PROJECT EXAMPLE

SAGICOR VISIONARIES CHALLENGE

Project Title: Rainwater, Butterflies and our School Yard's Live Laboratories

1. Challenge facing our school and/or community and our idea that uses Science, Technology, Engineering or Mathematics (S.T.E.M.) in a solution to make a more Sustainable Caribbean.

Our school compound has little green space as the entire yard is covered with concrete. When it rains the water runs off our property and floods the street below, making it difficult for us to access the school. This water then flows down to the community below and out to sea where it spoils our reefs. We envision a series of projects at our school that adds beneficial green space to our school yard, provides live laboratories for our classes, and simultaneously reduces the amount of stormwater that leaves our yard.

2. Provide background information on this problem and why solving it your way contributes to more Sustainable Caribbean Communities. A sustainable solution takes into account economic, environmental, and social factors.

Hard surfaces (e.g. concrete, asphalts and compacted earth) increase the rate and volume of pooling and rain water runoff, resulting in flash flooding and pollution of surrounding large water bodies. Countries around the world are reducing the amount of rainwater that runs off properties by collecting it from roofs in rain barrels, and increasing the areas on the property where it can infiltrate into the soil, thereby replenishing groundwater. These areas include rain gardens, stormwater ponds, green walkways and pervious pavements.

By creating green walk and drive ways, soil drainage will be greatly improved, which will alleviate settlement and flooding at the school and for the surrounding communities during the rainy season. These green spaces will also create live laboratories for the students at our school in classes like agricultural sciences, biology, mathematics, and integrated science.

3. Describe one or more appropriate methods of investigation needed to better understand the problem you want to solve and how your idea could solve it.

We will use the following methods to collect data:

1. Literature search for information on how much rain falls in our area, and how to reduce the amount of water that runs off our schoolyard when it rains.
2. Interviews with local professionals who have experimented with or have experience with the removal of concrete and the maintenance of green areas filled with plants native to our area.
3. Mini experiment to determine how much rainfall runs off our school property.

4. Design a simple instrument (protocol) to collect the data needed to better understand the problem you want to solve and how your idea could solve it.

Table 1: Summary of data collection methods and protocols for challenge project.

Method of Data Collection	Protocols
1. Literature search for information on how much rain falls in our area and how to reduce the amount of water that runs off our school yard when it rains. This activity will give ideas that can be implemented at our school to reduce rainfall runoff.	Conduct an internet search for rainfall data for our area. Contact the local MET office for rainfall data for our area. We will look for data that captures monthly variation and shows how rainfall amounts compare with that of previous years. Conduct Google searches with phrases like "reducing rainfall runoff" and "replacing concrete with green space". Articles or websites with information for our project will be discussed amongst our team members and shared with our classmates. They will be asked to vote on the ones most suitable for our school yard.
2. Interviews with local professionals who have experimented with or have experience with the removal of concrete and the maintenance of green areas filled with plants native to our area. This activity will give us an idea of what can be done in our school yard and how much time and money would be required to help care and maintain the place.	We will conduct telephone interviews with companies in the phonebook who list under "landscaping", "lawn maintenance" and "nurseries." We will also conduct interviews with companies or individuals who have existing areas which can be used as a benchmark. Pictures will be taken by our team of these areas.
3. Mini experiment to determine how much rainfall runs off of our school property. This activity will provide information on how much rainwater currently leaves our school site and the types of designs needed to reduce that amount of rainfall.	Map the school compound and measure the area. Calculate the amount of rainfall that would run off roof, on to the concrete areas. Observe what happens when rain falls on school compound.

5. Describe the procedures to collect data.

The procedures for the three methods of data collection identified above are summarized below.

1. Literature search: Google searches were conducted by two members of our team over the first three weeks of September, 2012. These searches were done using the following keywords and phrases: "reducing rainfall runoff", "replacing concrete with green space", "rain gardens", "butterfly gardens", and "stormwater management." The last three terms were suggested to us by our mentor, who is an environmental engineer in Florida. We reviewed what we read and summarized the key points that were relevant to our project. Some of the documents that we found required payment to read online. Fortunately, our mentor was able to provide the documents to us free of charge.

   Working through our teacher supervisor, on October 4th, 2012 the local MET officer, Mrs. Met, was invited to our geography class to give a presentation on weather and climate. Prior to her presentation,

our team contributed a list of questions that we wanted answered during that class. Our questions related to specific rainfall data for the area where our school is located, and when Mrs. Met presented the data, we used EXCEL to plot the information.

2. Phone interviews: Two other members of our team were responsible for interviewing professionals on the care and maintenance of green space. As mentioned above, the phone book was utilized to identify companies listed under landscaping, lawn maintenance and green construction. Our entire team also took pictures of areas in our town that we liked, and interviewed the property owner or the company responsible for maintaining the property. During the week of October 10th, our team called these companies between 3 and 5 pm. Once we got the manager on the phone, the following interview was conducted:

> Good Afternoon, my name is ____ and I am a 5th form student at School A in Town A. I am a part of a team working on a project to enhance the green spaces in our schoolyard We would like to ask you 4 questions related to our project:
>
> 1. We wish to convert our concrete yard into one that has more green space. What options are available to us?
>
> 2. Which plants require the least amount of nutrients and water?
>
> 3. If we wanted to plant a garden that allowed rainwater infiltrate quickly, what materials would be best suited for this?
>
> 4. Do you know about installing butterfly gardens? If not, do you know which plants attract butterflies in our area?

3. Mini Experiment: Our entire team of four spent three lunch periods measuring and mapping our school yard. Using a 1 meter ruler, we marked 1 meter increments on a 50 meter rope borrowed from a team member's home. We then measured the perimeter of the school yard and the buildings, and placed these measurements on a grid. Calculations were made on the amount of rainfall from our property, based on our measurements. Over the October-December period, whenever it rained and we were in school, we each made notes of what happened on the school grounds.

6. Compile your data, analyze it, and present your results and analysis using at least three different ways.

The four different methods of data presentation are: tables, bar graphs, pictures, and drawings.

Table 2: Summary of main findings from literature review

Area of Interest	Main Points	References
Rainfall and Stormwater Runoff	As a part of the water cycle, rainfall infiltrates the soil and percolates through to the water table where it replenishes groundwater. Rainfall on non pervious surfaces leads to increased runoff that does not replenish groundwater supplies. Stormwater should be managed properly to prevent flooding and pollution.	Otteley, J. and Gentles, M. (2006) Longman Geography for CSEC. Longman. Davis AP, M. R. (2005). Stormwater management for smart growth. New York, Springer.
Rain Barrels and Rainwater Harvesting	Collection of rainwater reduces runoff from properties, and supplies water for various needs such as gardening. Care must be taken to ensure stored water does not become a breeding ground for mosquitoes.	http://www.cehi.org.lc/Rain/Rainwater%20Harvesting%20Toolbox/about2.htm, Accessed 6/10/12 Dietz, M. E. (2007). Low impact development practices: A review of current research and recommendations for future directions. Water Air and Soil Pollution 186(1-4): 351-363.
Rain Gardens	"Rain gardens are an easy way to return water to our aquifer, reduce erosion, and help prevent stormwater runoff."	http://gardeningsolutions.ifas.ufl.edu/giam/planning_your_garden/theme_and_specialty_gardens/rain_gardens.html, Accessed 6/9/12 Davis, A. P. (2008). Field Performance of Bioretention: Hydrology Impacts. Journal of Hydrologic Engineering 13(2): 90-95.
Butterfly Gardens	Various plants are added to a garden to attract butterflies. Schools can use them as live laboratories.	Daniels, Jaret C. Butterfly Garden Basics. School Gardens. Institute of Food and Agricultural Sciences, 2011. Accessed on 05 Sept. 2012. http://gardeningsolutions.ifas.ufl.edu/schoolgardens/school_gardens/butterfly_garden.shtml
Stormwater ponds	Ponds can be created to capture rainwater from a property. The area required seems larger than what is available on our school property.	Collins, K. A., T. J. Lawrence, et al. (2010). Opportunities and challenges for managing nitrogen in urban stormwater: A review and synthesis. Ecological Engineering 36(11): 1507-1519.

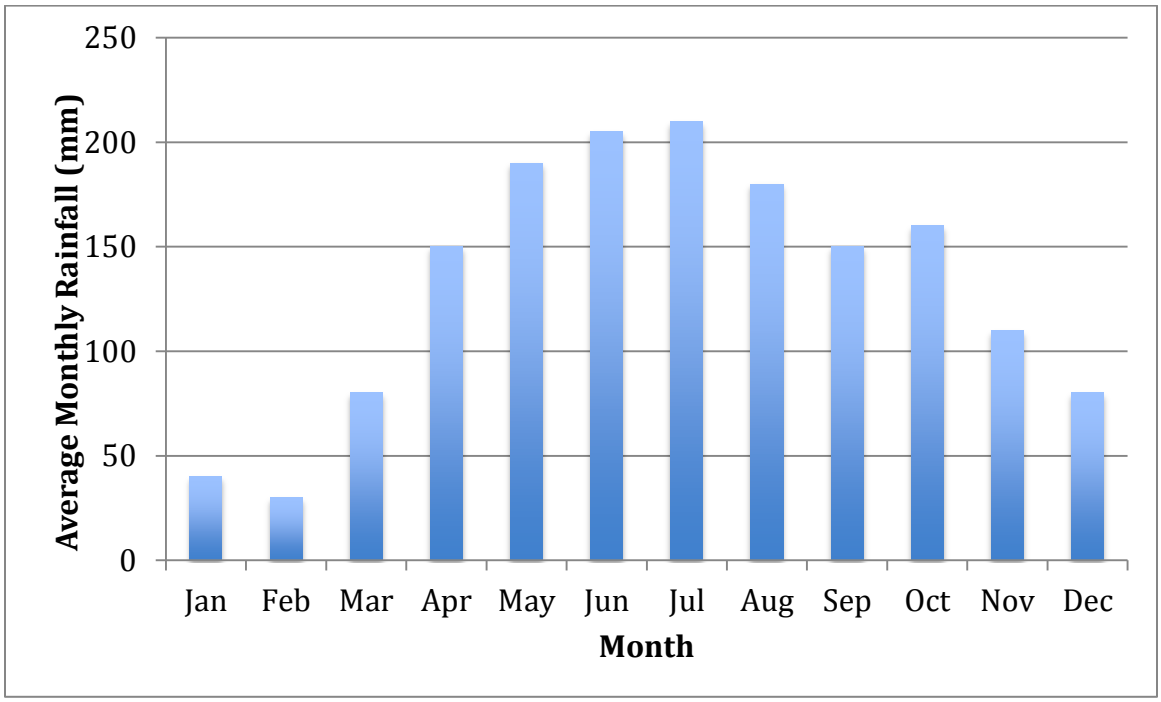

Figure 1: Plot of average monthly rainfall data for Town A from 1990-2011. Data obtained from Ms. Brown at the Town A MET office.

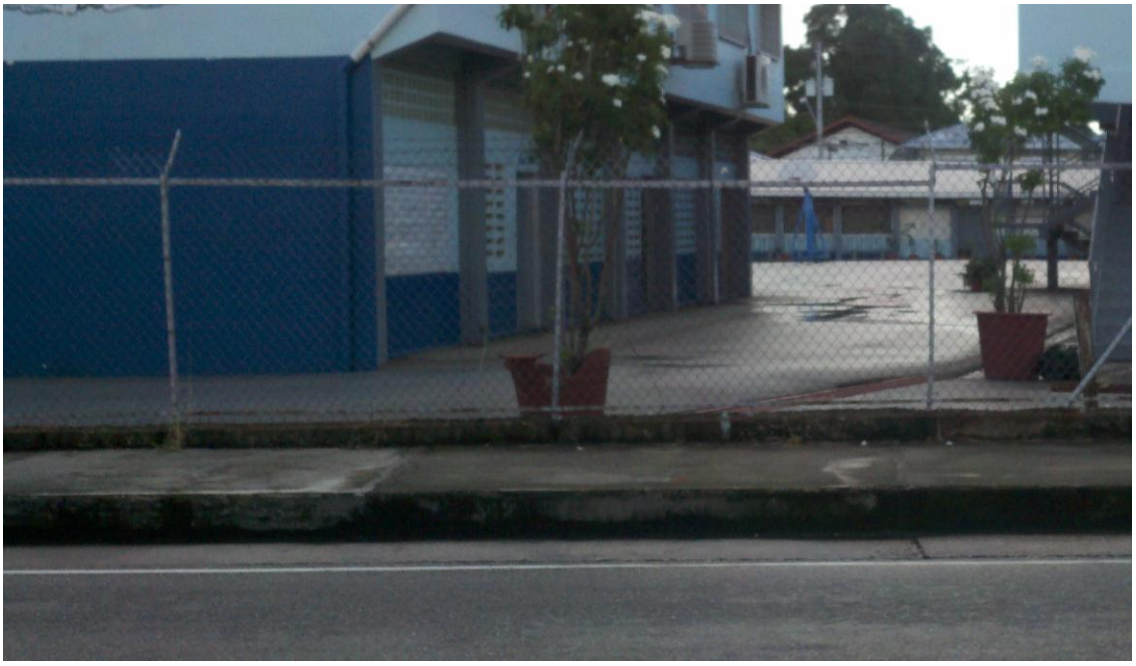

Figure 2: Image of our school yard taken on 30/8/12.

Figure 3: Example of a concrete pavement mixed with grass to create pervious areas. Picture taken at Sagicor's office in Town A on 24/08/12 (LHS) and a local residence in Town A on 24/08/12.

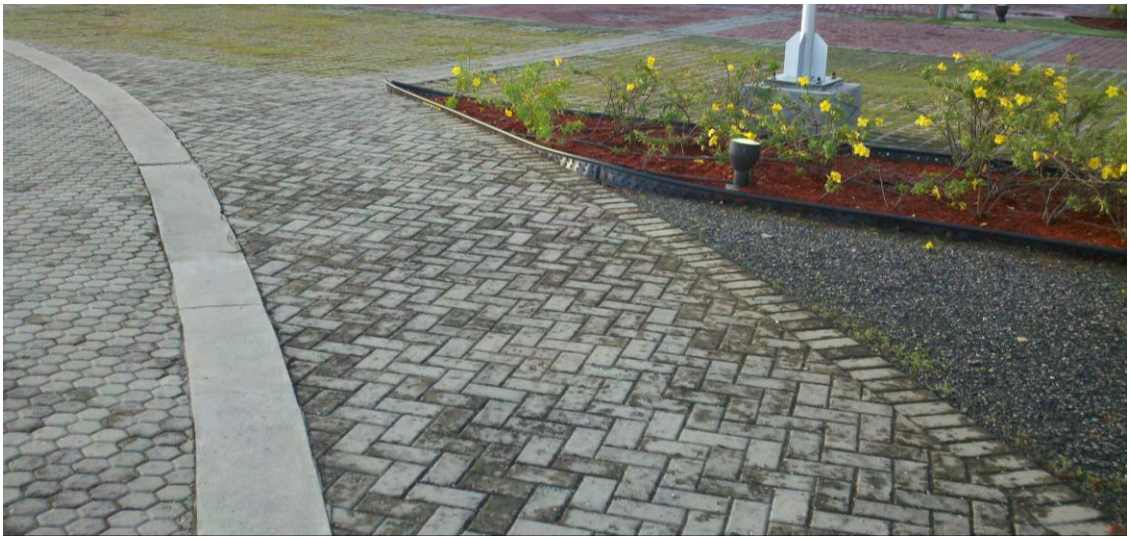

Figure 4: Example of pervious paved areas at a public space in Town A along with local mulch added to plant beds. Taken on 31/08/12.

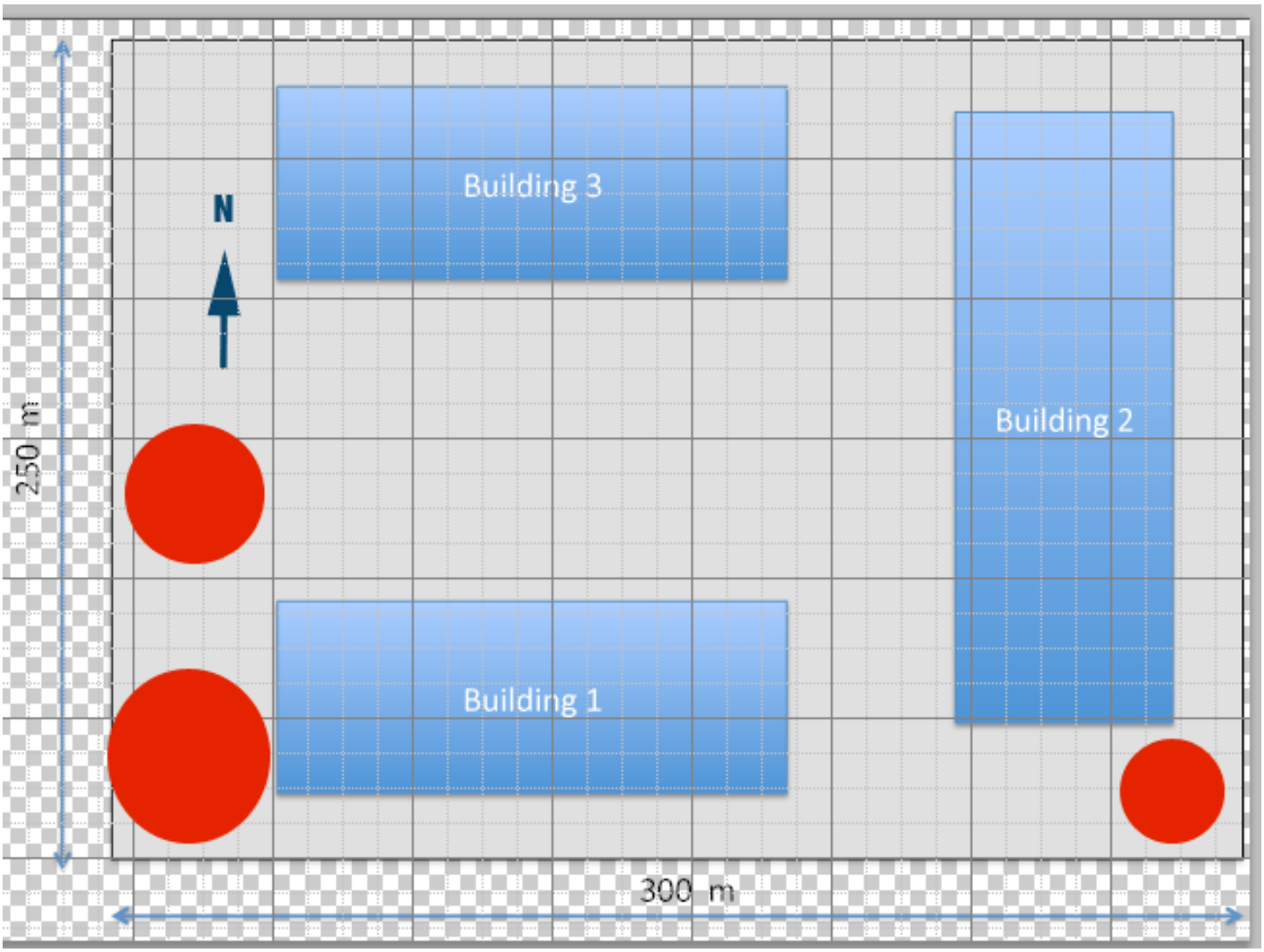

Figure 5: Map of our school yard with three school buildings. The red circles indicate places where we observed major pooling of water on the campus.

Table 3: Preliminary calculation of impervious area & project needs.

The total impervious area of our school property = 300 m x 250 m = 75,000 m^2
The roof area of Building 1 = 7,130 m^2
The roof area of Building 2 = 9,228 m^2
The roof area of Building 3 = 7,130 m^2
All of the roofs have gutters and drain to the ground.
Assume 1 mm of rain falls, then the volume of water running off of:
our entire school property ~ 75 m^3
roof of Building 1 & 3 ~ 7 m^3

roof of Building 2 ~ 9 m^3

Local tank suppliers have 1,000 gallon plastic tanks readily available.

1,000 gallons = 3.8 m^3

For 1 mm of rainfall, we would need two 1,000 gallon tanks on Buildings 1&3 and three 1,000 gallon tanks on Building 2.

Assume we built a rain garden that was 5 m in radius and was designed to collect 0.1 m of water. Then, the volume that it could hold would be = $\lambda(5\ m)^2 \times 0.1\ m) = 7.8\ m^3$

Given that more than 1 mm of rainwater falls, we can create a variety of things to reduce runoff from our schoolyard that include plastic tanks for collection of runoff from our roofs and rain gardens that also collect runoff from the roof and concrete surfaces.

Figure 6: Map of our school yard with proposed solutions to reduce rainfall runoff from the property: rain barrels, rain garden (RG), butterfly garden (BG), green walkways and basketball court.

Table 4: Summary of main finding from phone interviews with managers at Nature Conservation Group, Natural Care, TK's Green, Creating Landscapes, Green Landscaping, Lawn Producers, Growing Local, Quality Landscaping, Rain Landscaping, GL's Plant Nursery, and Landscape Nursery.

Many of the companies offer landscaping with green spaces mixed in with concrete, clay brick, gravel and stone. The company Rain Landscaping is trying to build its experience and popularity for rain gardens. The owner, who is the secretary of the Parent Teachers' Association, is the mother of a 2nd form student at our school. She has committed to assisting us with our rain garden. Mulch was recommended to reduce water requirements by plants and this can be sourced from a local supplier. None of the companies have heard of butterfly gardens, and recommended we speak with the Caribbean Agricultural Research and Development Institute (CARDI) as well as the botanical gardens.

7. State your findings and interpret the data in terms of the challenge and idea raised in Task 1

The data collected supports our idea and provides information needed to get the other members of our school community excited and supportive of our project. The challenge identified dealt with rainwater running off our concrete yard. Our literature reviewed identified many different solutions to deal with rainwater that also added green space to our school yard, which made the area more pleasant and purposeful for classes. Our interviews identified local sources to help with the implementation of our project. Our mini experiment results provided preliminary information on the amount of rainfall and the respective areas. Overall, our data indicates that our idea is feasible and has potential to transform our school surroundings in a positive way.

8. Describe how your idea incorporates science, technology, engineering and/or mathematics (STEM).

Table 4: Examples of how this project links to Science Technology Engineering & Math

Project Topic	**Link to STEM**
Algebra, rounding of numbers, Consumer arithmetic, surface area and volume,	Mathematics
Terrestrial Environment, Water and the aquatic environment	Integrated Science
Mapping, Scale Drawings, Water Cycle, inland pollution	Geography

Growth and reproduction	Biology

9. State three conclusions that you can make about your problem/idea, based on the information gained from your data.

Based on the data that we collected, we conclude that:

1. The water cycle depends on the infiltration of rain through the soil and percolation to the aquifer. This natural process becomes imbalanced with our buildings and paved areas that prevent infiltration and therefore increases runoff from our properties.
2. Stormwater management forms a major part of Civil and Environmental Engineering, and countries around the world are looking at cheaper and more efficient ways to deal with this issue.
3. Our schoolyard can be transformed into one which features greener, useful pervious space that will reduce flooding in our area, provide live laboratories for our classes, and improve the beauty and usefulness of our campus.

10. Propose the implementation strategy of your idea based on your findings.

Based on our findings, we will take the following steps to implement our project over the next 3 months:

a. The cost of this entire project is unknown. Our first mini project will focus on the collection of rainwater from the roofs of our buildings. The chairman of the local alumni association, and owner of a company that distributes large plastic tanks which can be used to collect rainwater, has committed to donating 5 tanks for our project, along with the gutters and pipes needed for installation. We will determine the best location for these tanks with the help of school administrators and the alumni association. Our team will work with the art department to paint these tanks to create better awareness of our greening project. Our team will monitor the tanks to determine how well they work at collecting rainwater. The collected water will be used for watering plants in our schoolyard, until other proposed projects for water usage come on stream.
b. We will make presentations on our project to every class, at PTA meetings, and at the alumni meeting. During these presentations we will solicit feedback on which features should and could be implemented next, and what resources and skills exist to complete the projects.
c. In the area where we marked RG (rain garden), the concrete is currently broken, because, many years ago, the area had been dug up to build a storage area, but the constant pooling of water cancelled that effort. Given that the manager from Rain Landscaping was willing to help us install a rain garden on the school grounds, we would undertake this project as one of our first activities.

11. List of references.

Collins, K. A., T. J. Lawrence, et al. (2010). Opportunities and challenges for managing nitrogen in urban stormwater: A review and synthesis. Ecological Engineering 36(11): 1507-1519.

Davis AP, M. R. (2005). Stormwater management for smart growth. New York, Springer.

Davis, A. P. (2008). Field Performance of Bioretention: Hydrology Impacts. Journal of Hydrologic Engineering 13(2): 90-95.

Daniels, Jaret C. Butterfly Garden Basics. School Gardens. Institute of Food and Agricultural Sciences, 2011. http://gardeningsolutions.ifas.ufl.edu/schoolgardens/school_gardens/butterfly_garden.shtml, accessed on 5/9/12.

Dietz, M. E. (2007). Low impact development practices: A review of current research and recommendations for future directions. Water Air and Soil Pollution 186(1-4): 351-363.

Otteley, J. and Gentles, M. (2006) Longman Geography for CSEC. Longman

http://www.cehi.org.lc/Rain/Rainwater%20Harvesting%20Toolbox/about2.htm, Accessed 6/10/12

12. Communicate information in a logical way using correct grammar & effective resources to support ideas.

a. Spelling and grammar

b. Clarity and appropriateness of language

c. Use of appropriate resources to support your idea

d. Ability to answer questions