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| **Lesson Title : Green Infrastructures** | **Unit #:****1** | **Lesson #:****2** | **Activity #:****2** |
| **Activity Title: The Challenge-Building a Green Infrastructure** |

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| **Estimated Lesson Duration:** | **9-10 class periods (47 minutes per period)** |
| **Estimated Activity Duration:** | **6 class periods (47 minutes per period)** |

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| **Setting:** | **Science Classroom** |

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| **Activity Objectives:** |

* To design a green infrastructure under given constraints

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| **Activity Guiding Questions:** |

* How can we prevent storm water run-off in a developing community/neighborhood?
* How do green-infrastructures counteract pollution in a community?
* What natural materials work best at gathering pollutants from run-off? (plants, soil, etc)

| **Next Generation Science Standards (NGSS)**  |
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| **Science and Engineering Practices (Check all that apply)**  | **Crosscutting Concepts (Check all that apply)** |
| ☒ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☒ Developing and using models | ☐ Cause and effect |
| ☐ Planning and carrying out investigations | ☒ Scale, proportion, and quantity |
| ☒ Analyzing and interpreting data | ☒ Systems and system models |
| ☒ Using mathematics and computational thinking | ☒ Energy and matter: Flows, cycles, and conservation |
| ☒ Constructing explanations (for science) and designing solutions (for engineering) | ☒ Structure and function.  |
| ☒ Engaging in argument from evidence | ☐ Stability and change.  |
| ☒ Obtaining, evaluating, and communicating information  |  |

| **Ohio’s New Learning Standards for Science (ONLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☒ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☐ Demonstrating Science Knowledge **(D)** |
| ☐ Interpreting and Communicating Science Concepts **(C)** |
| ☐ Recalling Accurate Science **(R)** |

| **Common Core State Standards -- Mathematics (CCSS)** |
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| **Standards for Mathematical Practice (Check all that apply)** |
| ☐ Make sense of problems and persevere in solving them | ☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | ☐ Attendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☒ Look for and make use of structure |
| ☒ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

**NGSS Standards:**

**MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into** **account relevant scientific principles and potential impacts on people and the natural environment that may limit possible** **solutions.**

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

**This activity was inspired by a lesson found on** [**www.teachengineering.org**](http://www.teachengineering.org)

(https://www.teachengineering.org/view\_lesson.php?url=collection/usf\_/lessons/usf\_stormwater/usf\_stormwater\_lesson02.xml)

**Day One:**

-Internet access (one piece of technology per group at the least)

-Design PPT presentation

-Design PPT worksheet (one per student)

**Days 2-5**

-Internet access (one piece of technology per group at the least)

-Teacher designated websites for research

-Blueprint paper (one per group)

-class set of calculators

-class set of rulers

-class set of coloring utensils

-blueprint of the Ballyshannon community (one per student group)

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| **Teacher Advance Preparation:** |

Be sure to have internet access through this activity for students

-Copies of the “Design PPT worksheet” (one per student)

Some websites that you may want to give to students to do research are:

* “How to Build a Rain Garden”-http://www.raingardennetwork.com/build.htm
* “Rain Garden – Plants” -http://extension.psu.edu/plants/gardening/eco-friendly/rain-gardens/plants-rain-gardens
* “Three Rivers Rain Garden Alliance”- <http://raingardenalliance.org/planting/plantlist>
* “Rain Garden Design Templates”- http://www.lowimpactdevelopment.org/raingarden\_design/whatisaraingarden.htm

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| **Activity Procedures:** |

Day One:

1. Have the Google maps screenshot of the Ballyshannon community up on the projector as students come in. Introduce the challenge to the students. Do this in a strategic way, by mentioning the essential questions the class has accumulated and how as the instructor, you “pulled” these ideas together to create one essential question for the creation of the challenge. The challenge is to create a green infrastructure which will reduce storm water run-off in the Ballyshannon Way community.
2. Discuss the constraints of the challenge, which are:
* area to build their infrastructure (not yet determined)
* cost of building the structure (soil media and plant costs)
* native plants ONLY
* time to work on their design (5 days)

Show the blueprint of the Ballyshannon Way Community up on the projector. Use this as a visual as you go over the constraints. Identify where houses will be built, and where the middle school will be built in the blueprint. Students will have to decide where would be the most optimal place to put their structure in the community as well. Keep in mind there is a lake within this community. Rain gardens are ideally constructed in areas where stormwater collects, typically adjacent to roof runoff and impervious surfaces, such as streets, parking lots and driveways.)

1. Put the students in groups of three. Give each student a specific job within their groups. Jobs could include: project manager, research manager, blueprint manager. Project manager would be the student who keeps all group members focused on the task for that particular day. Research manager is in charge of getting questions answered and following the constraints of the challenge through the information gathered. The blueprint manager is responsible for what information needs to go on the final design solution. Every group member is responsible for working towards completing the task for the day.
2. To finish the day, have students work with the “design scenarios” PowerPoint slides to identify possible green infrastructures they can brainstorm with for their designs. Not all of these scenarios are optimal for the challenge. Students will have to decipher which solutions would be optimal given the constraints of the challenge. The goal is to get students to want to come up with the idea of creating a rain garden on their own during this activity.

Day 2 and 3

1. A.) Ask students about their design ideas from the previous day. Which design scenario is the best for the constraints given? Groups should conclude that a rain garden or rooftop vegetation are the best ideas. Guide the groups to research the soil media and plants that they want to use in their green infrastructure. All of this information should be logged (or cut/glued) into their science notebooks from the previous activities in this unit. Allow students to work in their groups to begin designing and planning their solution. Encourage students to use ALL their data from the previous activities in this unit to create their solution. On Day 3 check to make sure students are researching the four major zones. The traditional rain gardens consist of four major zones, from top to bottom they are: Ponding zone (rainfall runoff collection area), mulch zone (provides carbon source for biological processes and maintains soil moisture), vegetative layer (native plant species and media mix), and a secondary media zone or engineered media layer. Please refer to the websites given in the “Materials” portion of this activity template.

B.) After groups design their soil media, give students the opportunity to test their soil media composition by using two liter bottles, cheesecloth/panty hose, and different soil media. Groups will cut the bottles in half, cover the bottom of the bottle in a cheesecloth/panty hose, and have students put their soil composition in the bottle. Then, run “contaminated” water through the media, and allow it to collect on the other side of the cheesecloth/panty hose. Students might want to test the pH of the water, or just look at the clarity of the resulting water.

Day 4 and 5

1. Give groups the blueprint paper to begin mapping/sketching out their designs. Allow students to work in groups to finish their designs.

Day 6

1. Finished solutions will be put up on the walls. Groups will complete a gallery walk activity where students will score the solutions using a rubric. On the rubric students will see if the groups stayed within the constraints (overall cost, area is correct, where they decided to put the rain garden in the community, checklist of native plants used in correct zones). Original groups will come back together after the gallery walk to reflect on how they could change their designs based on the feedback given. Groups will turn in a reflection form based on the changes they would make.
2. Students will complete the summative assessment for the unit.

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

1. Teacher should be doing check-ins on group progress every day. For example, on day 3 teacher should be asking students about their four zones in the rain garden.
2. Gallery Walk rubric: groups will be evaluating each other’s designs using a teacher created rubric. Students will have to identify if other groups stayed within the constraints given by the teacher, and pose questions for each group’s design.
3. Students will use peer graded rubrics to self-assess their original design solutions and will then make modifications based on the feedback from other groups.

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

Students will be asked to complete a summative assessment of the unit. This summative assessment will include a reflection of their original design and a design scenario that they will have to evaluate using the knowledge they gained throughout the unit. This will most likely be an open response like assessment with students writing out their reflection and using a rubric to score a given design scenario while discussing its strengths and weaknesses. Specifically the summative assessment will include:

-a reflection of their original design (how to improve it)

-a design scenario that they will have to evaluate using the knowledge they gained throughout the unit (plant and soil media usage, area, cost)

-urban and natural water cycles (compare and contrasting)

-transpiration of plants and plant structures

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.Refer to Activity Template for details. |

* Students will work in cooperative learning groups (which is beneficial for all learning styles)
* Students will be given jobs in their groups based on their individual strengths (for example, students who enjoy drawing could be the “blueprint” manager)
* Students can use technology to design their solutions if necessary instead of handwriting/drawing
* Students can use technology to read the research to them (Read Write Gold Program)

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson. |

Shortcomings:

I was unable to retrieve any information about the new middle school. Blueprints are not yet written, nor would anyone give me information on the new structure. I think this really hurt the “real-world” factor of the challenge.

Successes:

Students seemed really interested in designing the set-up of the green infrastructure. I also used TodaysMeet.com to spark a classroom discussion about what constraints would be appropriate for the project. On their own, students were able to come up with that every project should involve native plants, a media mixture layer design, and a specific area size. I was very surprised/impressed by how easily the students were able to discuss the constraints without my guidance.