Extension Activity – Water and Soil

Title of Activity - Save Our Shoreline

Concepts/Principles Covered –

The city of Annapolis, Maryland sits on the shore of the Severn River, close to where it enters the Chesapeake Bay. With increasing intensity of storm events and rising sea levels, the Annapolis waterfront experiences as many as 50 floods per year. According to the Maryland Sea Grant, an increase in sea level in the Bay area of as much as two feet is expected by 2050, and by 2100, the increase could be 3.7 feet or higher.

Increased rainfall contributes to erosion as well when water floods over the banks of creeks and rivers, pulling sediment with it. Polluted runoff affects the health of the marine life in the waterways and the Bay. As sediment increases, the water becomes cloudy and does not allow sunlight to reach plants that grow on the bottom of the shallow waters of the Bay. Without sunlight, these plants—including underwater grasses—die, negatively impacting the fish and shellfish that depend on them for shelter.

Concerned about the threats of increased flooding, Annapolis has multiple flood hazard mitigation measures in progress, including completing repairs to seawalls and installing better storm drainage systems and flood protection to buildings. Additional actions will include installing some type of erosion control barriers to offset the risks of high levels of rainfall as well as rising sea level flooding.

Your challenge, as an environmental engineer is to design and fabricate a means of minimizing erosion and flooding along the Annapolis shoreline.

Short Description –

Use engineering design and teamwork to design and fabricate a means of minimizing erosion and flooding along the Annapolis shoreline.

Standards Covered -

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.

MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Length - 2 hours. Allow additional time for research and re-iteration.

Age Group – Grades 7-10

Materials and Supplies -

Each team will need a large, shallow basin (like a plastic underbed storage tote) with a shoreline made from a mixture of clay, sand, and soil to emulate an estuary such as the Chesapeake Bay. Allow to dry over night to maintain shape. Shoreline controls will be tested by pouring water into the estuary source and allowing water to flow along the shoreline. Supplies below will be made available to all teams to "purchase". Monetary value can be assigned to all supplies for economic analysis.

- Cardboard, cardstock
- Straws, dowels, skewers
- Gravel
- Foil, wax paper, mesh, cloth
- Styrofoam, plastic bags
- Zip ties, t-pins, thumbtacks, masking tape, duct tape and other fastener materials
- Small paper cups, plastic cups

1. Riprap– loose collection of large stones, installed over geotextile membrane. $4-5/sq.ft.

2. Turbidity Barriers – geotextile membranes that float, is anchored with weights. $10/sq.ft.

3. Geotextile Membranes – open or closed weave fabric. Natural or synthetic. Coir is woven coconut fibers. Biodegradable and allows for vegetation to grow. $1-5/sq.ft.

4. Soil Nails– a series of steel bars drilled into the soil, capped at the surface with concrete to create a barrier. $45/sq.ft.

5. Cage System – rocks and boulders in separate wire cages, stacked in place. $5/sq.ft.

6. Articulated Concrete– form a grid of interconnected units of abutting blocks. $10-20/sq.ft.

7. Mechanically Stabilized Earth blocks - interlocking blocks set down over reinforced mesh. $15-30/sq.ft.

8. French Drain System - underground piping or drain tile that channels water to an exit point. May be perforated. $45/sq.ft.

Step-by-step Instructions -

- You must work in a team of four and can only use the materials provided to create a means to stop erosion as well as coastal flooding along a nearby shoreline.
- Research information has been included below that provides common methods and costs for erosion control.
- You must design a solution. Your entire team must concur on the design before securing materials and beginning construction.
- You must complete **an economic analysis and environmental justification** for your design.
- A successful design will minimize the amount of run-off during storm and flood conditions as compared to other designs.

Task	Successfully Met (2 pts)	Partially Met (1 pt)	Did Not Meet (0 pts)
Water turbidity when river floods			
Retention of shoreline when river/bay water levels swell			
Cost Analysis including list of additional considerations such as land preparation, maintenance, etc.			
Environmental Impact to show effect on area of installation as well as surrounding/long term concerns			
Fabrication complete and representative of design			
Teamwork			
Creativity			