can be used for the pipe. If we have a tank with built up pressure then we would be able to make water rise using no electricity.

What technology is being used in the solution?

A tank holding that air.

Does the solution exist in some form or shape in the market today?

No

How can we test the solution?

You can try it using large amounts of water and measure its efficiency.

### *Algae Filters by Kathir Maarikarthykeyan*

We are trying to solve the problem of the harmful algal blooms. There are many algal blooms happening in the US and all around the world. Many organisms are eating the toxic algae and getting ill and dying. Also, many water sources have lower pH because of the Algae which isn't good for the water and sea life. Finally, the algae just doesn't make the best appearance in your lakes, pools, etc;.

For the solution we need to filter out the one thing that it needs to survive. This one thing is phosphorus. There will be a filter where Lanthanum Chloride is added to the water, so that the Phosphorus does not go inside the lake. Lanthanum Chloride is a rare earth compound that gets rid of Phosphorus. There are drains on the coasts of the lakes where the water comes from, the water that comes from that drain goes through a pipe filter where the water is added with the LaCl. This will stop algal blooms, but there will be some algae which is good if there is only a little amount. This really helps anyone with a problem of Algae or just needs to get rid of some sort of phosphate from their lakes, pools, aquariums, etc;.

The problem is very big, this problem appears all around the 50 states and the rest of the world. Many attempts at a solution have been tried by scientists, but there is only a solution that gets rid of algae from pools and aquariums, but not a filter like my idea.

### Ideas

By creating a device/ or robot to make it easier for the people with disabilities and the elderly to help them on and off their water uses. Shower - motion sensor Faucet - and extension on it making it easier to move etc. Plants transport water because they have three sections. The first section is the hair of the roots where the water is absorbed because the roots is hypertonic compared to the incoming water. The next section, the secondary roots are hypertonic compared to the root hair attracting the water there. Then comes the main root, or the Xylem, this root is hypertonic compared to the other parts in the end leading the water to be absorbed there which then will be carried and will evaporate in leaves.

Basically we will make a filter where the water is placed in our artificial plant. The water that evaporates from this will be clean. The water will condense and we can collect it. 29% of our domestic water goes to flushing our toilet and with flushing over 50% is used for bathroom related matters. We could make a more water efficient way to flush. If we could achieve this, we would be saving LifeStraw and other similar products can kill lots of bacteria if we could find a way to clean out salinated water as well that would be ideal for hurricane situations because most of the water that come in will be salinated Using the thermoelectric effect but with water. Making it more efficient and reusable. Basically the actual process is where a hot wire made from a different material is connected to a different cold wire. Hot moves to cold so the

## Hydrodynamics: Harmful Algae Bloom (HAB)

energy in the hot wire will move to the cold wire therefore creating voltage. Biggest water source on the planet is humidity. Most of our atmosphere consists of humidity. If we could use reverse osmosis in to to capture the humidity and transform it into drinking water this could be a portable device for people to have a large supply of water. 3000 gallons of water go into making a pair of jeans.

### *Buoybot by Kathir*

Harmful Algae Blooms are forming in many waterways, such as lakes, rivers, etc;. These HABs harm sea life and outside ecosystem as well. Algae also blocks out sunlight from the waterways, which kills aquatic plants as well. Algae also depletes the oxygen from the ponds, which makes it very harmful for the sea life. Some types of algae release a toxic gas and that can be very dangerous to the ecosystem.

The solution to this problem is a bot that sends out ultrasonic waves to kill the algae. It has been studied that algae at a certain frequency (24-58 kHz) can be killed. So it will be an efficient way to kill the algae.

\*Better Explained with diagram

### Buoy

We need a Buoy to keep the robot afloat in the water, the best buoy I could find was a Sun-Moor Tapur Buoy. It is priced at 140\$.

### Rope

We need a strong rope to hold the emitter and driver up and not sink. A rope I found is priced at 2.36\$ a foot.

### Frequency Driver

We need the frequency driver to turn the electric signal into a sound waves so we can shoot it. I found one for 80\$.

<http://www.usspeaker.com/N151M8-1.htm>

### Sonic Emitter

These are kind of expensive because it needs a long range, where short range ones are cheaper. I found one for 849\$ There is also another one for around 600\$ but i'm not sure what the range of that is. Also, it will be attached to a metal plate, so the sound waves bounce and go to both sides.

<https://senix.com/ultrasonic-sensor-toughsonic-30/>

### Power

I'm thinking to run it on solar power or a battery, so it can move like a buoy and not be plugged in like some systems that they have. I found one for 195\$. It might need more power but probably not. If it does it will be run on battery for a few hours then charge it and keep on doing that.  
Total Cost <1400\$

### **Market Search to Discover that Our Invention is Unique**

Our team did a search on a product that was a mixture of a variety of biochars. We did not find anything like that that existed in the market current. There were products that used iron oxide mainly to reduce the phosphorus levels. We did not want to use a metal compound based solution but wanted to use something that made with cheaper material and could be easily recycled or reused.

Also the products that exist today are more fertilizer based.

There were patents about the process of making biochar but we did find a patent on a product that was a mixture.

### **Provisional Patent for our Invention**

We have filed a provisional patent for our solution. Before applying, we went to the USPTO website to find out if there were any similar inventions. We searched "Biochar Patents" AND "Patent Biochar Products" and found no matching product patents appeared. That means that our invention is unique.

A provisional patent will give us protection from people stealing our idea for one year. During that time, we can determine demand for our product.

Our product could be sold as a patent pending product once we get the provisional patent.



# Hydrodynamics: Harmful Algae Bloom (HAB)

## Patent US8361186 - Biochar - Google Patents

[www.google.com/patents/US8361186](http://www.google.com/patents/US8361186)   
 Jan 20, 2013 - The invention provides for methods, devices, and systems for pyrolyzing biomass. A pyrolysis unit can be used for the pyrolysis of biomass to form gas, liquid, and solid products. The biomass materials can be selected such that an enhanced biochar is formed after pyrolysis. The biomass can be pyrolyzed ...

## Patent US8986581 - Biochar products and method of manufacture ...

[www.google.com/patents/US8986581](http://www.google.com/patents/US8986581)   
 Mar 24, 2015 - A method for producing biochar particles or pellets which use sulphur and other additives. The method includes producing a mixture with biochar and additives selected from sulphur, lignin, and gluten. The mixture is mixed with water and passed through an extruder to produce an extrudate. The extrudate ...

## Patent US8236085 - Method for enhancing soil growth using bio-char ...

[www.google.com/patents/US8236085](http://www.google.com/patents/US8236085)   
 Aug 7, 2012 - US Patent Publication No. 2010/0040510 discloses a multistage pressurized fluidized bed gasifier operating between 750° C. and 1100° C. that converts biomass to syngas and biochar. The biochar is said to be capable of being added to soil. US Patent Publication No. 2008/0317657 provides a system ...

## Patent EP2834322A4 - Biochar compositions and methods of use ...

[www.google.com/patents/EP2834322A4](http://www.google.com/patents/EP2834322A4)   
 Feb 17, 2016 - Cited Patent. Filing date, Publication date, Applicant, Title, EP0716056A1 \*, Dec 8, 1995, Jun 12, 1996, Desmond St. A. G. Radlein, Method of producing slow-release nitrogenous organic fertilizer from biomass. EP1739067A1 \*, Jun 30, 2005, Jan 3, 2007, Roland Wolf, Process for manufacturing a soil ...

## Contacting a manufacturer of Biochar

### Wakefield Biochars

We contacted Wakefield Biochars which is a manufacturer of biochars. We spoke with Dr. Tom Marrero and asked questions which he answered.

### Republic Mills

From: derek@republicmills.com <derek@republicmills.com>  
To: Scham, Josh <josh@schamph@rocketmail.com>  
Sent: Monday, January 20, 2015, 9:20:20 AM EST  
Subject: RE: Science Project Questions

Hi Scham,

I don't really have any documents or brochures on the pelleting process. The materials we use at our facilities are purchased from other companies that we have had ties to with good business relationships over a period of time. Most of the regular ingredients we used such as Wheat Middlings, Soybean Meal, Corn and Distillers, etc. are purchased from the same suppliers on a regular basis. Some of these ingredients we set up contracts for purchasing that locks in our price for a set amount of product. Having a good business relationship with the other companies we work with means that we are both a buyer and supplier for these companies. I work with both companies when you can work together to supply a product or service that the other company may need. There are also times when our customers bring their own ingredients in for the pelleting process. Some of the factors that affect the price of our product include the grain markets, logistics, and the time involved in production. Because a lot of our ingredients are agricultural, the fluctuations in the grain markets affects the pricing on a weekly/daily basis. If customers want us to deliver finished pellets, either in bulk or bags, this also affects the price of the product, especially depending on the distance we have to travel to deliver. If we have a formula that we know is going to run smooth through the pelleting process it also will have influence on the pricing of the finished product. We can pellet a wide range of materials. If you look at our website, [www.republicmills.com](http://www.republicmills.com), you can view a lot of the products we make. We also run a fair amount of trials on new products/formulas that customers are looking to be pelleted.

Thanks,

Derek Damman  
Republic Mills  
(419) 758-3511

From: Scham, Josh <josh@schamph@rocketmail.com>  
Sent: Saturday, January 27, 2015 9:41 AM  
To: derek@republicmills.com  
Subject: Science Project Questions

Hello,

Any process flow documentation of the pelleting process? (Documents or Brochures)

How do you procure the materials? (Are there tie-ups with companies for the materials)

Other than manufacturing, what other factors sway the price of your product? (Marketing, Logistics etc.)

Why do you produce in Ohio compared to other countries? (Outsource the products)

What materials can you pellet?

Thanks,

### Birdsong Peanuts

From: Edwards, Cecil <jedwards@Birdsong-Peanuts.com>  
Date: January 30, 2018 at 12:34:19 PM EST  
To: Nutsman@Birdsong.com <nutsman@birdsong.com>  
Subject: Hull Information

Good afternoon!

We do sell the peanut hulls which our customers use for various purposes. Unground Hulls are typical used for livestock bedding applications. If the customers want ground hulls which they use in feed, the hulls get run through a hammermill which grinds them up to the consistency of powdered snuff. The customers bring us 48 - 53 foot trailers and we load whichever type they order. 48 foot trailers typically weigh 21,000 pounds if loaded with unground hulls and 40,000 pounds when loaded with ground hulls. The prices for the hulls are Ground Hulls \$23 / ton and Unground Hulls \$23 / ton.

Hopefully this information was helpful. If you need further information please let me know.



Cecil Edwards, Jr.  
Mill Human Resources/  
Recruit. and Representative  
311 Factory Street  
Suflon, VA, 22454  
757-539-9714



## Hydrodynamics: Harmful Algae Bloom (HAB)

### Birdsong Peanuts

Birdsong buys carefully selected peanuts directly from the farmers' fields. They are then cleaned, shelled, sized and shipped in truckload lots to manufacturers who turn them into many popular food items, from peanut butter to peanut M&M's. Today the company operates six shelling plants throughout the peanut-growing belt comprised of 11 states extending from Virginia to New Mexico.

## Golden Peanut and Tree Nuts

### Golden Peanut and Tree Nuts

Golden offers a full line of premium and nutritious wholesale peanut products. All of Golden's products are non-GMO, inherently gluten-free and kosher. Whether you are looking for raw peanuts, peanut oil, peanut flour or hull and fiber, Golden has the product to meet your needs

We are more interested in their Hull And Fiber line of products. They sell the peanut shells in 4 different ways

- a) AGForm 100 Granules
- b) Ground Hulls
- c) Pelletted Peanut Hulls
- d) Whole hulls

We reached out to them through Contact Us page and have asked for the retail and bulk pricing. We also have reached out to their Product Director.

The screenshot shows a web browser window with the URL <http://www.goldenpeanut.com/ContactUs.aspx>. The page title is "Contact Us". The form contains the following text:

1/30/2018

I am an 8th grader from Columbus, Ohio and am part of a science and research team. We are trying to manufacture Char from Peanut Hulls and use that for certain applications mainly as absorbent material. I see that your company sell these shells as different products according to its application. I am more interested in the Pelletted Peanut Hulls and Whole Hulls. But interested to receive the pricing for other ground hulls as well as AgForm. I would like to get the retail pricing as well as bulk pricing of the 4 products I selected, Pelletted Peanut Hulls, Whole Hulls, Ground Hulls, AgForm 100 Granules. Also is it possible to send the sample to my address below. Also any discounts for purchasing in bulk.

Would appreciate immediate and detailed pricing response. Thank you very much.

Regards,

Golden Peanut and Tree Nuts  
Corporate Office  
770-752-8160  
100 North Point Center East, Suite 400  
Alpharetta, Georgia 30022

## Premium PNut

### Premium PNut

Premium Peanut owns and operates the newest and largest peanut shelling facility in the world. The shelling plant is located in Douglas, Georgia and was founded in the Fall of 2014 when seven buying points in South Georgia came together to form Premium Peanut. The shelling facility is grower-owned and was designed to integrate the peanut production process, stabilize the market for growers in the region, and ensure a stable supply of peanuts at a competitive cost.

We contacted for the pricing information and they offer the shells in two different way, ground peanut hull costs \$23 per ton and whole peanut hull is 14\$ per ton.

## Georgia Peanut Commission

## Hydrodynamics: Harmful Algae Bloom (HAB)

### Georgia Peanut Commission

The Georgia Agricultural Commodity Commission for Peanuts was established in 1961 under the Commodities Promotion Act. The Commission conducts programs in the areas of promotion, research and education. Funding is derived from a \$2 per ton assessment on all producers. Governing the Commission is a five man elected board of peanut farmers. It is best known in the State House by its little red bags of Georgia Peanuts. Peanuts are a \$2.0 billion industry in Georgia



## The making of Biochar

### Ingredients:

Wakefield uses organic objects, or objects that contain a high amount of carbon such as softwood pine tree, biosolids(solid human waste), hardwood, oak wood, grasses, and cornsilver which is leftover residue after farmers plant corn. Each of these biochars has their own properties. Hardwood has a higher tendency to become ash and softwood is the most standard item used to make biochars because of its reliability and its effectiveness.

### The process:

In order to make the biochars, they use process called pyrolysis. This is when an object is burned in an area with little to no oxygen. This makes it so that the carbon does not combust with the oxygen and create ash, instead biochar is created. The biochar takes 5-10 seconds to make with a conveyer belt.

## Uses and Regulations

### Uses:

Wakefield sells their biochar to National Zoos who put the biochar in the reptile house to keep odors down. Biochar is porous so it can absorb and smells. Best of all, it isn't harmful to animals. It is also used in gardens and in plants to help plants grow. The biochar retains water really well for the plants and it also absorbs toxins that could potentially harm plants.

### Regulations for use:

## Hydrodynamics: Harmful Algae Bloom (HAB)

If the biochar is in a fertilizer, it can be checked by the EPA or the USDA to check the amount of phosphorus and nitrogen content which can end up hurting the environment more than it helps. Biochar generally doesn't need any certifications but there are certifications for it.

### **Existing problems**

Some existing problems with biochar is the cost of it. Biochar is very expensive so farmers end up turning down biochars, especially if the farmer is skilled. Another big problem is most of the public don't know what biochar is and how it is implemented.

### **Costing and Pricing of our product**

Costing of BIFI (when manufactured in Bulk)

Items	Quantity	Price in \$	Total Price
Plants with roots in water	4	\$3.00	\$12.00
Regular Plants	4	\$2.00	\$8.00
Bio Char Mix needed for Bottom Layer of BIFI in lbs	10 lbs	\$2.00	\$20.00
Dirt mixed with the choir mesh in lbs	15 lbs	\$1.00	\$15.00
Floating Island base with 2 layers 4' X 2'	1	\$10.00	\$10.00
Membrane covering bio char mixture in sq ft	35	\$0.10	\$3.50
Biochar Brisket	5	\$3.00	\$15.00
Manufacturing and assembling cost	1	\$10.00	\$10.00
Grand Total			\$93.50

These are sold as 4 X 2 sized floating Island.

Each Unit can be sold between \$149.99 to \$174.99, so the markup is around 60% to 90% profit.

As each unit is being manufactured in same way, discount might not be large if bought in bulk. If bought as 3 or more Units, then discount of \$10 per unit flat.

Product Implementation Plan											
	Sep 17	Oct 17	Nov 17	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18	May 18	Jun 18	Jul 18
Brainstorming											
Research											
Design											
Implementation											
Testing											
Feedback from Experts											
Finalize Manufacturing											
Marketing											
Patent Filing and holding Provisional Patent											



## *Core Values Report*

### *The Under Control Team #32140*

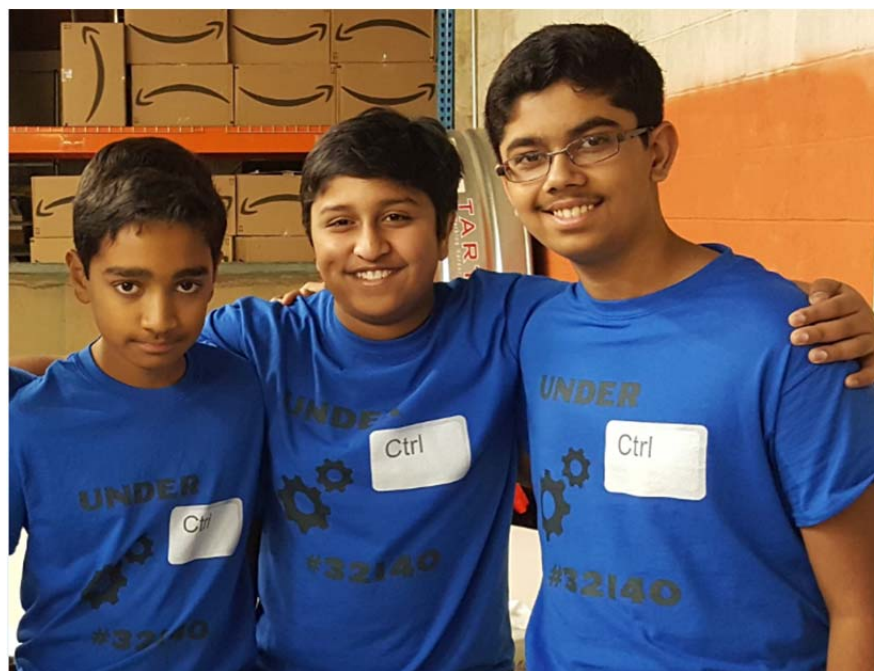




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## Legislative Resolution to Educate Middle and High Schoolers

### ***Senator Office visit***

We are drafting a legislative Resolution and we met with Senator Kris Jordan from the 19th district to form the Resolution. The Resolution was an education provisional bill to spread the word of how harmful algal blooms is a growing problem that is getting worse over time. During our first meeting with the senator on Dec. 5th, we showed the draft to the Senator and received feedback. The feedback was to focus more on one section where algae could be taught. We did some research and decided to spread the word in middle and high schools because they would capture the knowledge more and make actions accordingly to reduce this problem. We expanded our draft and decided that awareness should be spread in schools. On January 30th, we met with the Senator again.



## Community Benefit Report



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From: State Senator Kris Jordan <[Jordan@ohiosenate.gov](mailto:Jordan@ohiosenate.gov)>  
To: "'[keemus@yahoo.com](mailto:keemus@yahoo.com)'" <[keemus@yahoo.com](mailto:keemus@yahoo.com)>  
Cc: "Puff, Ron" <[Ron.Puff@ohiosenate.gov](mailto:Ron.Puff@ohiosenate.gov)>  
Sent: Friday, January 12, 2018 1:52 PM  
Subject: RE: Constituent Form Submission

Good afternoon,

First of all, congratulations on your victory! We are happy to hear that the competition went well for you. My apologies for the delayed reply. Between the holidays and some significant technology issues here in the Senate, things have moved a bit slowly over the last several weeks.

With regard to your request, I want to provide a little clarification as to how the bill drafting process works. Typically, bills and resolutions are drafted by individual legislators with the assistance of the Legislative Service Commission. Once drafted, a legislator or legislators may decide whether or not to formally introduce a piece of legislation for consideration. Should the legislator/s choose to proceed and introduce the bill/resolution, it would be submitted to the Senate Clerk and shortly thereafter, assigned to a committee for possible hearings. This is the earliest point at which a committee becomes involved in the process.

I spoke with Senator Jordan earlier this week regarding your proposal and he has agreed to begin the process of compiling draft legislation. In light of this, and the phone conversations you have had with the office over the last few weeks, it may be best to schedule a meeting with the Senator and staff to review your proposal, answer any questions that you may have regarding the process, and confirm our focus moving forward. If this is acceptable, please let us know and we can review some dates.

We look forward to hearing from you.

Best regards,

Brian Jewell  
Legislative Aide  
Office of State Senator Kris Jordan  
District 19  
(614) 466-8086  
[Brian.Jewell@ohiosenate.gov](mailto:Brian.Jewell@ohiosenate.gov)

### *Purpose of the Bill:*

To increase the public awareness about Harmful Algal Blooms (HAB), through a set of structured programs and initiatives, to create a community that can participate and contribute to fighting this national issue.

### **BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF OHIO:**

#### **Harmful Algal Blooms:**

HABs occur when environmental conditions promote the rapid growth of large numbers of single-celled algae in salt or freshwater. While not all algal blooms are harmful, a small percentage can produce toxins that negatively affect people, fish, shellfish, and other animals. These blooms often discolor the water and result in “red tides” or “brown tides” and may directly or indirectly cause illness in people.

Ingestion of these toxins can cause gastric distress, liver damage, and lung paralysis, and can lead to hospitalization or death. Swimming in or breathing the air near HABs can cause eye, nose, and throat irritation, as well as shortness of breath. In addition to producing toxins, HABs may clog or lacerate fish gills, decrease oxygen in the water (hypoxia), or block sunlight for aquatic plants. A National Oceanic and Atmospheric Administration (NOAA)-funded study by the Woods Hole Oceanographic Institute estimated that the annual economic impact of HABs in the United States is approximately \$50,000,000, including a cost of \$18,000,000 to commercial fishing industries, \$7,000,000 for recreation and tourism effects, and \$2,000,000 for monitoring and management.

Some statistics about the problem:

- 50 out of 50 states are impacted by Harmful Algal Blooms.
- States have identified about 15,000 water bodies in the US with HAB related problems.
- Reported drinking water violations for nitrates have nearly doubled in the last decade.
- About 10% of the nutrients that cause HABs and flow into the Gulf of Mexico come from urban storm water and wastewater/sewage treatment plants.
- An algal bloom contaminated with toxic bacteria shocked Toledo in August 2014, poisoning the city's Lake Erie drinking water and forcing the city of 400,000 people to drink bottled water for three days.

#### **Section 1: Short Title**

This Act may be cited as the “Harmful Algal Bloom Public Awareness Program (HAB-PAP) Act of 2017/2018”.

#### **Section 2: Establishment of the program**

Where our program will implemented in :  
Middle and High schools.

## Community Benefit Report

### Why we chose this location:

Middle school and high schoolers are already learning about things in school. It will be more effective if we inform students about it. There are about 990,000 middle and high schoolers in Ohio. This is about 8.4% of the Ohio population.

We can easily spark attention and interest in kids about the program. In fact the age group is just perfect; they are not too young to understand or too old to not care. Our message will clearly be stated as kids will learn about the awareness in harmful algal blooms.

### What the program includes:

STEM experts and companies can make guest visits to schools and use various methods such as hands on interactive activities to engage kids to stop the rising problem of harmful algal blooms. We could have one mandatory day of the year to learn about the harmful algal blooms, similar to "The Hour of Code".\* Making algal blooms something that is taught in school, even for a day can be helpful to spread the word.

\*"Hour of code" is a program where for an hour of the day, everybody in the school coded. This happened during just one day of the year.

### Overall significance:

This program raises awareness for algae using a strategic method. We teach kids about the problems with algae. The next generation will be more aware and people will take precautions to put algae to an end.

## Section 3: Details of the programs and initiatives

Following is some of the information that can be included in the above programs and initiatives:

### At home:

#### Cleaning Supplies-Detergents and Soaps

- Choose phosphate-free detergents, soaps, and household cleaners
- Only run your clothes or dish washer when you have a full load

#### Pet Waste

- Always pick up after your pet
- Avoid walking your pet near streams and other waterways. Instead, walk them in grassy areas, parks or undeveloped areas
- Inform other pet owners of why picking up pet waste is important and encourage them to do so
- Take part in a storm drain marking program in your area to help make others aware of where pet waste and other runoff goes when not disposed of properly
- Don't use toilets as trash cans. Excess solids can clog your drain field and necessitate more frequent pumping

## Community Benefit Report

- Choose products which are high performing and water efficient
- Use low-flow faucets, shower heads, reduced-flow toilet flushing equipment, and water-saving appliances such as dish- and clothes washers
- Repair leaking faucets, toilets and pumps
- Take short showers instead of baths and avoid letting faucets run unnecessarily

### Vehicles

#### Washing Your Car

- Use a commercial car wash; commercial car washes are required to properly dispose of wastewater and many filter and recycle their water
- If washing your car at home consider the following actions:
  - Wash your car on a pervious surface such as grass or gravel (not concrete or asphalt) so water is filtered before reaching a water body
  - Use nontoxic, phosphate-free soaps
  - Use soap sparingly
  - Minimize runoff by reducing water use, using a spray nozzle to restrict water flow
  - Wring out sponges and rags over the bucket or in a sink, not the ground
  - Empty wash water into the sink or toilet, or the grass if you wish to dispose of it outside
  - Use waterless car wash products for spot-cleaning or a car wash kit, which redirects water from storm drains

When conducting car wash fundraisers, use a car wash kit; many cities will lend kits free of charge to groups conducting car washes for fundraising, or you can buy car wash kits

#### In the yard:

##### Lawn care:

- Apply fertilizers only when necessary and at the recommended amount
- Don't apply fertilizer before windy or rainy days
- Apply fertilizer as close as possible to the period of maximum uptake and growth for grass and other plants, which is usually spring and fall in cool climate, and early and late summer in warm climates
- Avoid applying fertilizer close to waterways
- Do not overwater lawns and garden; use a soaker hose, a porous hose that releases water directly to the ground, which can reduce overwatering that carries away fertilizers that would otherwise enrich lawns and gardens
- Fill fertilizer spreaders on a hard surface so that any spills can be easily cleaned up
- Properly store unused fertilizers and properly dispose of empty containers
- Maintain your lawn mowers, snow blowers, chainsaws, leaf vacuums and similar outdoor power equipment to reduce nitrogen oxide emissions

##### Garden care:

## Community Benefit Report

- Plant a rain garden of native plants, shrubs and trees that reduce the amount of fertilizer needed and provide a way for water to soak into the ground
- Install a rain barrel to collect rainwater; the rainwater can later be used to wash your car or water your plants and lawn
- Adopt techniques that utilize natural processes to manage stormwater runoff and reduce the impact of impervious surfaces on water quality
- Use pervious pavers for walkways and low traffic areas to allow water to soak into the ground
- Install a green roof on your home or business
- Incorporate best management practices, such as grassed swales, filter strips, or buffer strips on your property to control and temporarily store stormwater runoff
- Use yard waste, which includes grass clippings and leaves, in mulch or compost for your garden. If this is not an option, prepare all clippings and leaves for community composting, or in barrels or secured papers bags for disposal, which keeps them from washing into streams

### Section 4: Implementation

This is how the program can be implemented:

Potential speakers and people who can teach about algae but no limited to

- Government agencies
- STEM companies
- Biologists
- Chemists

Companies that can educate kids on algae are to be contacted to see if they are willing to go to schools in their city to educate kids. If they are willing to volunteer, that would be fine, or else they can be paid \$30 or less to go. Approximately \$1500 would need to be spent on companies preparing and training and about \$5000 would be spent on supplies needed by the companies.

In the school end of things, they can allocate an hour during one day of the year as stated in section 2 to welcome scientists into their school to educate students. Contacting the superintendent and principal would be necessary to convince them into allowing this to happen.

### Section 5: Further goals

Here is what we can do if the program succeeds:

The whole purpose for the bill is to inform students on the growing algae problem. If this program is a success, a possible improvement is to add a fundraiser. People could donate money or the fundraiser money could go to scientists' research into harmful algal blooms.

This would make the public happy. We predict that students will tell their parents about the problem and it will soon spark awareness. This is when the fundraisers can come in.



## Section 6: Consultation

Here is where the public can contact if they want to learn more:

If the public wants to learn more about the program, they can contact companies listed in Section 4 to get more information. This will increase the effectiveness of our program because people will want to fact check what they are learning.

### In the community and classroom:

#### Get Involved

- [Monitoring and Assessing Water Quality - Volunteer Monitoring](#)

This page has EPA resources and links to information about volunteer water quality monitoring.

#### Spread the Word

##### Resources:

<https://www.epa.gov/nutrientpollution/harmful-algal-blooms>

<http://theoec.org/campaign/harmful-algal-blooms>

<http://lakeeriealga.com/>

<https://ohioseagrant.osu.edu/research/issues/habs>

<http://epa.ohio.gov/ddagw/HAB.aspx>

<https://www.congress.gov/bill/115th-congress/senate-bill/1057>

## Community Outreach - Implementing Our Solution at Orange Township Park

### At Orange Park



## Community Benefit Report

### Email from Orange Township Park

From: "Beth Hugh" <[bhugh@orangetwp.org](mailto:bhugh@orangetwp.org)>  
Date: Jan 26, 2018 1:56 PM  
Subject: RE: request for information  
To: "[pranav.thunder04@gmail.com](mailto:pranav.thunder04@gmail.com)" <[pranav.thunder04@gmail.com](mailto:pranav.thunder04@gmail.com)>  
Cc:

Pranav:

We would like to explore your offer to test out new algae solutions for the ponds. I will need to know a little more about the project and how long you would need with the pond. Currently, we contract with an outside pond company to keep the algae and pond weeds under control with chemicals. I would assume that we would not be able to do that while your experiment is on-going.

I'm excited to try something new and organic. Please forward your thesis and details and we can work out what you need.

Thanks for reaching out.

Beth Hugh  
Maintenance & Parks Director  
Orange Township  
[1680 E. Orange Road](#)  
[Lewis Center, OH 43035](#)  
[bhugh@orangetwp.org](mailto:bhugh@orangetwp.org)  
(740) 657-2630

**From:** Nancy Fay  
**Sent:** Friday, January 26, 2018 1:46 PM  
**To:** Beth Hugh  
**Subject:** FW: request for information

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**From:** Pranav K [[pranav.thunder04@gmail.com](mailto:pranav.thunder04@gmail.com)]  
**Sent:** Thursday, January 25, 2018 8:36 PM  
**To:** Nancy Fay  
**Subject:** request for information

\*\*\* ATTENTION: This email came from an external source. Do not open attachments or click on links from unknown senders or unexpected emails. \*\*\*

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Hello Orange Township,

My name is Pranav Krishnamoorthy and I am part of a science research team with three members. We live in Lewis Center, Ohio, we are 8<sup>th</sup> graders, and we go to Shanahan Middle School. Our project is about Algal blooms and how they affect wildlife in the environment. We have created a potential solution to solve this problem. We are requesting for if we can test our solution during algae season (spring-fall) in one of the small ponds in the Orange Township Park at [1680 East Orange road](#). Our solution does not involve any chemicals that will affect the water and our solution is organic.

Please let me know if this is possible. We can have a group call or come in person to discuss for more information about what we are doing.

Thank you,  
Pranav

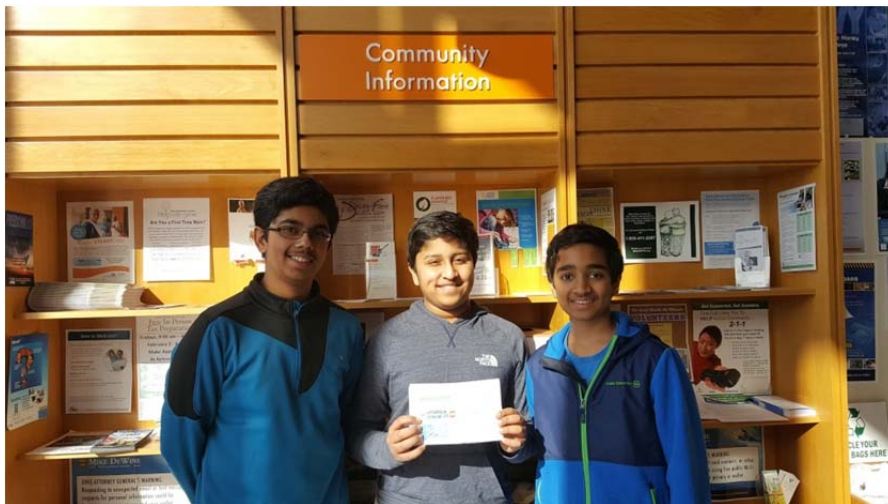


## Community Outreach - Spreading Awareness About HABs Through Delaware County Public Library

We visited the Orange Library as a way of outreach and to share our idea. We made flyers about FLL and our team that were a half a sheet of paper.

We talked to the library manager if we could do this and it was fine with her. The flyers were posted near the entrance of the library at the Community Information desk to be picked up by people visiting the library.

In fact, the flyers were also to be posted around and sent to other branches in the Delaware libraries.



## Community Benefit Report



## Email from Delaware County Orange Library

**From:** Amee Sword <[asword@delawarelibrary.org](mailto:asword@delawarelibrary.org)>  
**Date:** January 24, 2018 at 8:05:36 AM EST  
**To:** Kathir Maarikarthykeyan <[kathir.maari@icloud.com](mailto:kathir.maari@icloud.com)>  
**Subject:** Re: Passing out flyers

Dear Kathir,

You are welcome to drop off flyers to the branch. We will place on our community information shelves as well as send flyers to the other branches for you.

Will that work?

Thank you, Amee

On Tue, Jan 23, 2018 at 7:15 PM, Kathir Maarikarthykeyan <[kathir.maari@icloud.com](mailto:kathir.maari@icloud.com)> wrote:

Hello. My name is Kathir Maarikarthykeyan and I'm part of an eight grade science team and one of our goals was to complete a project that pertains to the Human Water Cycle. Our team chose Harmful Algal Blooms as our problem for our project. We were wondering if we could pass out flyers/brochures to the Delaware library visitors. These flyers would contain information about this problem and not anything to buy or sell. We think it would be a great opportunity to inform the public about a ongoing problem, which is just starting to rise up in today's news. Thank you in advance.

--

Amee Sword MLIS  
Assistant Branch Manager-Adult Services  
Orange Branch  
Delaware County District Library

## Community Outreach - Spreading Awareness About HABs Community Presentation

We gave a community presentation at the Robot Academy Camp about our problem and solution. We gave a presentation about the growing algae problem to an audience that is unfamiliar with this issue. The audience was very intrigued and interested in the problem. They were engaged and asked specific questions about our idea and also general questions about FLL and lego robotics.

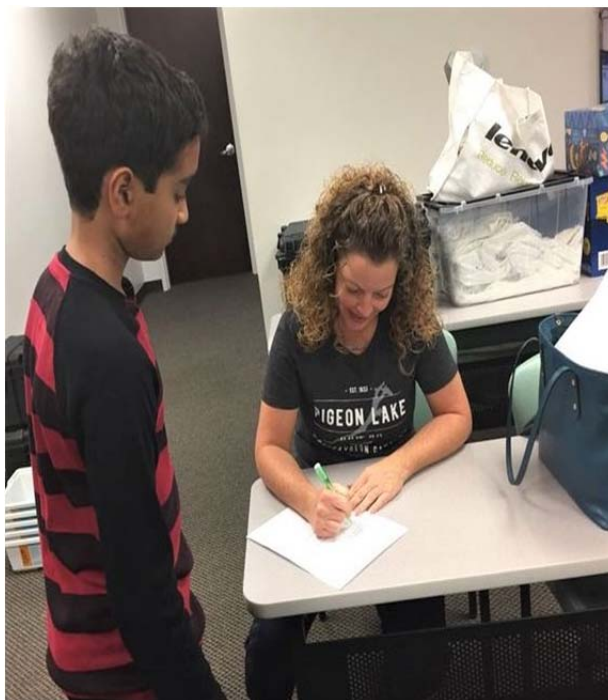
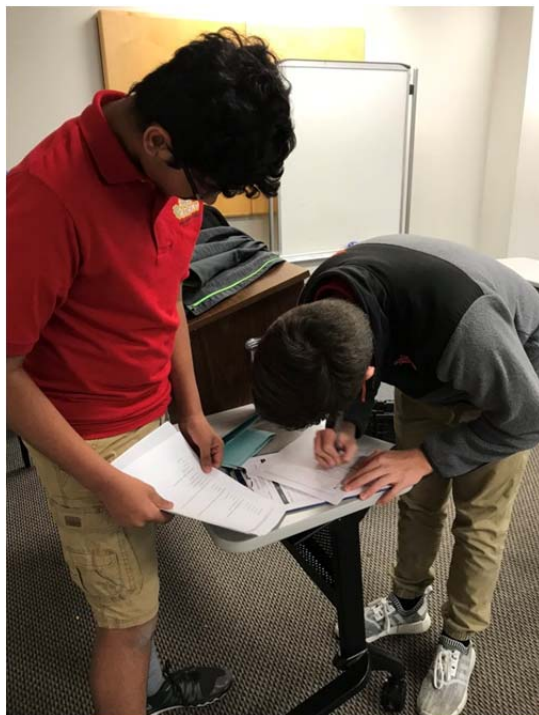




## **Community Outreach - Spreading Awareness About HABs Through Survey**

We created and posted a survey to learn about what the public knows about algae and what they think about algae. We posted it in SurveyMonkey and we also handed out physical copies to people. We got 200 responses in total and they were all aged 10 and above. We also surveyed all 132 legislators in Ohio and we got back five responses. We asked some basic general questions such as, “What is the largest contributor to algae?” and “How many states are affected by harmful algal blooms?” Only 41.09% of people thought agriculture was the largest contributor to algae (which it is), and 22.7% knew that algae affects over 40 states, 50 to be precise. We also asked some complex questions like “Which disease is related to harmful algal blooms?” This questions’ answer were almost nearly split evenly with the correct answer, legionnaires disease only be chosen 26.37% of the time. With our survey results, we can conclude that the public is not very educated about this issue of harmful algal blooms and that they must be educated. This really ties into the bill we have written because it is an educational provisional plan about algae.

# Community Benefit Report



1. How old are you?

- ☐ 10 - 17 years old
- ☐ 18-30 years old
- ☐ 31 -45 years old
- ☐ 45+ years old

2. What is the largest contributor to Algal Bloom growth?

- ☐ Trees surrounding affected water bodies
- ☐ Water wildlife
- ☐ Agriculture
- ☐ Recreational Fishing

3. How many states in the United States are affected by Harmful Algal Blooms?

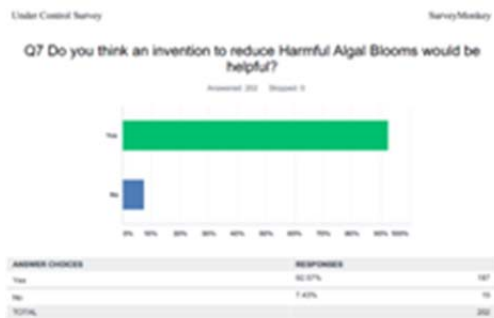
- ☐ Less than 10
- ☐ From 11 - 40
- ☐ More than 40

4. How much money does Ohio spend on Harmful Algal Blooms infrastructure?

- ☐ Less than \$1,000,000
- ☐ From \$1,000,000 to \$9,000,000
- ☐ From \$10,000,000 to \$99,000,000
- ☐ More than \$100,000,000

5. Which disease is related to Harmful Algal Blooms?

- ☐ Legionnaires Disease
- ☐ Amoebiasis
- ☐ Cholera
- ☐ Cryptosporidiosis



# Community Outreach - Spreading Awareness About HABs Through Social Media

## Social Media – Team Website, Facebook

We have also developed a team website to spread the word about FLL, Our Core values, Our Problem and Our Solution.

