Into the Outdoors

Educational Partners:

EGLE MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENER

First State Tire Recycling

COLORADO Department of Public Health & Environment

TDA MANUFACTURING A Division Of First State Tire Recycling PRISTINE BY DESIGN

SUSTAINABILITY, ENGINEERING AND TIRES

9th-12th Grade Discussion Guide

Teacher - Joseph Kanke

GRADE LEVEL: 9-12

TIMEFRAME: 5-7 lessons

MATERIALS: technology for research, links embedded within lesson, general classroom supplies

KEY WORDS: Tire Derived Aggregate, Byproducts, Engineering, Backfill, Brownfield, Impervious, Storm Water, Infiltration Base, Geotechnical Material, Aquifer, Permeable, Insulating, Lateral Loading, Hydrophobic, Porosity, Shear Strength

SCIENCE CATEGORIES: Energy & Sustainable Science

LEARNING OBJECTIVES

Students will be able to:

- explain what TDA is and how it is used in engineering and stormwater practices.
- understand and explain how TDA is considered a sustainable resource.
- research and compose a project proposal.

ACTIVITY SUMMARY

The following activities will explore how TDA is used in engineering and stormwater projects. The activities will also consider TDA as a sustainable resource. Since there are several complex engineering concepts connected to the properties of TDA, students will explore these properties by engaging in a mini-research Frayer model activity.

Following the opening activity, students will more deeply explore the sustainability component of TDA by reading individual reading of a website and collaborative synthesis of the material into a reason/example list. The list will be expounded upon by engaging in the peer activity, Give One, Get One.

Then, in small groups, students will consider a school/community project they feel would add value and develop a visual project proposal. They will practice sharing this proposal to their classroom peers. To conclude the lesson cycle, students will reflect on learning using the Triangle, Square, Circle protocol.

BACKGROUND INFORMATION

This clip will explore how Tire Derived Aggregate (TDA) can be used as a sustainable resource.

In 1984 the state legislature mandated that old tires be recycled. Following the passage of this law, At First State Tire Recycling in Minnesota began taking the tires and turning them into TDA. Essentially old tires are put through machines which shred them into smaller pieces. There is no waste stream at this company; every tire is either sent back into the market as a usable tire, or made into a usable byproduct. The company sees an average of 2 million tires a year and, since its creation, over 60 million tires have been reused in engineering projects.

Since tire shred is much lighter than soil, it can be used in construction to take weight stress off walls. In one example of a housing complex being built in Minnesota, over 35,000 shredded tires were used and kept out of landfills. In another location, a town wanted to build a park near a pond, but the ground was wet and swampy. They opted to put down tire aggregate first and then soil to build the park space. This project used 1 million tires! Another way to use TDA is under blacktop in places where soils and organic matter may not be able to support the weight. TDA is also very good at draining water and is a great resource in building areas where this could be a concern. Because of TDA's ability to interlock with itself and provide drainage, it lessens the damage to roads that northern states often see from freezing and thawing.

Another example of how TDA was used in Minnesota is at the Port Authority site. This site used to be home to a baseball stadium and was also used as a dump. Because of this it had been considered a brownfield. Since the building site was impervious, collecting rainwater needed to be taken into consideration before construction of any buildings. In the past, storm water would run into the streets picking up chemicals and carrying them into the Mississippi River. To solve this problem, the site built an infiltration base under a parking lot with a layer of TDA and sand. The water is directed to this lot where it is collected and allowed to slowly seep back into the underground aquifer.

The Minneapolis Convention Center also looked to TDA as a product when it installed an urban meadow. Underneath this large urban green space is TDA. This meadow is built atop an underground parking garage. Since TDA only weighs 20% of what soil does, it was a great alternative

LEARNING PROCEDURE

Frayer Model Activity:

Instructor states, "In our video clip today, we saw that Tire Derived Aggregate is a material made from old tires. We also learned that this shredded tire material is often used in engineering and stormwater practices. What exactly about this material makes it a reliable resource for construction and stormwater projects?"

Instructor reactivates new knowledge by posting the following question and capturing responses visually (board, projected google doc, anchor chart).

What do you remember from the clip?

Instructor states, "There are a variety of reasons engineers may look to TDA as a material with multiple benefits. In groups of four, I will give each of you a specific characteristic of TDA. Collectively, you will engage in a mini-research of the term, as it applies to TDA, and complete a Frayer Model Template. We'll post these templates around the room to aid us as we further explore the use of TDA."

Below is a list of words describing characteristics of TDA. The instructor should offer each group a description from the list and encourage them to use technology to perform research. The document, 10 Properties Poster, may be a great starting point.

- ***Lightweight***
- ***High Permeability***
- ***Void Space***
- ***Snowshoe Effect***
- ***Shear strength***
- ***Water Cleaning properties***
- ***Vibration mitigation***
- ***Insulating***
- ***Hydrophobic / Prevents frost-heaving***
- ***Reduces Lateral Load***

As student groups complete their Frayer models, the instructor may choose to have student groups present and/or hang the templates around the room as anchors to future lessons.

VOCABULARY

- **TIRE DERIVED AGGREGATE (TDA):** a building material made of recycled tires, which are shredded into pieces of varying sizes.
- **BYPRODUCTS:** a secondary product created during the manufacturing process.
- **ENGINEERING:** the branch of science and technology concerned with the design, building, and use of engines, machines, and structures.
- **BACKFILL:** refill (an excavated hole) with a material.
- **BROWNFIELD:** a former industrial or commercial site which may have been contaminated and is no longer being used for development.
- **IMPERVIOUS:** not allowing fluid to pass through.
- **STORM WATER:** water from rain or storm events that flows off a house or building site.
- **INFILTRATION BASE:** water storage area which receives stormwater runoff and contains it until it infiltrates the soils.
- **GEOTECHNICAL MATERIAL:** permeable textiles used in conjunction with soil, foundation, rock, earth.
- **AQUIFER:** a body of rock and/or sediment that holds groundwater.
- **PERMEABLE:** having pores or openings that permit liquids or gasses to pass through.
- **INSULATING:** a material that prevents the loss of heat or intrusion of sound.
- **LATERAL LOADING:** a horizontal force acting on a structure.
- **HYDROPHOBIC:** tendency to repel water.
- **POROSITY:** the quality or state of being porous; liquids and gasses can move more freely through.
- **SHEAR STRENGTH:** a material's ability to resist forces that cause it to slide.

ACTIVITY 1

For this activity, students will focus directly on answering the question: How is Tire Derived Aggregate a sustainable resource? This activity should be completed in dyads. Ask students to individually read the information presented on the following site: Green Aggregate Fill. Remind students to use any note-taking processes they are familiar and comfortable with.

After reading the material, dyads should discuss and create a list of reasons/examples of how TDA is a sustainable resource (about ten minutes). At this point students will engage in the activity, Give One, Get One.

Give One, Get One.

The instructor will tell dyads to move around and find another dyad to partner with. Each dyad "gives" or shares things from their list. For instance, Dyad A shares their responses until Dyad B hears something that is not already on their list. Dyad B writes the new reply to their list. When Dyad B has "gotten" one, the roles change. Learners repeat this process with other peers until time runs out.

At the completion of the activity the teacher can take volunteers to share one new or surprising thing they learned regarding TDA as a sustainable resource.

ACTIVITY 2:

In this activity students will have the opportunity to work on a team to propose a project that they think would add value either to the school site or the community.

Explain to students that they should consider either an engineering and/or stormwater project that would be seen as a valuable addition to the community. The project must take into account the use of TDA and the project proposal should explain why this material was chosen over other materials.

The proposal should contain visual components-students may choose to use a ppt format, create a website ordevelop a poster. Essentially the audience would be some type of community or school leadership team who would have the authority to approve the project.

Some components that should be considered in the inclusion of the proposal include:

- Title
- Background
- Objectives
- Methodologies
- Deliverables
- Timeline
- References cited

(Components adopted from San Jose State University Mechanical Engineering program)

Inform students that they will be delivering their proposals to the class and should also provide time and space for questions. Equity of the presenter's voice should also be taken into consideration.

After students have finished the first draft of their article, they should exchange with a partner for peer editing. The instructor may want to provide some stems to guide peer feedback. Some sample stems are listed below:

You may want to offer the TAG Feedback Sentence Starters or collectively develop a list with the class.

CONCLUSION

The instructor states, "As we have learned in the past several lessons, Scrap tires provide raw materials that are useful in various construction, engineering and industrial applications. As you reflect on what you have learned, I would like you to journal using the following protocol."

Triangle, Square, Circle

Triangle: What are three important points from your learning that you want to carry forward?
Square: What was something that squared with your thinking (agree with)?
Circle: What is still circling in your head, or what questions do you still have?

EXTENDING THE LESSON

Example:

- Venn Diagrams – create Venn diagrams to compare and contrast TDA to another type of engineering material (such as soil).
- Dig into the Minnesota Statute and Administrative Rule regarding recycling old tires and present the material in a way that could be understood by a Middle or Elementary school student.
- Explore Land Revitalization and present your findings and create a flowchart representing how land becomes a brownfield and how it could be revitalized.
- Advertisements – design advertisements to represent TDA and why it is a great material to consider in engineering and wastewater projects.
- Proposal to Action-After all students have shared their proposals, choose one as a class that could be moved forward into action. Who would need to see the actual proposal? What steps would need to be taken to move the project forward.

RELATED LINKS

How to write a Project Proposal (San Jose State University)

First State Tire

Land Revitalization EPA

Minnesota Statute and Minnesota Administrative Rule regarding tire recycling

EDUCATIONAL STANDARDS

ELA STANDARDS

8TH GRADE:

CCSS.ELA-LITERACY.RI.8.1	Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
CCSS.ELA-LITERACY.RI.8.2	Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.
8.3.	Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories).
CCSS.ELA-LITERACY.W.8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
CCSS.ELA-LITERACY.W.8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS.ELA-LITERACY.SL.8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.W.6.5	With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
CCSS.ELA-LITERACY.SL.8.1.A	Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
CCSS.ELA-LITERACY.SL.8.1.B	Follow rules for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles as needed.
CCSS.ELA-LITERACY.SL.8.1.C	Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
CCSS.ELA-LITERACY.SL.8.1.D	Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.
CCSS.ELA-LITERACY.SL.8.5	Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.
8.7.	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
8.8.	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

9TH-10TH GRADE

CCSS.ELA-LITERACY.RI.9-10.1	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
CCSS.ELA-LITERACY.RI.9-10.2	Determine a central idea of a text and analyze its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.
CCSS.ELA-LITERACY.W.9-10.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
CCSS.ELA-LITERACY.W.9-10.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS.ELA-LITERACY.SL.9-10.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-LITERACY.SL.9-10.1.A	Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
CCSS.ELA-LITERACY.SL.9-10.1.B	Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.
CCSS.ELA-LITERACY.SL.9-10.1.C	Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.
CCSS.ELA-LITERACY.SL.9-10.1.D	Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.
CCSS.ELA-LITERACY.SL.9-10.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
9-10.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation
9-10.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

11-12th Grades

11-12.1.	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain
11-12. 2.	Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.
11-12. 2.	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
11-12. 4.	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
11-12. 1.	Initiate and participate effectively in a range of collaborative discussions (one on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
a.	Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well reasoned exchange of ideas.
b.	Work with peers to promote civil, democratic discussions and decision making, set clear goals and deadlines, and establish individual roles as needed.
c.	Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.
d.	Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.
11-12. 5.	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
11-12. 7.	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
11-12. 8.	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

SCIENCE STANDARDS

MS-ESS3-3 EARTH AND HUMAN ACTIVITY

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*
Performance Expectation

Grade:

Middle School (6-8)

MS-ETS1-1 ENGINEERING DESIGN

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.

Performance Expectation

Grade:

Middle School (6-8)

HS-ESS3-4 EARTH AND HUMAN ACTIVITY

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*

Performance Expectation

Grade:

High School (9-12)

HS-ETS1-3 ENGINEERING DESIGN

Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Performance Expectation

Grade:

High School (9-12)