Executive Summary

Our main objective is to be acquired by a biotechnology company.

The total market opportunity in the mercury bioremediation industry across the Midwest is over $16.5M, however our analysis does show that this device will be profitable on its own once launched full-scale (see appendix A and appendix B). We believe so for the following reasons:

1. Porter's Five Forces conclude that there is medium to high profitability potential in the industry.
    a. All of the forces are in our favor or neutral to our profitability.
2. There are very few competitors currently seeking market share in the industry.
    a. These competitors are conducting their own research in the field of bioremediation, which presents a significant R&D hurdle to overcome.
        i. Bioremediation of different metals
        ii. Different contaminants extraction methods

In order for our product to be successful, four objectives must be accomplished:

1. Device needs to be applicable in all aquatic environments.
    a. This will take significant capital investment.
2. Quick adoption amongst our key customer groups (see customer analysis section).
    a. With a number of major players potentially entering the market, this is not likely to occur across the nation.
3. Launch a sustainable solution that requires little upkeep.
4. Adaptability of our device for different output levels and specific company needs.
    a. This is highly dependent on the following factors:
        i. Cost of product
        ii. Need of product and encouragement from regulations across consumer organizations
        iii. Difficulty of use
        iv. Difficulty of implementation

We are confident that our value proposition presents a compelling enough argument for governmental agencies and mining companies to adopt this product on the mass market.

We have to overcome serious challenges and risks:

1. Challenges
    a. Full scale trials
    b. Implementation process and Upkeep
2. Risks
    a. If this program fails, investments will be irrecoverable
    b. Unknown companies may be researching similar concepts

In summary, we feel that biotechnology companies will be eager to acquire our product.

Situation Analysis

Midwest Annual Market Opportunity

Total Consumer Base	59
Average Revenue Per Order	$40,000
Average # Transactions Per Customer/YR	4
Total Implementation Revenue	$7,092,000
Total Market Opportunity	$16,548,000

Industry Profitability

Profitability Force	**Expected Level of Force**	**Rationale**	**Influences The Following Profit Level**
Power of Suppliers	Low	-Once purchased, the bacteria will reproduce, creating a self-sustaining supply. -A number of suppliers exist.	High
Intensity of Rivalry	Medium	-As one of the top global health concerns, there are many research projects currently under way to solve the issue. -None have proven to be any more reliable than the other as a final solution to the problem.	Medium
Power of Customers	Medium	-Medium market concentration across customer base.	Medium
Availability of Substitutes	Low	-Only substitute is to pay taxes on the produced pollutants. -No mercury bioremediation has been launched full-scale to date.	High
Barriers to Entry	High	-Very difficult to find method that is	High

		sustainable, scalable, and economically feasible. -Large R&D and technological hurdles to overcome.	

Customer Analysis

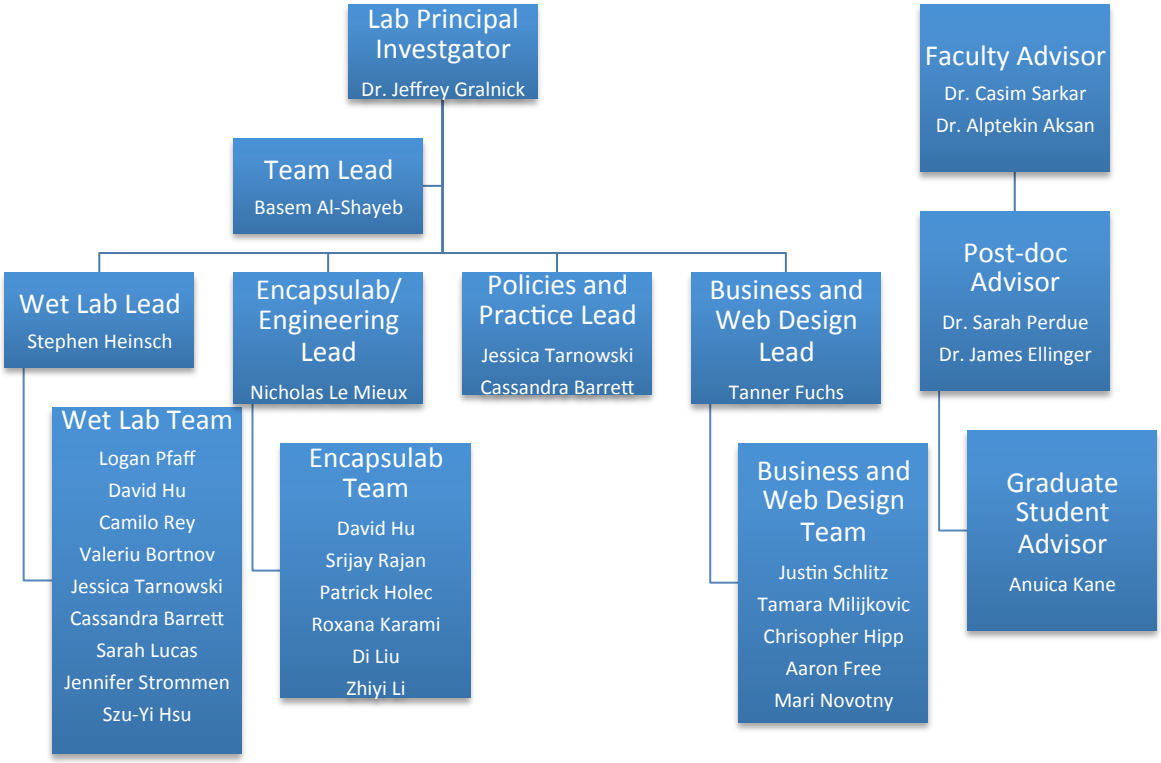
Customer Segment	**Customer Needs**	**Typical Behaviors**
Government Agencies	-Reliable method to remove mercury contamination from water. -Ensure long-term health of water systems and animals associated with it. -Promote health of general public.	1. Monitor health of water ecosystems. 2. Implement laws, taxes and regulations to reduce negative effects of mercury pollution. 3. Create warnings to make visiting guests aware of any irregularities in the water ecosystem.
Mining Companies	-To avoid environmental contamination, which helps companies avoid significant fines. -To avoid the halting or cancelation of operations.	-Regularly monitor operations, procedures, and policies for regulatory compliance. -Invest in new, more environmentally friendly technologies that require less energy and produce less waste.

Value Proposition

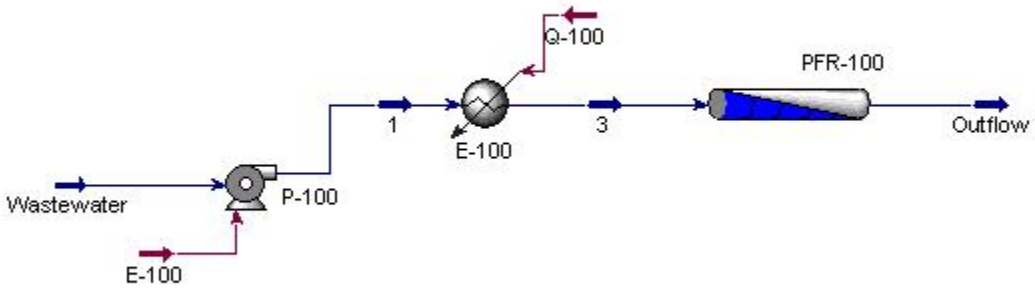
Costs	**Benefits**
Very new technology (reliability issue)	Ecologically safe and natural process to dealing with mercury pollution
Significant learning curve with implementation	Little risk to any persons involved in process
Association with sensitive buzzwords like genetic engineering, biotechnology, biological engineering, etc	Cleaner water ecosystems, which grant long-term economic opportunities
Implementation resources and costs	Positive PR spin for any organizations that employ this technology
Technology upkeep resources and costs	Positive impact on the general public

Company Assessment

Current Organizational Setup



Future Directions



Based on the small-scale experiments we conducted in lab, we calculated a few values that will be useful in scaling up our process to a pilot-plant size. Shown above is a simple process flow diagram (PFD) for a pilot scale wastewater treatment process utilizing our

encapsulated bacteria. An in-depth scalability analysis is linked below, and the results are quickly summarized on this page. A residence time of 8 hrs is used as a first approximation based on small scale time-point studies of 1 mg/L methylmercury degradation. For a flow rate of 0.1 m^3/h, which is within the range used in other pilot-plant studies, a 0.8 m^3 packed bed will be needed, with a diameter of 0.6 m and a length of 2.8 m. Based on a SEM characterization of our beads and an approximation for how they would pack in our reactor, the pressure drop across the reactor was calculated to be 5970 Pa•s, equivalent to frictional losses of 5.97 J/kg. Based on these calculated values, it is concluded that our encapsulation technology can be used in a larger scale plant.

Additionally, a small scale device can be envisioned for household use in contaminated areas. Our system was tested to successfully remediate at least 1mg/L of methylmercury within a 5 hour time period. Water entering these homes will likely have methylmercury concentrations a hundred-a thousand fold lower than 1 mg/L. Based on our time-point degradation studies, a filter for this concentration level would need smaller residence times and consequently a smaller volume. Therefore, a filter using encapsulated bacteria on the scale of domestic water softener filters is possible.

In response to our survey results showing that there was some concern about the bacteria escaping the device, we have designed two kill switch proposals to address this concern and highlighted their advantages and disadvantages.

Market Strategy

Key Business Objectives

1. Creating a sound, environmentally sustainable device to clean up mercury pollution by year 2.
2. Continue developing the device in order to achieve larger filtration capabilities by year 4.
3. Develop the capability to bioremediate other metals by year 7.

These all will take significant capital investment. However, we can confident that we have the skillsets available to launch a sustainable solution that requires little upkeep. We are currently advancing the adaptability of our device for different output levels and specific company needs.

These advancements are highly dependent on the following factors:

A. Cost of the product
B. Need of product and encouragement from regulations across consumer organizations
C. Difficulty of use
D. Difficulty of implementation

External Analysis

When looking at what markets to focus on, we heavily considered the external environment we would be launching the product into.

Physical Factors**:**

Looking locally to the Midwest, and Minnesota specifically, there are 3,800,000 acres of fresh H2O, 5,493 fishable lakes, and 15,000 miles of fishable stream. In these waters Walleye, Panfish, and Northern Pike are the most harvested fish which are also among the predator fish that contain the highest percent of MeHg (methylmercury). We also found that 10% of all newborns have higher than recommended MeHg levels. On a more global scope, mercury pollution is among the top 10 of major public health concerns, specifically in Asia where up to 20% of the diet is seafood. In a report done by the World Health Organization it stated, "about 400 million women of reproductive age in world rely on seafood food for at least 20% of animal protein." These women generally come from low-income communities, which do not have access to MeHg caution levels and whose newborns are the most susceptible to long-term damage from the mercury pollution. (Reference 1).

Legal Factors:

Although the technology to remove current pollution levels has yet to be developed, the state of Minnesota has made an effort to monitor the current pollution levels and reduce the total factors contribution to the mercury pollution. The Minnesota Statewide Mercury Total Max Daily (TMDL) program was approved in 2007 as a result of the federal Clean Water Act in order to monitor MeHg levels. It achieves this by testing fish tissue for contamination, and if the mercury level is past a certain point, the water system is added to the Impaired Waters List (updated lakes list available as of 2013). The most current list shows 820 lakes and 411 rivers on the list. The state of Minnesota was the first to outlaw the use of mercury in dry-cell batteries. Mercury is prohibited in inks, dyes, pigments, paints or fungicides as well as in any packaging products. The mercury from thermostats, thermometers, gauges, medical and scientific equipment, electrical devices, motor vehicles and household appliances must be removed for reuse or recycling before these products can be disposed of or scrapped. The Minnesota Waste Management Act of 2007 implemented guidelines about proper disposal and efforts to reduce mercury contamination in the state.

These efforts on the state-level are minor considering that about 90% of the total mercury omissions originate from outside Minnesota's borders. Looking at a larger scale the Great Lakes Binational Toxics Strategy between the United

States and Canada and the NARAP on Mercury between the United States, Canada and Mexico are meant to address the actual limitation of factors contributing to mercury pollution. Since its inception in the 1990's the initiative has seen more than 50% reduction of U.S. Mercury release in the Great Lakes Basin area. The purpose of the North American Regional Action Plan (NARAP) on Mercury was to "reduce the exposure of North American ecosystems, fish and wildlife, and especially humans, to mercury through the prevention and reduction of anthropogenic releases of mercury to the North American environment." (Reference 2). Since mercury pollution is a global issue, the United Nations Environmental Program Global Mercury Partnership was created in order to protect human health and the global environment from the release of mercury and its compounds by minimizing and, where feasible, ultimately eliminating global, anthropogenic mercury releases to air, water and land. (Reference 3).

Economic Factors:

Minnesota is nationally the number one state in terms of fishing licenses sold per capita with $1.58 billion dollars in sports fishing expenditures. In 2013 4.6 million pounds of Walleye, 4.6 million pounds of Northern, and 9.7 million pounds of panfish were caught. Since these predator fish are the harvested by fisherman, developing technology to eliminate mercury pollution would be especially prevalent towards this market. In addition to the sport's fishing, 3.5 million pounds of fish were commercially harvested. While Minnesota has a very active fishing industry, the real focus would be on countries that rely on fish and seafood as some their staples. Globally in 2013 it was estimated that $80 billion per year was generated by the fishing industry.

Social Factors:

The most prevalent social factor for this particular research is the focus on organic food, which is up 12% from 2012. As it becomes more important for consumers to know exactly where their food is coming from, and as is seen more increasingly in Minnesota, to know that it is being produced locally, ensuring healthy ecosystems will become even more prevalent. This organic movement is in response to the focus on health and food safety that is especially present in the United States. An increased focus on environmental protection and animal welfare is also a beneficial social factor.

A negative social factor is the cultural aversion towards genetically modified things, which might cause some push-back on our method of bio remediating mercury. In order for the research to be properly introduced, it would require very careful presentation to the entry markets.

Technological Factors:

There is no technology currently in the market to remove mercury pollution, but several research institutions are currently working towards the goal.

Market Segmentation

Three industries were examined to support the research based on relevance to the issue and/or resources to continue the research. These industries were:

1. Fishing industry
    a. We determined that no single player is large enough to invest in these technologies for the future of their industry.
2. Mining industry
    a. Significant taxation and regulation exists here.
        i. We are confident that this technology has the capability to both increases production due to legislative constraints on heavy metal outputs as well as decrease taxation and fees for heavy metal emissions due to more of it being cleansed.
3. Environmentally focused governmental agencies
    a. More and more lobbying is occurring at the governmental level to increase legislation on heavy metal emissions.
    b. Internationally lobbying groups are growing the awareness of mercury and other heavy metal pollutants.
    c. Potential for significant funding on this front.

Target Market

After analyzing the potential markets, Minnesota iGEM decided to proceed with Biotechnology Research and Development companies as our primary target market which comprises 9.2% of all Research and Development companies in the United States. While the industry is in a mature lifecycle, the importance of the industry will support market growth by 2.4%from 2014-2019. This market is supported by both the private sector and the public sector, so it is expected that this growth rate will continue.

The competition within the industry is high, but with little concentration. The top four companies only make up 11% of the industry. While the companies with the most recognizable names do enjoy certain advantages, smaller companies are also succeeding regularly which expands the potential buyers for the iGEM bioremediation research. Not only are there a great deal of potential investors, but the industry has a lot of buying power as seen in **Appendix C.**

Value Proposition

Through our research we could discover a scalable, sustainable way to deal with one of the world's top 10 major health problems. Need more information. Realistically how much could this clean-up, how many years would it take to see large-scale results (just for MN), and what makes our research different than all the other research going on?

Marketing Mix

Product:

The product is a biosensor and bioremediation device to eliminate methylmercury from water systems. The biosensor and bioremediation device incorporates the use of microbes encapsulated in novel silica sol gel technology within a water filtering column. This device is designed to facilitate the detection of mercury in the immediate environment and the detoxification of the neurotoxin methylmercury and hazardous mercury ions from the target site.

Price:

Implementation per unit: $600
Replacement per unit: $200

Place (Distribution):

The initial presentation will occur at the 2014 iGEM Jamboree where the scientific community will have a heavy presence. After the Jamboree, the focus will be on finding research and development companies within the Minneapolis area. Depending on the level of interest generated from the iGEM Jamboree, additional trade shows, and leveraging influential people in our network, we will approach this stage when appropriate.

Promotion:

The primary forms of promotion will be the online website, social media, and public relations events. The online website will be the one stop shop for information about the research project: the research, the development, and the team behind the project.

Challenges and Risks

Challenges:

The next logical step is to conduct full-scale trials of the device. These full-scale trials will give us the opportunity to see how the device fairs in different environments. The implementation process of the device will also need to be perfected. A streamline method is necessary to keep costs low and usability

high. As of now the device needs replacement of encapsulated beads every 20 days. So going into the aquatic environment and replacing the proper equipment efficiently and effectively will needed for success.

Risks

The lab time, modified bacteria and all custom supplies will be lost if the program fails. The only investments that can be salvaged will be the materials that have not been contaminated. Another risk is that other research institutions and companies may be researching similar modes of bioremediation behind closed doors, which if they were successful would cause competition in the market.

Appendices

Appendix A

Total Annual Market Opportunity for Midwest at Maturity

Segment	Factors	Assumptions/Resources
Governmental	3	IBIS World
	0.333333333	Adoption Rate
	1	
Mining	581	IBIS World
	0.1	Adoption Rate
	58	
Total Consumer Base	59	
Implementation Revenue	$ 7,092,000.00	200 units per implementation
Average Replacement Revenue Per Order	$40,000	
Average # Transactions Per Customer/Yr	4	
	$16,548,000	

Appendix B

Per Transaction Contribution Margin

Revenue on Buy In		**$600**	**100%**	ASSUMPTIONS
Variable Costs				
	Mineral Oil	$20.41	5%	30% wholesale discount
	Device Compartments	$192.90	44%	Prototype = $77.16, To full scale = 10X, Economies of Scale=75% Cost Savings
	Lab Time	$120.00	27%	Ten hours of lab time per unit
	Bioremediation Components	$104.03	24%	$.386 per ml of TMOS, 30% wholesale discount
	Total Variable Costs	$437.34	100%	
Contribution Margin		**$163**	**37%**	
Revenue on Replacement		**$200**	**100%**	
	Bioremediation Components	$104.03	100%	$.386 per ml of TMOS, 30% wholesale discount
	Total Variable Costs	$104.03	100%	
Contribution Margin		**$96**	**48%**	

Appendix C

Revenue Outlook

Year	Revenue $ million	Growth %
2015	131,987.8	1.0
2016	134,759.5	2.1
2017	138,667.5	2.9
2018	142,966.2	3.1
2019	147,255.2	3.0
2020	152,261.9	3.4

References

1) www.unep.org/PDF/PressRelease/GlobalMercuryAssessment2013.pdf
2) http://www.cec.org/Page.asp?PageID=924&ContentID=1297
3) http://www.cec.org/Page.asp?PageID=924&ContentID=1297