PROPOSAL

Never Tapped Out

HOW MIGHT WE IMPROVE SANITATION SYSTEMS IN AREAS WITH MINISCULE POPULATION NODES AND IMPERMEABLE SOIL IN A COST-EFFECTIVE MANNER TO IMPROVE INDIVIDUAL HEALTH AND WELL-BEING?

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Problem:

Individuals within poor areas with miniscule population nodes and soils not conducive to percolation of wastewater systems sometimes lack a proper system for wastewater disposal leading to occasional backup and other problems such as the emergence of sewage pools within the region. He estimates that 52-89% of land within the Black Belt area contains soil incompatible with traditional onsite wastewater treatment systems (He, 2011). The problem is occurring currently and has large-scale impact on Lowndes County and other counties in regions like the Black Belt that tend towards lower community resources and poorer soil for piping. The EPA estimates that 40 to 90 percent of households in Lowndes County lack proper sanitation, and the situation exists far outside Lowndes' borders and extends to a large number of households in Virginia, Texas, and other locations with dispersed population nodes and tough soil. According to both UN and EPA estimates, proper systems in Lowndes can cost anywhere between 6,000 and 30,000, often out of the reach of the individuals in these communities (Loveless, 2015) (Williams, 2011) . Ultimately, the team views this as largely a cost issue and believes that if a working system can be made financially affordable within these areas, the problem will become much less prevalent. The team also views the problem as a community engagement issue and sees a need to interact directly with community organizations to enable implementation that works well with the people closest to it.

Significance:

This problem is caused by three main factors, which are addressed in both this section and the section above. The soil is impermeable, the people lack resources to purchase proper systems, and the population nodes are miniscule forcing either decentralization of systems of expensive sewage systems (Albuquerque, 2015). If the problem were addressed in a feasible and sustainable way, the individuals within the region would be healthier due to the decrease in tropical diseases and microbes. Currently, a substantial portion of the county deals with these diseases which can include Hookworm, Strongyloides, and Entamoeba according to researchers from Baylor College of Medicine (Walton, 2015) (McKenna, 2015) , which have otherwise been mostly eradicated within the continental United States. Wang relates this to the broader context of health within the American society and of environmental and social sustainability of the region and the health of the individuals of the region (Wang, 2012), and Kaminsky reports directly on the social sustainability of sanitation infrastructure. Kaminsky's discussion of the abandonment of sanitation systems create an easy comparable to Alabama within the context of the increase of social capital and social sustainability in the region. This clearly points to an increased ability to sustain Alabama society in the context of better sanitation (Kaminsky, 2014). Beyond these improvements, improvements would be made within water supply and the environment to allow for better health on the community and water intake level (Wedgeworth, 2014). The region would be more economically viable and sustainable in the future because of an increase in quality of life. There would be less sewage issues and an allowance of further growth and development because of the better environmental quality. The team fundamentally believes that solving the problem previously identified, while not a silver bullet for all issues in the areas by any means, will enable an improved overall quality of life for the citizens of areas with similar problems.

Stakeholders:

The people within areas specifically impacted by the problem want the problems associated with backups, breakdowns, and sewage pools to be removed from their lives. Fundamentally, the people directly impacted by the problem on a day-to-day basis want the pipes to be fixed and the wastewater systems to work.

Ten percent of the population does not have to deal with the consistent backups and problems with sewage pools (Loveless, 2015). However, they would likely be required to pay for any incrementally improved system or new device within the area as waste infrastructure costs tend to be dispersed among the entire community. Among these individuals, there are likely some with strong viewpoints in favor of directly fixing the problem regardless of cost, and there are likely some who would be unwilling to pay for additional infrastructure if the costs were too high. Based on the potential for economic benefit to the region, it seems sufficiently likely to assume that nearly all parties would recognize that a solution could be revenue-neutral to all residents and overall potentially revenue-gaining if implemented correctly in a way that decreases other costs and increases revenues from other sources.

Hospitals near these areas have to deal with individuals with tropical diseases and have to build up resources to deal with sick families who often lack sufficient insurance. As such, hospitals would like to reduce the burden of sickness stemming from wastewater problems on the general population of the area and wastewater finances.

Researchers are interested in either the development of a solution or the creation of research that helps further knowledge in the area. As such, researchers would like to find a solution and work towards such; however, there has been a lack of focus on the issue, and many researchers are leaving the problem space after a short period of time (Tavernise, 2016).

Federal and state regulators have the difficult task of having to deal with a portion of regulation that remains difficult to create and manage. The regulators would like to ensure that regulations are followed while causing the least damage due to regulatory overreach.

Skilled workers on infrastructure desire to earn a living implementing septic systems and working to manage, build, and repair systems. These skilled workers spend their lives working with complex systems and have an interest in any long-term project on the system. They have an interest in a working system that could allow for continuous operations and maintenance (O&M) and repair work.

Existing Solutions:

A great number of existing solutions exist for each of the parts of the problem; however, many either have been implemented in Lowndes to no avail or are cost prohibitive for the areas NTO is specifically looking at impacting. Some of these solutions have been policy and infrastructure oriented while others have been more geared towards directly working on the systems. Policy solutions have focused on universal enforcement and making septic tanks mandatory for all individuals. This has led to at least 12 arrests and still has not fixed the sanitation problems of the region. According to the Associated Press, for solution implementation, pounds of dirt must often be brought from distant places and taken to Lowndes at high costs of over 3000 dollars, an impractical sum given the low value of average income in the area (Associated Press, 2015). It is clear in this respect that forcing people to purchase an overly expensive product cannot make the product more desirable. Other more innovation centered ideas have failed largely because of a lack of attention to aspects of the problem; for instance researchers in the region previously attempted to create a large central septic field; however, the fields were unsuccessful in their intended purpose and ended up creating more harm than good because the individuals who built such a field did not account for the soil's failure to percolate as the soil percolation level was not accurately tested before the implementation of a drainage field (Flowers, 2014). Current and promising solutions include STEP and STEG systems, small bore metal piping, sand-packing of pipes, and decentralized treatment facilities. STEP and STEG systems use pressure and gravity respectively to get effluent from the houses to the areas of treatment and often work better for decentralized areas with miniscule population nodes. Small Bore piping utilizes a small diameter to allow for better transport of liquid effluent that works better with decentralized systems. Sand-packing pipes allows for pipes to go through tough soil and facilitates transfer of effluent in this area. Decentralized treatment methods treat effluent on a local level and can be substantially less expensive for rural communities. The team plans to use MatLab to determine costs and to create an algorithm for the optimal placement of treatment facilities within the area. This MatLab algorithm will take in the topographic data for the area and use it to find an optimal placement of the piping and decentralized treatment facility (MatLab, 2017). This will allow the team to get a better picture for how to implement a solution, and how to utilize these methods.

Why is this still a Problem?:

The problem is wicked to an extreme. There are no easy solutions, and any implemented solution will require a large understanding of confounding variables and problems in all areas. Ultimately, any solution the group could implement would only address certain aspects of the problem and would create an incrementally better society instead of a drastically better world. Regulatory clout and cost of implementation create a system wherein just attempting a solution is very difficult and requires long-term investment of time and a strong commitment to the community and its people. Many researchers in this space focus on documentation and fail to demonstrate commitment to finding a long-term solution inclusive to the region's people (Tavernise, 2016).

Goal:

Our test an assumption assessment demonstrated that primarily, proper systems have not been implemented because they are unaffordable, so by the end of our project, the members of NTO would like to see the creation of a more cost-effective system for the regions identified above. Specifically, the team would like to bridge the gap between the resources of the individuals and communities that require the type of systems on which NTO is working and the cost of the systems to said individuals and communities. If the solution is successful and the decentralized system works, the areas currently dealing with the problem can afford to deal with the wastewater in an effective manner.

Objectives

Objective 1: Develop a first-draft plan for a testable system capable of theoretically reducing costs to a level affordable for individual households in the area. This entire system will be broken up into parts that we would test individually by the end of October 2017.

Background: The importance of this objective lies in its tangibility. Creating something tangible as a first draft simplifies the discussion of funding and will be a useful tool in garnering resources. Before any implementation or real testing can occur, NTO needs proof of concept. Obviously these cuts in system costs will be difficult, but the team believes a high number of areas desperately need a solution that cuts cost. The team understands it is not feasible to build and test a full scale decentralized system, but building and testing its constituent parts seems for more feasible.
Methods: First, the team needs to research multiple possible solutions. Such solutions currently include Concentrated Solar evaporation of the wastewater that is piped to a central location servicing 5 to 10 houses. Then the team will be required to test such solutions for their feasibility by building scaled models or building test structures on site.
Outcomes: If the costs remain too high, cost savings of parts can't be proved, or parts cannot be built independently of the system, the project will never be feasible for broader implementation. The system will be too expensive, and the testing will not be feasible. The group's current expected solution can be found in the first appendix of this document.
Anticipated Problems: It will be difficult to produce a first artifact without being able to conduct substantial, field based tests. This anticipated problem stems from the necessity of soil tests in soil based solutions. Beyond this, it can be difficult to create substantial savings as are needed within this area.

Objective 2: Meet with and develop a relationship with at least three organizations connected to problem, stakeholders, or the Lowndes County community by the end of December 2017. This should, at minimum, include one organization directly related to the government or a potential source of funding and one organization directly related to the community.
Background: Partnerships and relationships are critical for this problem space. This problem space is extremely intimate to the people of Lowndes County, and in order to test solutions, NTO needs to be able to count on both community support and community trust. These two things are fundamental for any potential solutions.
Methods: First, NTO needs to contact partners in the area. Second, NTO needs to visit the area at least once during the Fall 2017 semester. During this visit, NTO needs to make sure to engage and interact with the individuals in the area on a personal level. This will allow the team to understand governing dynamics of relationships between community individuals.
Outcomes: If this objective is met, the team will have created some sort of artifact which displays joint commitment to three third parties.
Anticipated Problems: It can be difficult to establish long-term relationships on short-term projects, and it will be even more difficult given that our experiences and location create some level of divide between group members and the individuals in these areas. Beyond these problems, establishing trust will be a fundamental issue going forward, and the team will have to establish an investment for the future of the potential solution.

Objective 3: Develop a planned and testable system capable of decreasing the cost of sanitation treatment for at least 5 properties within a decentralized area to a level affordable to individuals in the area by the end of December 2017.
Background: This goal moves from drafting to planning. After this goal comes to fruition, the team will have a plan in hand for broader implementation of the solution. This will allow the

team to attempt to receive permits and facilitate conversation about long-term implementation plans and goals.
Methods: The team will move toward this objective by creating artifacts that will help lead to a testable final product. According to Dr. Joseph Brown, a professor at Georgia Tech and a Professional Engineer for Alabama, if the team develops a solution, he will help us implement a test of the solution in the area.
Outcomes: After developing a plan for the solution, the team will be able to discuss the ideas with individuals in Lowndes County and with Dr. Joe Brown in order to find a way to implement the plan.
Anticipated Problems: It will be difficult to come to agreement about how a final system should be designed before such a system has been tested on a macro-scale.

Objective 4: Receive required permissions to begin implementation of solution on a scale of 5 properties by March 2018. Find properties for testing and create an implementation/evaluation plan by May 2018.
Background: Sanitation is one of the most heavily regulated areas in public policy. Getting permissions not only validates the solution but also makes a solution implementation possible.
Methods: First, the team will need to write a proposal for the creation of such a project. This will require work with a Professional Engineer as well as substantial work to explain the technical and policy-related aspects of the project.
Outcomes: After receiving permissions for implementation, the team will be able to implement the solution in the five test properties in Lowndes County.
Anticipated Problems: It will be difficult to decide which five properties should be the test properties because all of the families that live on all five of the properties must agree to the implementation of the solution. The people of Lowndes County and the Black Belt Region have been lead astray time and time again. Getting them to agree directly to a test on their home may be extremely difficult. It will be hard to create an implementation plan without consistent and direct access to the area.

Objective 5: Secure funding for a broad implementation plan by October 15th, 2018.
Background: Funding will be crucial to the overall success of the solution.
Methods: The team hopes to form partnerships with Alabama Center for Rural Enterprise (ACRE) and other local organizations such as the Town of Whitehall, the Environmental Protection Agency (EPA), and the Alabama State Water Resources Research Institute Program (WRRI).
Outcomes: After securing funding, the team will be able to make the solution affordable for residents in the area.
Anticipated Problems: Many groups have invested large amounts of money in the area. However, many of the solutions did not work, so some groups are not willing to provide more grants.

Objective 6: Begin to test said solution on the scale of 5 properties by the end of December 2018.
Background: This builds on all previous plans and works to bring what was previously developed into the real world. This objective is the first chance to begin realistically changing the

nature of this problem through some trial. If this objective goes unaccomplished, the team cannot realistically implement the solution on a broader scale.
Methods: This will require the team to contract individuals to build treatment facilities and to work on the laying of pipes. This will likely require meetings with local companies and discussions with individuals about what they can do and accomplish in conjunction with our timeliness and plans.
Outcomes: If construction has not been started on a system for the houses by this time, the goal will not be met.
Anticipated Problems: Implementation will be expensive, and the team does not know exactly how much a feasible solution will cost or what sources of funding will be directly available. As of now, the team estimates that the total cost of the solution for five properties is about $5000. It may take years to actually build the system even for the first group of houses.

Objective 7: Evaluate success of solution on current scale by the end of May 2019.
Background: Program evaluation is crucial both to proving an investment and to the iterative building of solutions. All aspects of programs must be addressed in this evaluation.
Methods: Throughout the project, individuals need to be designing a method for testing and evaluating the progress
Outcomes: At that time, we will be able to know with some degree of certainty whether the program was a success or a failure. After this occurs, the team will either choose to continue on or go back to the drawing board.
Anticipated Problems: It may take substantially longer to be able to test the systems than is anticipated. It will be quick to know whether the system is affordable to the communities in the beginning; however, it may take years to know with certainty what upkeep will cost and whether the system will actually work in the area.

Project Team:

The team feels that to be successful, at least 5 continuing students will be required. The team will utilize technical, policy-focused, and leadership-oriented expertise of all students to ensure that the team functions effectively in all capacity. The team feels its current roster works well for these problems but understands the need going forward for a good team dynamic.

At least one individual with a technical, materials, or construction engineering-based skillset will be required to facilitate the direct building of the project. This person would hopefully be either in MSE, ME, or CEE. The team will also require at least one individual with good chemical and biological engineering skills for the eventual chemical aspects of the project, such as the treatment of the effluent and the health aspects. This person will ideally be BME or Chem E. These two to three individuals will be crucial in the engineering and design aspects of the project. While others will work simultaneously on building up the plans, these individuals will be directly responsible for the design aspect and will help learn the technical side of the problem.

The team will also require at least one individual who will focus on building relationships, community engagement, and day-to-day operations of the project. This would hopefully be an Industrial Engineer or any individual with a strong interest in leadership and teamwork. This person will be directly in charge of ensuring deadlines are met and making sure that the team functions effectively going into the future.

The team will also need to ensure that the public policy aspect of the problem is handled properly, which will require an individual responsible for ensuring proper management of public policy related issues. This person will attempt to secure funding, work on proposals, and maintain civic engagement. The ideal candidate will have a decent background in something policy-oriented and management-focused, such as public policy, international affairs, business, or economics. During the objectives of the project, this person would focus more on economic impact and a long-term proposal.

Finally, the team sees a need for an individual who has a direct focus on either health or the environment and can maintain this focus on a long-term basis. This individual will help with environmental impact and health policy with regards to the system. Ideally, this person is either in CEE, biology, or BME. This person will be crucial at every step of the way but will be particularly helpful when working with the individual focused on public policy to ensure that all public policy procedures are followed regarding health and public policy. All individuals will facilitate all pieces of the project.

Dr. Joseph Brown agreed to be an advisor on this project. The team also anticipates working directly with community leaders such as Mrs. Flowers and other academic individuals such as Philip McCreanor of Mercer University and Mark Elliott of the University of Alabama. All of these individuals have been contacted about the project, have worked in this area before, and will help establish knowledge on the fundamentals of this problem space.

Budget (no more than 1 page):

Materials and Supplies: Reasonably, materials and supplies will be the most expensive portion of the project but will also be crucial to implementing a successful solution. Over time, the team will require materials and supplies for testing and building the system. This will probably be $4,500-6,500 within the first year.

Equipment (anything over $1000): Currently, NTO does not see the direct need for any equipment above $1000.

Services: The group will need to pay to obtain a permit for the implementation of the solution. Also, there will be a cost associated with the actual implementation of the solution, including the sand-packing of the pipes and the building of the decentralized treatment plant. The team estimates that the cost of services will be about $2000.

Travel: The group plans to travel to Lowndes County at least twice a semester. As each trip should cost about $300, the total cost will come out to around $1200. The team feels that the trips remain necessary to establish partnerships and connections within the community and to discover any potential problems with the implementation direction.

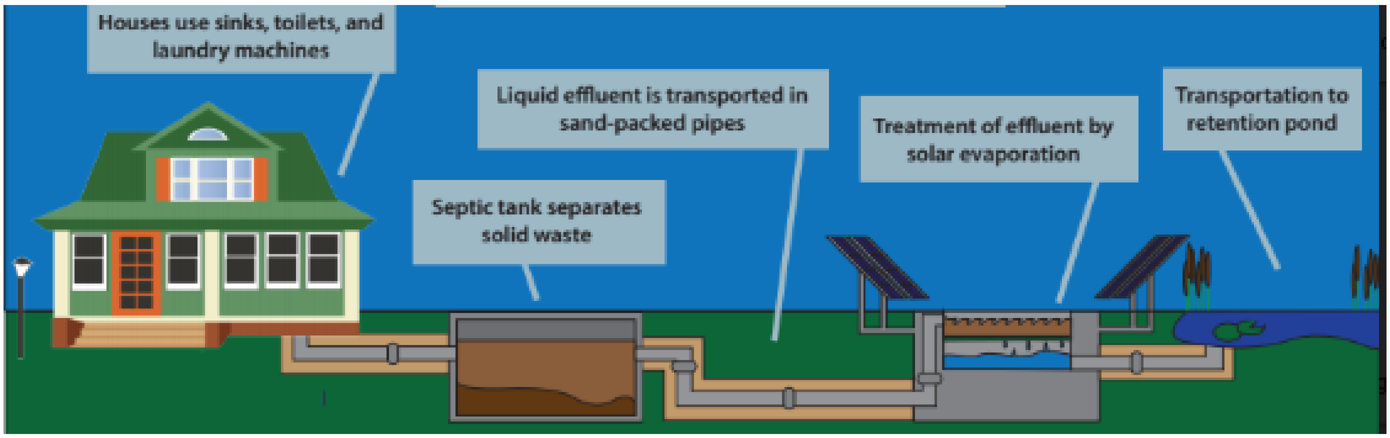
The total expected cost is $9,700 within the first year.

Expected Outcomes and Future Directions:

After year two, the team should both have a good idea of how the solution should be able to work and whether large scale implementation of the current solution(s) may be possible. By this time, according to current objectives, the project will have been put into place on a smaller scale, and the group will have seen if the current project is viable for the community and workable for all stakeholders. After year two, the group hopes to move towards broader implementation and work on both capitalizing on built relationships and partnerships for long term improvement of the situation.

Currently, NTO does not have any substantive partnerships within the region, but the team would like to work directly with the ACRE and other local organizations such as the Town of Whitehall, the EPA, and the WRRI. These partnerships will help to keep any progress the team makes going forward and to allow for continuing work on the solution after all members of NTO have been forced to move in different directions from the project. If NTO makes substantial progress in the area, the team believes that funding will not be an issue and that the group will be able to expand into regions similar to Lowndes County for broader implementation. However, the team also acknowledges that a major issue exists with being able to keep a team going long enough to work towards implementation. During the second year, the team will look into longer term options for maintenance of a team for the project, such as a Vertically Integrated Project (VIP).

Appendix 1:
The solution focuses on a vacuum system that transmits liquid effluent to a decentralized facility. This decentralized facility will take in liquid effluent and put said effluent through evaporation using mirrors. The inflow will never exceed flow-rates because a retention pond will be used to hold excess effluent. The plan is currently to implement this solution at a scale of five properties and 25 households and to keep the costs below $5000 per household in order to make said solution affordable.



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