

American Eagle Paper Mills Waste Management

Project Summary

American Eagle Paper Mill is a paper-making company which produces 100% recycled paper products. During the paper-making process, a waste sludge is generated. The sludge is a carbonaceous waste composed of recycled paper waste. American Eagle currently uses the sludge as a soil amendment on mine-impacted lands. This application is ending soon. American Eagle has asked for help determining alternative disposal methods for the sludge, as transportation to site is costly. Three disposal alternatives were proposed to American Eagle by students: composting of the waste material, applying the material as a daily landfill cover, and combusting the material.

Initial Proposed Disposal Alternatives

Composting

Composting sludge material with added nitrogen source, such as food waste, to create a desirable soil amendment.

Daily Landfill Cover

Using sludge as a legally required landfill cover which protects landfill cell contents from weather, scavengers, and reduces odor.

Combustion

Combusting sludge as an energy source for American Eagle's operations was proposed. Additional waste generated on site, low-density polyethylene (LDPE) was suggested to be co-fired with sludge.

Final Proposed Disposal Alternative

Combustion of LDPE and Sludge

Student research partners proposed for American Eagle Paper Mills to combust LDPE and paper sludge to create an additional energy source at their facility. Feasibility evaluation, environmental impact, economic analysis, and industrial equipment recommendations were provided to the client.



Figure 1. American Eagle Paper Mills Outdoor Signage

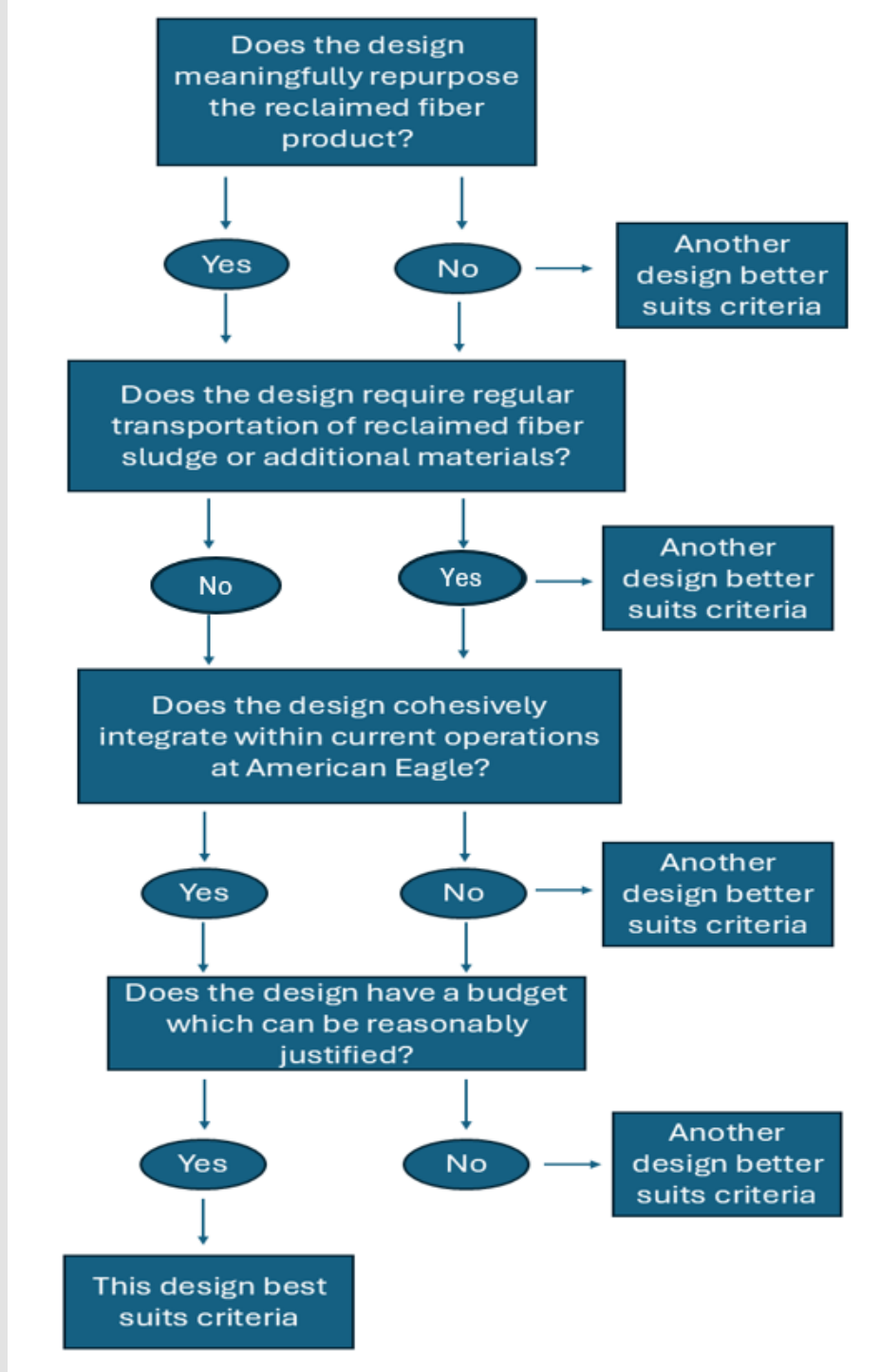


Figure 2. Flowchart designed to weigh project criteria from most strongly considered in determining which disposal alternative to recommend to client as final design.

Table 1. Results of ASTM E711 Testing for Sludge Dried Via Belt Press and Screw Press and Low-Density Polyethylene (LDPE)

Parameter Tested	Screw Press Sludge (As Received)	Screw Press Sludge (Dry Basis)	Belt Press Sludge (As Received)	Belt Press Sludge (Dry Basis)	LDPE (As Received)	LDPE (Dry Basis)
BTU/lb.	2121	4161	1149	3534	12982	14859
Moisture %	49.03	-	67.48	-	12.63	-
Ash %	14.51	28.47	10.54	32.42	0.43	0.49
Sulfur %	0.03	0.06	0.01	0.03	0.03	0.03

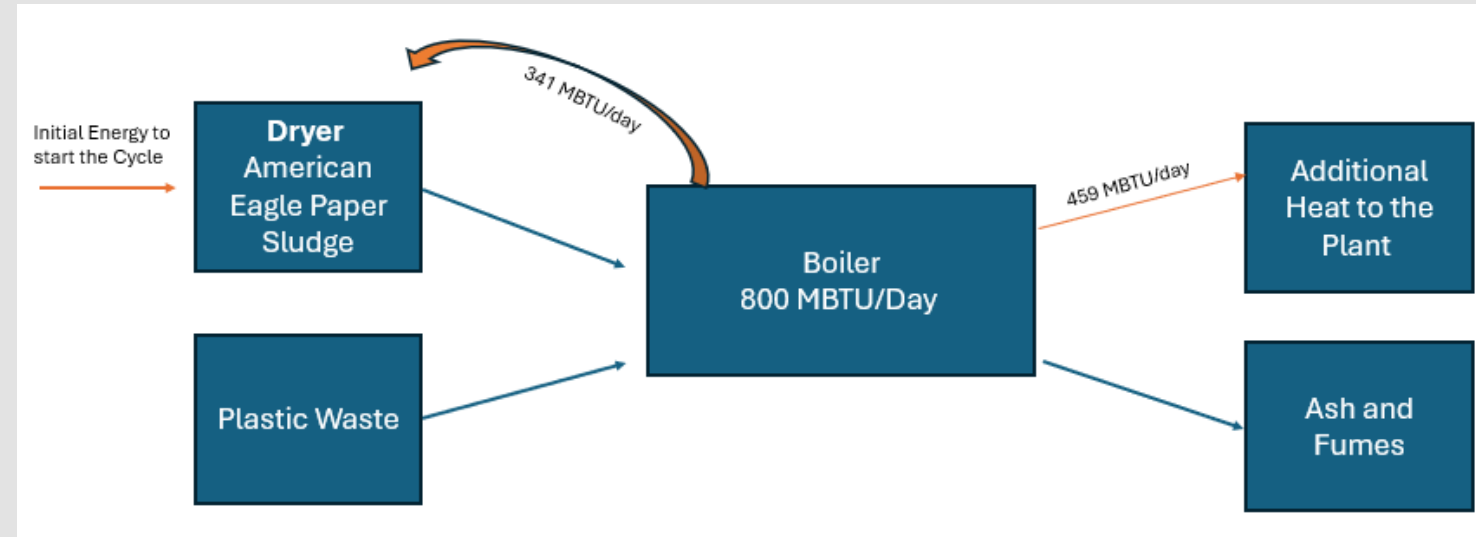


Figure 3. Schematic of proposed combustion process with quantification of energy inputs.

Health, Safety, and Welfare

All proposed designs took strides to improve health, safety, and welfare of humans, animals, and the planet. Following considerations were made for three proposed designs:

- Reuse of materials decreases landfilled waste
- Application of reuse on American Eagle grounds decreases transportation which decreases risk to human lives

Composting

- Composting would create a soil amendment which promotes BMPs
- Reuse of nutrients and organic matter which remain in sludge

Daily Landfill Cover

- Legally required engineering BMP to protect human health, environmental processes, and animals from accessing landfilled waste

Combustion

- Provides energy which is internally sourced at the facility
- Similar carbon emissions to natural gas were stoichiometrically calculated
- Emissions can be controlled via boiler specifications

Multidisciplinary Collaboration and Professional Participation

Multidisciplinary Collaboration

Although this project was introduced to environmental engineering students, multiple different engineering and other disciplines were involved in the consideration and evaluation of proposed processes.

Environmental and Chemical Engineering

- Compliance with state environmental permitting
- Chemical analysis resourcing and interpretation
- Environmental-based constraint and criteria evaluation

Process and Industrial Engineering

- Understanding waste streams
- Changing phases in material
- Combustion input and output characterization
- Quantifying and characterizing fuel

Professional Participation

Various advisors and faculty aided in the development of the project. The following aids with the following roles provided the following:

Primary Advisor: Professional Engineer in the Environmental Engineering discipline.

Guided project group in all development stages of project. Maintained deliverable dates, provided feedback on deliverables, and aided in project development.

Secondary Advisor: Background in resource management. Holds M.B.A. Aided students in project management, development, planning, organization, and advancement.

Technical Advisor: Environmental health and safety manager with experience in hazardous waste management and pollution mitigation. Led project in preliminary phases and advised on permitting processes. Aided in choosing appropriate analysis methods.

American Eagle Primary Client: E.I.T. in Mechanical Engineering discipline. Holds Environmental and Sustainability Manager role in American Eagle's operations. Led contact between American Eagle and project group.

Mechanical Engineer: Professional Engineer in Mechanical Engineering discipline, aided in determining combustion processes.

Research Professor: Professional Engineer in Mechanical Engineering discipline. Provided aid in determining combustion processes through background in combustion research at a nearby university.

Lab Technicians: Helped students understand chemical analyses interpretation and aided in determining best testing methods.

Professional Knowledge and Skills Gained

Project Management and Communication Skills

- Learned how to navigate project constraints and criteria
- Developed understanding of project scope and delegation of tasks which align with scope of project
- Communicated project needs to group partners, faculty, and advisors
- Developed skillset on presenting engineering solutions to non-technical audience and technical audiences alike
- Presented project findings to various audiences at various stages of project development
- Communicated project needs to group partners, faculty, and advisors
- Developed skillset on presenting engineering solutions to non-technical audience and technical audiences alike
- Wrote deliverables on project scope, proposed designs, data collection, data analysis, constraints and criteria of project, and final proposed designs were created during the design process – this increased student's awareness of communicating every step of the engineering design process and the importance of clarity, documentation, and technical writing

Technical Skills

- Developed quality data analysis plans for each proposed disposal alternative
- Modified known ASTM methods to determine needed data for composting feasibility
- Performed analysis of composting performance in laboratory pilot scale testing
- Quantified and characterized output from American Eagle's waste stream to determine combustion output
- Expanded knowledge on combustion processes
- Introduction to permitting language and requirements

Project Implementation Steps

