3R's of the Common Core

REDUCE REUSE RECYCLE

go green

Use it Up, Wear it Out, Make it Do, or Do Without:

A Teacher's Resource Guide to Solid Waste and Recycling

Brought to you by

Northeast Resource Recovery Association
2101 Dover Rd | Epsom, NH 03234
www.nrra.net | info@nrra.net
800-223-0150

NRRA School CLUB
www.schoolrecycling.net
theclub@nrra.net

USDA Rural Development
Committed to the future of rural communities.

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Cynthia Sterling
Project Director

Kimberlie Berrigan
Jessica Brewer
Kathaleen Cobbs
Susan Megas-Russell
Authors

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3R'S OF THE COMMON CORE: A TEACHER'S RESOURCE GUIDE TO SOLID WASTE AND RECYCLING. THIRD EDITION.

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Funding: The United States Department of Agriculture Rural Development Water and Environmental Programs

Grant Writer: Impact Earth

Project Director: Cynthia Sterling

NRRA Executive Director: Michael Durfor

Field Educators/Activity Development: Pamela Ahern, Nancy Belsky, Kimberlie Berrigan, Kathaleen Cobb, Daniel J. Dindal, Kathy Jacob, Tom McKone, Susan Megas-Russell, Lisa Paulsen, Susan Pedicord, Andre Rouleau, Brian Slopey, Cynthia Sterling, Karen Terry

Illustrations and Design: Steve Barrows, Ellen Cabral, Rosanne Charland, Curtis Johnson, Susan Pedicord

Editing: Nancy Belsky, Kimberlie Berrigan, Jessica Brewer, Ellen Cabral, Kathaleen Cobb, Michael Durfor, Gwen Erley, Elizabeth Robertson, Susan Megas-Russell

Executive Editor: Cynthia Sterling

Typesetting and Design: Rosanne Charland

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go green

To waste, to destroy, our natural resources...
will result in undermining in the days of our children
the very prosperity which we ought by right to hand down
to them amplified and developed.

—Theodore Roosevelt, Message to Congress [December 3, 1907]

Forward

3R's of the Common Core (Use it Up, Wear it Out, Make it Do, or Do Without): A Teacher's Resource Guide to Solid Waste and Recycling Education is meant to give busy teachers a resource for integrating the important topic of sustainable materials management into their existing schedules and required courses. The activities are culled from a variety of sources because one teacher may prefer a blackboard-oriented lesson, while another prefers a student scavenge hunt in the schoolyard to collect equivalent results from the same activity. NRRA understands that teachers may disagree about what is a good activity but agree on its significance as long as the educator has the resources to provide it. *3R's of the Common Core* is a guide filled with solid waste and recycling resources written for teachers.

NRRA's curriculum adheres to the 'keep it simple' code. It is organized so that by consulting the How to Use This Guide and the Sample Activity Page, an educator will know where to find related activities, information and resources to encourage a dialogue about local and global material management practices (MMP). The Guide provides educators with the tools and resources to expand a student's understanding of how personal disposal habits and purchasing decisions can affect climate change. The Information section, if read consecutively, provides background specific to lesson activity topics.

3R's of the Common Core is a multi-disciplinary curriculum for exploring a variety of solid waste and recycling issues. It is necessary to publish a third edition and make it available electronically. Plus, the Common Core State Standards (CC) Initiative and the Next Generation Science Standards (NGSS) is requiring teachers to move the best state standards and curricula to the next level. To remain on the same page as students, parents, and teachers that are working together toward shared goals, NRRA wants to ensure that the students learning from their curriculum are making the progress each year to graduate from high school prepared to succeed in college, career, and life.

Many teachers have embraced the Common Core as an alternative to the scripted commercial formulas of recent experience and are trying to use the space opened up by the Common Core transition to do positive things in their classrooms. Environmental protection, pollution prevention, and stewardship are positive lessons; plus, the activities are fun and hands-on! By addressing the topic of what is being thrown away with household trash, students in the classroom learn about an integral component of increasing the public's awareness of hazardous, recyclable, and compostable products. The success in teaching these issues lies in presenting the information in a way that empowers students instead of overwhelms them.

This is a winning state of affairs.

Cynthia Sterling, Founder and Owner
Impact Earth

PREFACE

In 2012, the Northeast Resource Recovery Association (NRRA) assumed ownership of the school resources and materials produced by the former Association of Vermont Recyclers (AVR), a leader in Vermont recycling education programs for twenty-five years. One of these resources was AVR's popular curriculum, *A Teacher's Resource Guide (TRG)*, which was originally created to renew the Vermont spirit of frugality and environmental stewardship:

"Long before the present Age of Waste, rural Vermonters practiced thrift and conservation of resources, often by force of necessity. As the wealth and international influence of the United States has grown in the last century, and Vermont has become fully integrated into national and international markets, it has become profitable and easy to waste our resources. Things are designed to wear out, are made to be used once, and thrown away, or are simply over-packaged. Ease and convenience, the values implicit in these practices–how alien they are to the Vermont traits of hard work and durability!" Curtis B. Johnson, AVR President, 1989.

The original TRG (©1989) was primarily the collaborative work of two people - Susan Pedicord and Curtis Johnson. Susan labored countless hours collecting and analyzing the best solid waste curricula across the United States, researching and writing complementary Information and Resource Sections and designing the user-friendly format for the guide. She coordinated workshops involving at least fifty teachers and solid waste professionals in VT to evaluate curricula and guides, develop lesson plans, and then field-test them in classrooms. She further enhanced the TRG with her artistic talents, creating fun and informative graphics to be used throughout. Curtis Johnson, AVR's Board President for many years, volunteered hundreds of hours, from conceptualization to fundraising to distribution, to ensure a well-written and professional document. Without the insight and dedication of these two individuals, this invaluable resource would never have existed.

In 1998, AVR Educator Julie Hand, began updating the Information Section. When Julie left AVR for naturalist and landscaping work, AVR contracted with Michael Wood-Lewis, former researcher for the DC-based Institute for Local Self-Reliance (now living in Vermont), to complete the Information update. Michael's knowledge of solid waste issues and writing talents were extremely useful in broadening and editing each section. AVR staff member Lauren Traister took on the arduous task of updating the Resource Section.

As stewards of AVR's resources, NRRA received funding to update this outstanding curriculum to align with the national common core standards. The intent was to correlate the standards to the lesson plans as originally written. This proved to be an incorrect assumption. Most of the lessons were revised and the Information and Resources sections upgraded, but the authors upheld the original concepts and objectives. 3R's of the Common Core is the 21st century edition of a Teacher's Resource Guide to Solid Waste and Recycling Education.

KIMBERLIE BERRIGAN—

has a Bachelors Degree in Elementary Education from Lesley College in Cambridge, MA and a Master's Degree in Special Education from Boston University. Throughout her career she has worked with students of many ages ranging from preschool through adult. Her experiences include positions as special education teacher for children on the autism spectrum, third grade teacher, reading/math interventionist, and kindergarten teacher in public elementary school. Mrs. Berrigan has also served as an adjunct professor in the Early Childhood Education program at Mount Washington University, where she helped revise the core curriculum. Kimberlie currently leads the student and staff Green Team at Allenstown Elementary School and has helped the school win the Keep America Beautiful: Recycle Bowl for the state of New Hampshire, as well as Best Earth Day Event for two years in a row! The NRRA recognized Kimberlie for outstanding achievement in the field of environmental awareness in May of 2016 by presenting her with the Teacher Recycler of the Year award. She is active in her community, having served on the town recycling committee and PTO, as well as operating the scrapbooking program for the recreation department.

JESSICA BREWER—

received her B.A. in Medieval Studies and Classical Studies from Tulane University and her M.A. in Medieval Archaeology from the University of York in the UK. Before working with the Northeast Resource Recovery Association (NRRA), Jessica taught English as a Second Language in China, Argentina, Indonesia and Turkey and worked in heritage tourism in the UK. Jessica currently teaches yoga and is applying her research skills to obtaining Italian citizenship ius sanguinis.

KATHALEEN COBB—

has been in the education field for more than twenty years, spending many of those years teaching special education and grade 4. She earned her B.S. and additional certifications from the University System of New Hampshire and feels extremely fortunate to do what she loves during her career. Kathaleen is pleased to have collaborated with NRRA on our efforts to correlate timeless learning materials to the Disciplinary Core Ideas of the Next Generation Science Standards (NGSS) and the Common Core National Standards for English/Language Arts and Mathematics. When she is not working, Kathaleen enjoys reading, dancing and exploring life with her grandson.

SUSAN MEGAS-RUSSELL—

developed an early interest in reading and made it her career. She holds a Master's Degree in Reading from American International College, earning her B.A. from Westfield State University in Massachusetts. As an educator, Susan is excited to bring to students relevant science lessons now aligned with the common core standards in reading, writing and math. Her established 40-year background as a classroom teacher in elementary, middle and high school, and as a reading-writing specialist providing curriculum development workshops to teachers, was invaluable to editing this curriculum. A gardener, reader, recycler and owner of an electric car, caring for the earth is in Susan's heart.

INTRODUCTION

The 3R's of the Common Core Standards provides teachers with a relevant curriculum complete with a wide range of lessons and activities that offer students concepts, knowledge, and understanding of environmental problems and possible solutions. The activities within the curriculum present a variety of real life tasks and hands-on experiences for students to experience and understand, all related to the main concepts, which are: What is waste? How do we manage waste? How can we reduce waste? Teachers are presented with opportunities and flexible activities in which to engage their students. Depending on student needs, abilities and learning styles the teachers can determine which knowledge, skills and literate competencies their students need and the options to help them go about learning. The curriculum fosters the expansion of students' knowledge and understanding through their own examination and exploration of current environmental issues.

Each lesson opens with a leading question to stimulate thought and curiosity. Students are to ponder the question and to keep it in mind as each explores the issue throughout the procedure. Each lesson arouses prior knowledge therefore supporting the concept of connecting the students' knowledge to new understandings. If knowledge is lacking, lessons from earlier grades can be taught to establish a base. Each lesson includes an opportunity for students to communicate and collaborate with the teacher and peers. Students are offered a wide range of activities that include discussions, collaboration, experimentation, reading, research, shared writing, mathematical inquiry, web site exploration and use of technology as well as hands-on explorations that require observation skills and promote questioning and further investigations.

Some activities require students to compile their thoughts as a group, while others use an individual report format. The lessons are easily correlated to a core subject such as math, science, or language arts and offer connections that are easily accessible to the students. The teacher serves as a resource and often, as a team member. His or her role is largely to facilitate and assist students as they access knowledge and explore the subject matter. All the activities promote collaboration and team building among students. Understanding is constructed actively by the students as they conduct their investigations and explorations.

The activities are also designed to allow the teacher to create groupings that support various learning styles and needs. The student who may need extra support in reading and/or writing may work in a group where they may be an active participant yet gain knowledge through listening to others communicate, and perform hands-on experiments. This design allows everyone access to the concepts and gives everyone an active role in the group. In the event that it is a more individual activity, accommodations within the activity can easily be made.

All of the activities are related to improving our world and problem solving real life situations. The students are exposed to information that will help them examine issues and make decisions about their impact on the earth, helping them develop into more informed and active citizens. Through the wide diversity of lessons, varied teaching approaches, promotion of individual exploration, adaptation to individual learning styles and exposure to real world problems and their solutions, the curriculum embraces and enhances every student.

EXPLANATION FOR COMMON CORE ALIGNMENTS

The lessons provided in this manual guide students to understand important concepts in the area of science and to develop skill in a variety of areas, all necessary for learning and living. Suggestions of three to five Common Core Standards that align to each lesson in the areas of English Language Arts and Math are listed on the left-hand side of the page within each lesson. The suggested standards are aligned in a manner to work all together in the lesson or individually in isolation. The use depends on how the teacher will be presenting the lesson and his/her purpose and goals for the students. The teacher may choose to pick other standards depending on goals and desired outcomes since the lessons are versatile and integrate easily throughout various subjects.

Forty-two states and the District of Columbia have adopted the Common Core State Standards. Each state has various ways of implementing and aligning the common core to its state standards. For this curriculum the standards were referenced using the Matched New Hampshire Standards. Individuals using this curriculum may use their own state standards for further alignment.

The standards in this curriculum use the same format as the Common Core State Standards. Here are some examples:

1. In English Language Arts (ELA) the format is:
   CC. Area. Grade. Standard Number
   CC. RI. K. 3
   Common Core. Reading Informational Text. Kindergarten. Item 3

2. In Math the format changes to maintain consistency with how the Common Core State Standards presents them:
   CC. Grade. Area. Standard Number
   CC. 6. SP. 5c
   Common Core. Grade 6. Statistics & Probability. Item 5c

   CC. Grade. Area. Standard Number
   CC. HSG. MG. 1
   Common Core. High School Geometry. Modeling with Geometry. Item 1

3. Other standards formats used are:
   CC. Area. Grade. Standard Number
   CC. RST. 6-8. 3
   Common Core. Reading for Literacy in Science & Technical Subjects. Grades 6-8. Item 3

   CC. Area. Grade. Standard Number
   CC. RH. 9-10. 4
   Common Core. Reading in History and Social Studies. Grades 9-10. Item 4

   CC. Area. Grade Standard Number
   CC. WHST. 11-12. 7
   Common Core. Writing in History/Social Studies, Science & Technical Subjects. Grades 11-12. Item 7

Section Organization

This book is organized into sections for K-3 Activities, 4-6 Activities, 7-8 Activities, 9-12 Activities, an Information Section and a Resources Section. The beginning of each of these sections is identified by a divider with a tab with the section name on it.

Conceptual Outline and Numbering

The lessons within the curriculum all relate to the chief curriculum concepts, which are: What is waste? How do we manage waste? How can we reduce waste? The decisionmaking directives for the K-12 lesson activities are outlined below.

I. What Is Waste?
- The Solid Waste Stream
- Natural Resources and Waste
- Waste and Society

II. How Do We Manage Waste?
- Solid Waste Handling and Litter
- Treating and Disposing Waste
- Deciding Where Waste Goes

III. How Can We Reduce Waste?
- Changing Habits and Designs
- Recycling
- Composting

Each of the activity sections as well as the information section is organized according to the same conceptual framework and outlined for reference (e.g. I.A. = What is Waste? The Solid Waste Stream). Each activity within the conceptual outline has a sequential number associated with a lesson (e.g. I.A.3 = What is Waste? The Solid Waste Stream. Too Much Packaging?) The conceptual outline reference and lesson number are combined in the upper right-hand corner of each activity page. For example, lesson number 3 under conceptual question I.A. in the K-3 Activities has K-3, I.A.3 in its upper righthand corner. (The conceptual framework organizes activities and information but is NOT meant to serve as a unit of study.)

Finding Parallel Activities and Information

By looking up the same conceptual outline reference in each Activity Section, you will find Parallel Activities and Information related to topic of activities under NRRA 3R's Resources. For example, activity K-3, I.A.3, any Parallel Activities can be found under section I.A. in the 4-6, 7-8, or 9-12 Activity Sections. The Information and Resources Sections do not have the same outline reference as the Activity Section. Instead those sections are outlined by a topic title (Components of the Waste Stream, Green Consumption, Consumerism & Sustainable Development, etc.).

Interrelation of Activities

Each activity may be used with others or alone. It is up to teachers to create their own study units; these activities are meant only as an aid to that end. Many of the activities, though found in one grade-level group, are suited to other ages as well. Because of space limitations, different approaches to teaching about one subject are spread throughout the four grade-level sections and are not repeated in each grade-level section. It is recommended that all activities be reviewed before beginning. Then, when considering one activity, its Parallel Activities should be consulted in other grade-level sections for alternate lessons. Not all topics have Parallel Activities in all grade-level sections.

As an example, packaging is treated in each grade-level section. In K-3, Too Much Packaging teaches the concept of how packaging contributes to waste. A natural followup to this activity is to create a multi-media component to explain the different types of packaging. 4-6 The Story of... tells how to do this, while the 7-8 and 9-12 Activities give details on the resources which make up some typical packages and the environmental impact of different types of packaging.

The Activity Pages

The first page of each lesson plan has a word bubble containing a conceptual question, to the left header margin of the bubble is the title of the activity, its grade level and outline reference number are on the right side of the header. In the left column of the first page are the Concept, Objective, Method, Materials, Subjects, Skills, Time, Vocabulary and Resources for the activity. Followed by related NRRA 3R's Guide Parallel Activities, Information and Resources found in this curriculum and a listing of CC Alignments. In the larger right column, the activity itself begins with Background and a Leading Question, Procedure, Evaluation and additional Classroom Activities.

The following Sample Activity Page (p. xiii) outlines these parts in graphic detail.

Resources

Many of the original sources and resources of the first two editions of the TRG curriculm have retired. The available ones are contained in NRRA's 2nd edition. The 3R's of the Common Core Standards authors combined the aged sources from the original activities with available resources. All activities have been rewritten to meet CC standards and NGSS. Under the 'Resources' heading are suggested books, audio-visuals and other materials that may directly complement the activity. The Information and Resources chapters of the 3R's Guide may be consulted for full citations and/or how and where to obtain materials.

Under the 'NRRA 3R's Guide Resources' heading are listed the sections of the Guide related to the topic of the activity, including the titles and outline reference numbers of Parallel Activities and the topics of the Information and Resources Sections that will contain the most helpful information and resources.

NRRA 3R's Guide Resources

Many activities in one age level are suitable for younger children. Due to space limitations in this guide, we have tried to avoid duplication of activities, while still covering all the important concepts at each level. One of the Parallel Activities may present a better activity for your class. Teachers are encouraged to look through other age levels for activities.

Sample Activity Page

Top: Age Group (K-3, 4-6, 7-8, 9-12) & Conceptual Framework Reference Number

Sources: Some activities have been loosely adapted from their sources; others have been used with little or no changes from the original. Material photocopied directly is credited at the bottom of the page.

NRRA Guide Resources: Many activities in one age level are suitable for younger children. Due to space limitations in this guide, we have tried to avoid duplication of activities, while still covering all the important concepts at each level. One of the Parallel Activities may present a better activity for your class. Teachers are encouraged to look through other age levels for activities.

Printing: This document is set up for duplex printing on 3 hole drill paper. Reduce paper use by printing two-sided when possible. Save and reuse lessons and activities pages by building your own resource guide and storing in a loose leaf notebook.

Waste Walk **7-8, II.A.1**

Concept
Littering is improper waste disposal. Education and publicity can help prevent it.

Objective
Students will document and categorize litter in their neighborhood and will brainstorm ways to get people to stop littering.

Method
Students will photograph and collect local litter.

Materials
Bags for collecting litter, litter survey charts, camera, poster board, glue, non-latex gloves

Subjects
Art, Language Arts, Science, Mathematics, Social Studies, Photography

Skills
Applying mathematical concepts, collecting data, interviewing, problem solving

Time
Three full classes: one outside, one in small groups processing, one class discussion

Vocabulary
Littering, biodegradable, organic, disposable, human-made, resource base, recyclable

Resources
Lawrence Pringle, *Throwing Things Away*

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Parallel Activities
K-3, Litter Garden
4-6, Plastic Litter
Information
Litter
Resources
General
Solid Waste and Recycling

Background
Sometimes we may not be aware of how much litter there is until we consciously look for it. However, its ugliness may motivate us and others to dispose of it properly.

Leading Question
What is litter?

Procedure
1. Read article(s) about littering from the web: "Various Facts About Littering," *Conserve Energy Future*, http://www.conserve-energy-future.com/various-littering-facts.php. *"10 Interesting Littering Facts,"* Daily World Facts, http://www.dailyworldfacts.com/littering-facts/. "9 Interesting Facts and Statistics About Littering," *Litter. It Costs You.*, http://www.litteritcostsyou.org/9-interesting-facts-and-statistics-about-littering/.
2. Students can interview a person familiar with litter collection before modern recycling laws were enacted and/or before recycling became part of the garbage pick up routine.
3. Break the class up into small groups or pairs and assign a local strip of road for each to survey.
4. Have each student take pictures of litter they find. Each strip should be documented for types and number of pieces of litter found. Then have the students collect all the litter in their strip.
5. Weigh total litter collected and compare results of collection from other strips in different parts of town and on different types of roads. Make projections to determine amount of litter generated and requiring clean-up each year. What is the per-mile average of litter objects collected in the area?
6. Brainstorm a variety of ways to categorize the litter. Define terms such as resource base, biodegradable, disposable, recyclable, non-renewable, organic, human-made, deposit containers, etc. Create litter composition charts documenting the different categories or graph the results (e.g.: Glass, Aluminum, Plastic, Paper). Compare the amount of deposit to non-deposit containers found.
7. Brainstorm ways to help people stop littering and start an anti-littering campaign. Illustrate the problem by creating a photographic display of the litter survey along with litter statistics to post in the

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A Word About Rubrics

Rubrics are an excellent tool to enhance instruction. By using rubrics teachers may focus on what they intend students to learn rather than on what they intend to teach. Rubrics are descriptive and not evaluative and provide a way for teachers to assess student performance. Rubrics help clarify for students the performance necessary for the successful acquisition of knowledge.

The following are a list of sites that can be helpful to teachers:

- Book: How to Create and Use Rubrics for Formative Assessment and Grading, Susan M. Brookhart
  http://www.ascd.org/publications/books/112001/chapters/What-Are-Rubrics-and-Why-Are-They-Important%C2%A2.aspx

- PowerPoint: Rubrics in the Primary Classroom
  https://readingrecovery.org/images/pdfs/Conferences/NC12/Handouts/Plant_Amy.pdf

- Web site: Kathy Schrock's Guide to Everything: Assessment and Rubrics
  http://www.schrockguide.net/assessment-and-rubrics.html

- Rubistar
  http://rubistar.4teachers.org/index.php

- TeAchnology Rubric Generator
  http://www.teach-nology.com/web_tools/rubrics/sciences/

- Build a Rubric
  https://www.learner.org/workshops/hswriting/interactives/rubric/

- Read.Write.Think Writing Rubric
  http://www.readwritethink.org/files/resources/lesson_images/lesson398/rubric-essay2.pd

- 6+1 Traits Rubrics
  http://educationnorthwest.org/traits/traits-rubrics

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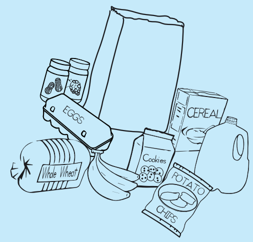
K-3 Activities

Lesson Matrix



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NRRA School CLUB
www.schoolrecycling.net
theclub@nrra.net

USDA Rural Development
Committed to the future of rural communities.

Lesson Matrix Grade K-3

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Lesson	Leading Question	Objective	Common Core Alignments		Skills
K-3 Garbage Bag Recipe **I.A.I**	What things do we throw away?	Define solid waste Identify components of waste stream Question personal rubbish habits	**Kindergarten** CC.RI.K.10 CC.SL.K.1 CC.W.K.2 CC.K.MD.3 **Grade 2** CC.RI.2.1 CC.SL.2.3 CC.W.2.8 CC.2.MD.10	**Grade 1** CC.RI.1.1 CC.SL.1.2 CC.W.1.2 CC.1.MD.4 **Grade 3** CC.RI.3.1 CC.SL.3.1.c CC.W.3.4 CC.3.MD.3	Collaborating Communicating Conducting investigations Gathering information Using mathematics and computational skills
K-3 **Litter Walk** **I.A.2**	What's the difference between human-made and natural litter?	Identify human-made and natural objects Classify	**Kindergarten** CC.L.K.5a CC.SL.K.2 CC.W.K.2 **Grade 2** CC.L.2.5a CC.SL.2.2 CC.W.2.8	**Grade 1** CC.L.1.5a CC.SL.1.2 CC.W.1.8 **Grade 3** CC.L.3.5b CC.SL.3.3 CC.W.3.2a	Collaborating Communicating solutions Investigating Problem solving
K-3 **Too Much Packaging** **I.A.3**	Will eating one piece of gum affect the size of our trash pile?	Examination of over-packaging	**Kindergarten** CC.RI.K.1 CC.SL.K.1 CC.K.CC.5 **Grade 2** CC.RI.2.6 CC.SL.2.1 CC.2.MD.10	**Grade 1** CC.RI.1.1 CC.SL.1.2 CC.1.MD.4 **Grade 3** CC.RI.3.1 CC.SL.3.3 CC.3.MD.3	Collaborating Collecting data Communicating Problem solving Applying mathematical concepts
K-3 **What's Hazardous?** **I.A.4**	What does "toxic" mean?	Understand the meanings of: poison, toxic and hazardous waste Identify examples of poison,toxic and hazardous wastes and where they are found in the home	**Kindergarten** CC.RI.K.4 CC.SL.K.1 CC.W.K.2 **Grade 2** CC.RI.2.4 CC.SL.2.1 CC.W.2.2	**Grade 1** CC.RI.1.4 CC.SL.1.1 CC.W.1.2 **Grade 3** CC.RI.3.4 CC.SL.3.3 CC.W.3.2	Communicating Defining problems Gathering information Sharing research and writing

Lesson	Leading Question	Objective	Common Core Alignments		Skills
K-3 Machine I.B.1	Where do the things we use come from ?	Develop awareness of the natural origin of products we use Understand limited availability of some natural resources	**Kindergarten** CC.L.K.1.d CC.RI.K.3 CC.SL.K.2 **Grade 2** CC.L.2.5a CC.RI.2.1 CC.SL.2.3	**Grade 1** CC.L.1.6 CC.RI.1.3 CC.SL.1.2 **Grade 3** CC.L.3.5b CC.RI.3.7 CC.SL.3.3	Analyzing Asking questions Communicating Problem solving
K-3 Grandparents' Toys I.C.1	What kinds of toys are better for our environment?	Develop understanding of the amount of material consumed to make things Develop understanding of types of materials needed to make things Develop awareness of the impact of the things we make and the impact on solid waste	**Kindergarten** CC.SL.K.1 CC.SL.K.4 CC.W.K.8 **Grade 2** CC.SL.2.1 CC.SL.2.4 CC.W.2.8	**Grade 1** CC.SL.1.1 CC.SL.1.4 CC.W.1.8 **Grade 3** CC.SL.3.1 CC.SL.3.4 CC.W.3.4	Communicating Comparing multiple solutions Interviewing Sharing research and writing
K-3 Impressions with E.B. White I.C.2	What does "garbage " mean to you?	Define garbage and evaluate their first understanding of it Develop reasoning skills by looking for more productive alternative uses for garbage	**Kindergarten** CC.RL.K.1 CC.SL.K.1 CC.W.K.3 **Grade 2** CC.RL.2.1 CC.SL.2.1 CC.W.2.3	**Grade 1** CC.RL.1.1 CC.SL.1.1 CC.W.1.3 **Grade 3** CC.RL.3.1 CC.SL.3.3 CC.W.3.3	Analyzing Applying ideas to solve problems Communicating Predicting
K-3 Taking Trash Away II.A.1	Why do we take trash away? Where does it go? How does it get there ?	Understand the importance of trash removal Learn where trash is taken to and what happens to it	**Kindergarten** CC.RL.K.1 CC.SL.K.1 CC.W.K.8 CC.K.CC.5 **Grade 2** CC.RL.2.1 CC.SL.2.1 CC.W.2.8 CC.2.MD.10	**Grade 1** CC.RL.1.1 CC.SL.1.1 CC.W.1.8 CC.1.MD.3 **Grade 3** CC.RL.3.3 CC.SL.3.3 CC.W.3.4 CC.3.MD.3	Collaborating Collecting data Interviewing Sharing research and writing Applying mathematical concepts

Lesson Matrix Grade K-3

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Lesson Matrix Grade K-3

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Lesson	Leading Question	Objective	Common Core Alignments		Skills
K-3 **Come Back to Me** **II.A.2**	When we throw things away, where do they go?	Understand the problem society is having with proper placement of solid waste Understand that we need to find new solutions to solid waste that won't harm the environment	**Kindergarten** CC.RI.K.1 CC.RL.K.5 CC.SL.K.2 CC.W.K.2 **Grade 2** CC.RI.2.1 CC.RL.2.1 CC.SL.2.2 CC.W.2.8	**Grade 1** CC.RI.1.1 CC.RL.1.10 CC.SL.1.2 CC.W.1.2 **Grade 3** CC.RI.3.1 CC.RL.3.1 CC.SL.3.2 CC.W.3.4	Collaborating Communicating solutions Defining problems Problem solving
K-3 **Litter Garden** **II.A.3**	What happens to our trash after we throw it out?	Compare decomposition rates of different objects Develop an understanding of how littering impacts the environment	**Kindergarten** CC.RI.K.4 CC.SL.K.1 CC.W.K.8 **Grade 2** CC.RI.2.4 CC.SL.2.3 CC.W.2.8	**Grade 1** CC.RI.1.4 CC.SL.1.1 CC.W.1.8 **Grade 3** CC.RI.3.4 CC.SL.3.4 CC.W.3.7	Analyzing Developing models Investigating Sharing research and writing
K-3 **Egg Cartons** **III.A.1**	Is some packaging better than others?	Recognize that some products entering the waste stream are more harmful to the environment than others Develop an understanding that one can make a difference by carefully choosing what they use	**Kindergarten** CC.RI.K.4 CC.SL.K.1 CC.W.K.2 **Grade 2** CC.RI.2.4 CC.SL.2.3 CC.W.2.8	**Grade 1** CC.RI.1.4 CC.SL.1.1 CC.W.1.8 **Grade 3** CC.RI.3.1 CC.SL.3.3 CC.W.3.7	Collaborating Communicating solutions Inventing Researching
K-3 **Yesterday's Paper** **III.A.2**	What can we make with this box?	Recognize other uses for items we normally throw away Create a new purpose for something being thrown away	**Kindergarten** CC.RL.K.5 CC.SL.K.4 CC.W.K.2 **Grade 2** CC.RL.2.4 CC.SL.2.2 CC.W.2.1	**Grade 1** CC.RL.1.1 CC.SL.1.5 CC.W.1.2 **Grade 3** CC.RL.3.5 CC.SL.3.3 CC.W.3.2	Applying ideas to solve problems Collaborating Designing Sharing research and writing

Lesson Matrix Grade K-3

3R's of the Common Core

Lesson	Leading Question	Objective	Common Core Alignments		Skills
K-3 **Trash or Treasure?** **III.A.3**	Does everybody agree what might be trash and what might be treasure?	Develop understanding of waste as a resource Identifying what others consider trash Exploring trash and redefining it as a treasure	**Kindergarten** CC.RL.K.5 CC.W.K.2 CC.K.CC.5	**Grade 1** CC.RL.1.1 CC.W.1.2 CC.1.MD.2	Applying mathematical concepts Communicating Explaining Inventing
			Grade 2 CC.RL.2.4 CC.W.2.3 CC.2.MD.1	**Grade 3** CC.RL.3.5 CC.W.3.3 CC.3.MD.4	
K-3 **Cycles** **III.B.1**	What happens to things after we throw them out? What is their life cycle?	Trace the life cycle of a familiar object from production to disposal to develop an understanding of its disposal impacts on the earth Develop an understanding of the difference in disposing of an object and recycling it as a resource	**Kindergarten** CC.SL.K.1 CC.W.K.2 CC.K.CC.5	**Grade 1** CC.SL.1.1 CC.SL.1.5 CC.W.1.3	Collaborating Communicating Gathering information Predicting *Using mathematics (Kindergarten only)
			Grade 2 CC.SL.2.1 CC.SL.2.6 CC.W.2.8	**Grade 3** CC.SL.3.3 CC.SL.3.4 CC.W.3.3	
K-3 **What's Recyclable?** **III.B.2**	What objects can be recycled in your area?	Distinguish recyclable materials from non recyclable materials Understand how to prepare materials for recycling	**Kindergarten** CC.RI.K.1 CC.SL.K.1 CC.W.K.8	**Grade 1** CC.RI.1.1 CC.SL.1.1 CC.W.1.8	Analyzing Investigating Problem solving Sharing research and writing
			Grade 2 CC.RI.2.1 CC.SL.2.3 CC.W.2.8	**Grade 3** CC.RI.3.1 CC.SL.3.4 CC.W.3.7	
K-3 **Take Me Out to the Compost** **III.C.1**	How does composting work?	Understand the cycles of compost pile Learn the benefits of composting	**Kindergarten** CC.L.K.4 CC.RI.K.1 CC.W.K.2	**Grade 1** CC.L.1.5 CC.RI.1.2 CC.W.1.8	Communicating Explaining Researching Synthesizing
			Grade 2 CC.L.2.5 CC.RI.2.4 CC.W.2.8	**Grade 3** CC.L.3.5 CC.RI.3.2 CC.W.3.3 CC.W.3.6 CC.W.3.7	

What is in Our Solid Waste Stream?

Concept
Solid waste is everything we find useless and throw away.

Objective
Students will define solid waste, identify major components of the waste stream and begin to question their throw-away habits.

Method
Students will create a classroom trash bag.

Materials
Waste basket, typical trash items from the attached Garbage Bag Recipe, diagram of a landfill. Classroom activity: fish tank, clay, small rocks, plastic wrap, soil, chopped up trash

Subjects
Language Arts, Social Studies, Mathematics

Skills
Conducting investigations, gathering information, communicating, using mathematical and computational skills, collaborating

Time
One to two class periods, homework

Vocabulary
Trash/garbage, resource, waste, reuse, recycle, landfill

Resources
Current waste stream composition studies; Erika L. Shores, *How Garbage Gets from Trash Cans to Landfills (Here to There)*; Marlene Targ Brill, *Garbage Trucks (Pull Ahead Books)*; Barbara Odanaka, *Smash! Mash! Crash! There Goes the Trash!*

3R's of the Common Core
Parallel Activities
4-6, Litter Search
7-8, School Trash Analysis
Information
Components of the Waste Stream
Litter
Resources
General
Environmental Education and Educational Resources

Background

According to the EPA, approximately 70% of what we throw away still has a value and could be reused, recycled or composted. Diverting these resources from the waste stream begins with recognizing the resource potential of what we throw away each day. This activity sets the stage for many different lessons by creating a classroom prop you can use repeatedly.

Leading Question

What kinds of things do we throw away?

Procedure

1. Begin by examining the objects in the classroom trash can. Discuss the differences between trash in different places. What kinds of trash would be found in the cafeteria or in different rooms at home?
2. Cut up the attached list so that each student has only one or two items. Ask them to bring either the item itself or a drawing of the item pasted on cardboard to class the next day. Put all of the 'recipe' items into a clean garbage bag.
3. When all the components have been assembled, the garbage bag can be used for different lessons. The contents can be sorted and classified by different packaging types, objects with different resource bases, biodegradable or nonbiodegradable, made from renewable or nonrenewable resources, recyclable or reusable, etc. Count, categorize and compare numbers of 3 or more groups of garbage (e.g.: recycle, reuse, compost). Graph the results. What can they be recycled into? How could they be reused? Pick an item and draw and/or write to show how you can reuse the 'garbage' item.

Evaluation

- What is waste? (things we don't use/want anymore)
- What are resources? (things that we do use/need or value)
- Name one thing that is waste and one thing that is a resource.
- Name one thing that you throw away which could be a resource instead of waste.

Common Core Alignments

KINDERGARTEN

CC.RI.K.10
Reading Informational Text:
Range of Reading & Level of Text Complexity

CC.SL.K.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.K.2
Writing:
Text Types & Purposes

CC.K.MD.3
Mathematics:
Measurement & Data

GRADE 1

CC.RI.1.1
Reading Informational Text:
Key Ideas & Details

CC.SL.1.2
Speaking & Listening:
Comprehension & Collaboration

CC.W.1.2
Writing:
Text Type & Purposes

CC.1.MD.4
Mathematics:
Measurement & Data

GRADE 2

CC.RI.2.1
Reading Informational Text:
Key Ideas & Details

CC.SL.2.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.2.8
Writing:
Research to Build & Present Knowledge

CC.2.MD.10
Mathematics:
Measurement & Data

Classroom Activities

A. Who wants to go to the dump? Hand one trash object to each student and have all the students stand together in a group representing one large trash bag. The teacher can be the trash collector who will take the trash away. Show the diagram of a landfill. Describe what happens at a sanitary landfill and ask if anyone really wants to go to the dump. If not, they can be rescued by thinking of a way they can be reused or recycled. Try to save all the items of the trash bag by thinking of alternatives. Discuss ways to redesign products that cannot be recycled or reused. Continue until all the students have been rescued.

B. Make a trash can display showing typical breakdown of different types of trash, similar to the attached illustration. Use magazines cutouts for a collage and bring in real items.

C. Find magazine pictures of things that get thrown out after one use (or a short period of time) and things that last a long time. Make posters or a display of the two types. Compare each throw away object to the same object fifty or one hundred years ago.

Examples of Things Thrown Out After One Use (or Short Period of Time):

- Paper towel/napkin
- Paper grocery bag
- Disposable razor
- Plastic sandwich bag
- Plastic utensil
- Straw
- K-cups for coffee makers
- Dryer sheets
- Disposable diaper/wipe
- Plastic water bottle
- Pen

Examples of Things That Last a Long Time:

- Reusable water bottles
- Cloth napkins
- Canvas grocery bag
- Reusable sandwich/snack container
- Metal utensil
- Cloth diapers
- Clothes
- Books
- Tools

D. Have the children work together to create a sanitary landfill model or provide a teacher-created landfill model to be used throughout the lessons in this Guide. Have students examine the diagram of

GRADE 3

CC.RI.3.1
Reading Informational Text:
Key Ideas & Details

CC.SL.3.1c
Speaking & Listening:
Comprehension & Collaboration

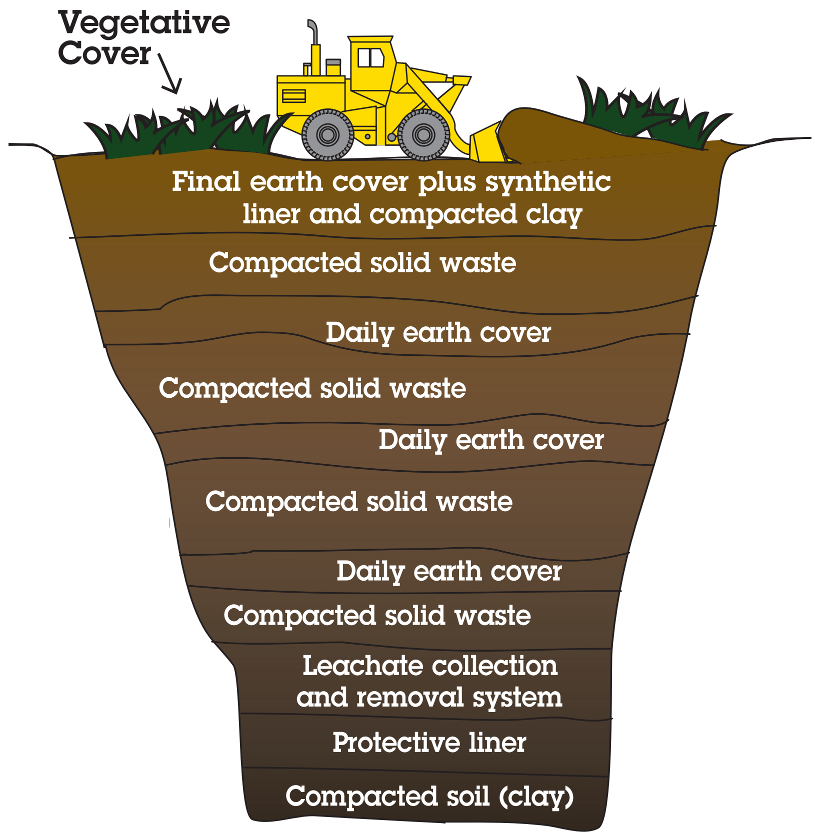
CC.W.3.4
Writing:
Production & Distribution of Writing

CC.3.MD.3
Mathematics:
Measurement & Data

a landfill below and then take turns adding items to a fish tank in layers. The fish tank is ideal because the children can see the contents.

E. As an alternative activity, build a 3-D model of a landfill using cereal boxes covered in construction paper labeled with a layer name. Stack the boxes horizontally.

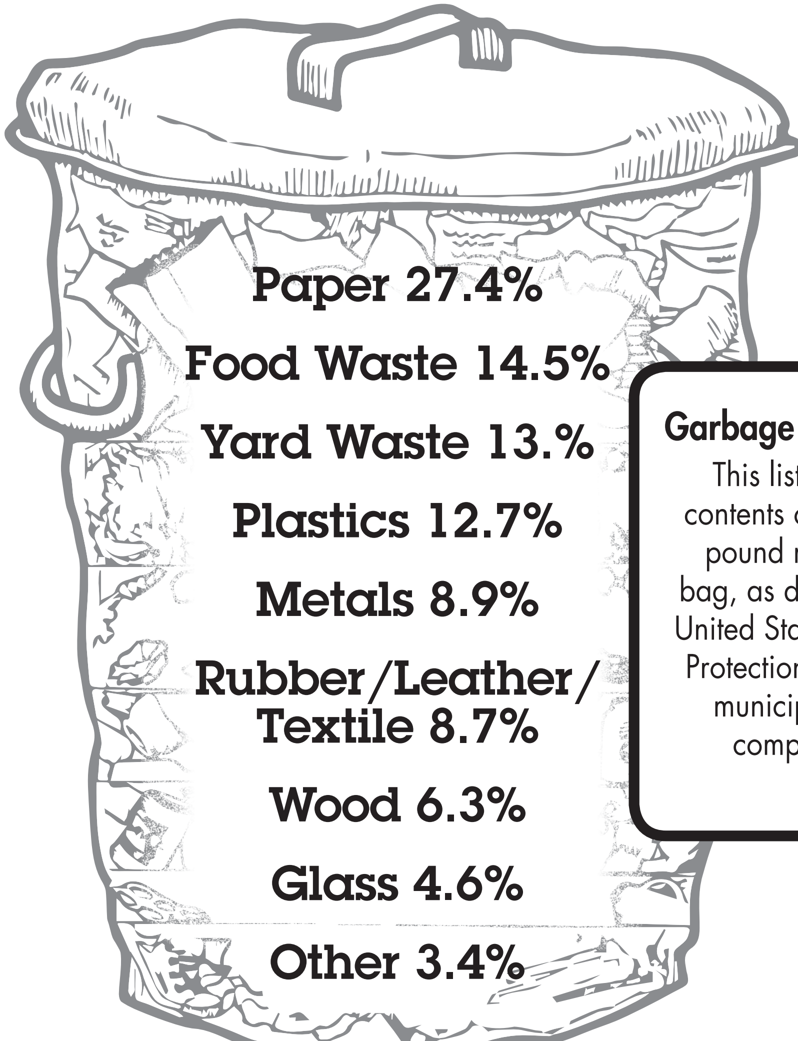
Cross Section of a Landfill



Reprinted from United States Environmental Protection Agency, "Landfills and Combustion," *Quest for Less: Activities and Resources for Teaching K-8*, EPA530-R-05-005 (Washington, D.C.: Government Printing Office, 2005), 165.

Trash Can Display

How can we save our resources from being landfilled?



Garbage Bag Ingredients

This list represents the contents of a typical three-pound residential trash bag, as determined by The United States Environmental Protection Agency's 2012 municipal solid waste composition study.

paper plate	glass jar	an old rag	six-pack ring
brown paper bag	aluminum can	egg carton	some junk mail
corrugated paper box	plastic fresh produce bag	Styrofoam cup	plastic detergent bottle
plastic film	newspaper	apple core	banana peel
some dead flowers	dead leaves/ branches	plastic container	milk container
juice container	fast food packaging	plastic milk jug	coffee grounds
disposable diaper	chicken bones	cereal box	

Name:_______________________________ Date: ____________________

Save these from the trash.

Draw a line from the trash object to its bag of recyclables

What is in Our Solid Waste Stream?

Concept
Solid waste can be classified as natural or human-made.

Objective
Students will identify natural and human-made objects while outside and will classify them as litter or not litter.

Method
The class will collect and classify local litter.

Materials
Brown lunch bags, local litter, used cardboard for displays or posters, ten natural objects and ten human-made objects

Subjects
Science, Language Arts

Skills
Collaborating, communicating solutions, investigating, problem solving

Time
One class period

Vocabulary
Natural, human-made, litter, waste

Resources
Lisa S. French, *The Terrible Trash Trail: Eco-Pig Stops Pollution*; Charlotte Guillain, *Cleaning up Litter (Help the Environment)*; Ann Zane Shanks, *About Garbage and Stuff;* Fulvio Testa, *Too Much Garbage;* Dare Wright, *Edith and Little Bear Lend a Hand;* Michelle Lord, *Nature Recycles, How About You*

3R's of the Common Core
Parallel Activities
7-8, Throwing it All Away
7-8, School Trash Analysis
Information
Components of Waste Stream
Resources
General
Environmental Education and Educational Resources

Background

When waste is disposed of improperly, it is called litter. Litter can be human-made objects such as plastic bags and paper cups. Litter can also be natural materials such as apple cores, fallen leaves or dead flowers. Whether an object is natural or human-made will have an effect on what we should do with it. Natural litter can include seed pods, leaves and torn branches all of which nourish and replenish natural systems if they are composted or left in the forest. Human-made litter needs to be sorted and disposed of in special ways. If done properly, this can save some of the natural resources that were used to make it.

Leading Question

What is the difference between human-made and natural litter?

Procedure

1. Write the words natural and human-made on the board. Ask each student to look around the room, name an object and tell whether it is natural or human-made.
2. Sorting and Classifying:
   - Assemble at least ten natural objects (e.g.: shell, pine cone, seed, tree branch or leaves, stone, moss, apple, bird's nest, piece of fur or hair, sand, earthworm, mulch, pine needles, antler, tooth, flower, egg) and ten human-made objects (e.g.: tape, key, plastic toy, shoe, sweater, pencil, envelope, can, glass bottle, candy wrapper, jewelry, button, clothes pin, crayon, stapler, ballpoint pen, desk calendar, spoon.)
   - Place the assortment on a table where all the students can see them easily. Be sure to include an approximately equal number of both human-made and natural objects.
   - Hold up each object and ask the students to say its name. Ask a few students to group the objects on the table by various characteristics such as color, size, hardness and softness, length.
   - Now ask students what natural and human-made mean. Explain that natural means all things made by nature that people or machines cannot make. Natural objects include: all living things, plants and animals and all non-living things such as rocks, dirt and sand. Human-made means anything in our world that people or machines do make.
   - Have students arrange the objects on the table into these two groups–natural objects and human-made objects.

Common Core Alignments

KINDERGARTEN

CC.L.K.5a
Language:
Vocabulary Acquisition & Use

CC.SL.K.2
Speaking & Listening:
Comprehension & Collaboration
CC.W.K.2
Writing:
Text Types & Purposes

GRADE 1

CC.L.1.5a
Language:
Vocabulary Acquisition & Use

CC.SL.1.2
Speaking & Listening:
Comprehension & Collaboration

CC.W.1.8
Writing:
Research to Build & Present Knowledge

GRADE 2

CC.L.2.5a
Language:
Vocabulary Acquisition & Use

CC.SL.2.2
Speaking & Listening:
Comprehension & Collaboration

CC.W.2.8
Writing:
Research to Build & Present Knowledge

GRADE 3

CC.L.3.5b
Language:
Vocabulary Acquisition & Use

CC.SL.3.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.3.2a
Writing:
Text Types & Purposes

3. Have the students make litter bags from brown lunch bags. They can decorate them for the litter walk and reuse them each time they collect litter or they can be recycled after the activity.
4. Take the class on a short walk around the school yard. Ask the students to name objects they see on the ground, sidewalk, street or road side and decide if they are natural or human-made. Where did each item come from? Does it belong on the ground? If not, where? If it is human-made, can it be recycled? Explain that when any object (human-made or natural) has been discarded improperly, it is called litter.
5. Pair students and have one student in each pair pick up an example of human-made litter and one pick up a sample of natural litter. Bring the class back and make posters or a display of natural and human-made litter from the collections of the class walk.
6. Ask the students to think of ways nature uses natural litter objects. (e.g.: Leaves replenish the soil, pine cones can be food for birds or squirrels and spread seeds.) How do people use the natural objects? Write and/or draw a picture of how people use natural objects. For older students write a 'how to use' recipe, informative text and/or create a poem about objects use in nature. (People can use natural items to make things and to decorate their homes, or add them to a compost pile for their gardens.) Think of a project (e.g.: compost, natural sculpture, build fairy houses) for the class to do with some of the natural litter.

Evaluation

What is litter? What kinds of litter are there? How should we dispose of the following kinds of litter? (list of examples)

Classroom Activities

A. Litter Box: Ask the custodian for a discarded cardboard box. Decorate it with pictures of nature and label it nature's litter. Label the trash can and recycle bin human-made litter. Ask the students to empty their litter bag contents into the appropriate container. Let them know that it is important to keep natural litter out of the trash because it is still useful to the earth. Make a trip out to the woods or somewhere where the natural litter can be disposed of where it will be of use to the earth and won't be litter.

B. Use the collected natural litter to begin a class compost. See 4-6, III.C. l, Mini Compost.

C. Make a litter garden to test decomposition rates of different litter. See K-3, II.A.3, Litter Garden.

D. Pictures, Book, or Game
- Ask students to draw two pictures - one with four human-made objects in it and the other with four natural objects in it.
- Introduce a book such as *Look Out for Litter* by Lisa Bullard ("Earth has a litter problem. How can you help? Join Trina to learn how little pieces of trash can become big problems. Find out safe ways to take care of litter. Do your part to be a planet protector!")

- Have children play the Dolphin game online at http://www.aplkids.org/dolphingame.html. The website describes it as a "short, interactive experience (designed for elementary school students) provides an overview of how our actions can affect animals in the ocean. It follows the story of a dolphin who has become sick from all of the litter that ends up in his home. It shows what students can do to clean up and prevent litter from polluting the oceans and keep the animals in the ocean happy and healthy."

E. More Classifying

Put a sign reading Natural Objects on one desk or table and a sign reading Human-made Objects on another. Ask each of five students to find a natural object in the classroom and place it on the Natural Objects desk. Do the same for the Human-made Objects desk. Discuss the characteristics of each group of objects. (For example, plants are one important type of natural object and plants are often green in color.) Have the students use their senses of touch, smell, sight and hearing, to help describe the characteristics of the objects. Help the class find any misplaced objects and group them correctly. Name some object not in the classroom. Ask a student to tell whether it is natural or human-made. Have students name other objects outside the classroom and ask other individuals to correctly classify their examples.

F. Feeling Game

Make a surprise box by cutting a fist-size hole in the side of a covered corrugated box. Decorate the outside of the box to increase the student's interest in it. Put several small natural and human-made items in the box. Change the items every few days. Ask the students to reach inside the box with their eyes closed. Tell them to pull out three natural objects and three human-made objects using their senses to identify them.

How Does Packaging Contribute to Waste?

Concept
Packaging is a major component of the waste stream.

Objective
Students will examine over-packaging.

Method
Students will unwrap and count gum wrappers and make posters.

Materials
Enough packages of gum or candy for each student to have one piece, construction paper, glue, examples of consumer products with lots of packaging (e.g. vegetables wrapped in cellophane on a Styrofoam tray; individual packages of crackers or chips; snack-sized applesauce cups, etc.), examples of items sold in bulk (e.g. family-size container of crackers; economy-sized jar of applesauce, etc.)

Subjects
Mathematics, Art, Social Studies, Language Arts

Skills
Applying mathematical concepts, collaborating, collecting data, communicating, problem solving

Time
One class period

Vocabulary
Packaging, composite, layers, natural resources, trash

Resources
Jan Berenstain, *The Berenstain Bears Go Green;* IKids, *Little Pirate: Why Do We Recycle;* Jen Green, *Why Should I Recycle?;* Anne Shanks, *All About Garbage;* Ellie Bethel, *Michael Recycle*

3R's of the Common Core
Parallel Activities
4-6, The Story of…
7-8, Potato Cakes
9-12, Packaging Preferences
Information
Components of the Waste Stream
Packaging
Resources
Green Consumption, Consumerism and Sustainable Development
Solid Waste and Recycling

Background

In 2012, packaging accounted for approximately 30% of the total solid waste generated in the United States. Packaging of some kind is necessary in many cases to protect food and keep it clean and free from contaminants, but composite and duplicate layers of packaging often add unnecessarily to the waste stream and are not recyclable. For instance, paper packaging coated with plastic or aluminum prevents it from ever being recycled. We are rarely aware of how much waste we produce, especially when we throw out one candy wrapper at a time, but lots of little pieces add up quickly to a surprisingly large amount. We can each help reduce the volume of solid waste plaguing our society by choosing products that produce less packaging and by choosing products with less composite packaging.

Leading Question

Do you think eating one piece of gum will have much effect on the size of our trash pile?

Procedure

1. Read and discuss the poem: *"How The Trash Pile Grows."* Do you think this is what we should do? Why? What does "Oh, no - where is 'away'" mean?
2. Divide students into groups with the same number of students as there are pieces of gum/candy per package. Pass out one package of different gum/candy to each group and ask them to carefully unwrap the gum/candy without tearing the wrappers.
3. Have each group create a poster by gluing all the wrappers and the packaging on a piece of construction paper. Glue wrappers in patterns, grouping them in fives or tens so they can be easily counted.
4. When the posters are finished, ask the students to guess how many wrappers there are and then to count them. As a class, figure out: if you chewed one pack of gum and/or candy a week, how many separate wrappers would you be adding to the waste stream each week? Each year? Make a picture and/or bar graph to show the data collected. Example: How many wrappers for one person, two people, etc. in a week, month, year. Use the graphs to answer questions such as "How many more wrappers are in the waste stream when you have additional people each week, month and year generating waste?"

Common Core Alignments

KINDERGARTEN

CC.RI.K.1
Reading Informational Text:
Key Ideas & Details

CC.SL.K.1
Speaking & Listening:
Comprehension & Collaboration

CC.K.CC.5
Mathematics:
Counting & Cardinality

GRADE 1

CC.RI.1.1
Reading Informational Text:
Key Ideas & Details

CC.SL.1.2
Speaking & Listening:
Comprehension & Collaboration

CC.1.MD.4
Mathematics:
Measurement & Data

GRADE 2

CC.RI.2.6
Reading Informational Text:
Craft & Structure

CC.SL.2.1
Speaking & Listening:
Comprehension & Collaboration

CC.2.MD.10
Mathematics:
Measurement & Data

GRADE 3

CC.RI.3.1
Reading Informational Text:
Key Ideas & Details

CC.SL.3.3
Speaking & Listening:
Comprehension & Collaboration

CC.3.MD.3
Mathematics:
Measurement & Data

5. Discuss the reasons why there are so many wrappers. Identify the possible purposes of each layer. Ask the students how they would package the gum. What are the reasons for their design choices?
6. Ask the students to identify the source of raw materials for packaging, such as the plastic, the aluminum foil, the paper. Discuss depletion of natural resources and possible ways to conserve these resources (e.g.: recycling, reusing, using less).
7. Ask the students to think of other items that their families buy that come in packages. What items have the most number of separate packaging pieces per package? (Consider individually wrapped sliced cheese, candy, crackers, single serving instant foods and beverages, etc.) If we reduce the amount of packaging, will we reduce the amount of trash? Brainstorm ways to reduce packaging. Once children have shared their ideas, show them examples of products with a lot of packaging versus the same object in bulk packaging. Encourage them to be aware of purchases and to help the adults they shop with to make good choices. How can you take applesauce to school if it is in a bulk jar? (Show a reusable container and a metal spoon.)

Evaluation

Students should be able to define recycling. Name two types of packaging which are difficult to recycle and two which are easy to recycle. How can you reduce the amount of packaging in your trash can?

Classroom Activities

A. Have students think of one thing they enjoy eating that uses a lot of packaging. And then, one thing that uses very little packaging. Can they choose to eat the kind that uses less? Does the same product come in different types of packaging so they can choose the least amount of packaging and still have their favorite food?

B. How long will the wrappers take to decompose? Bury a sample of each of the different wrappers in the ground. Check after one week, one month and six months. Also see: K-3, II.A.3, Litter Garden.

C. Try the attached Wrapping and Unwrapping Activity.

D. Compare and make displays of nature's packaging (orange rind, nutshell, banana, etc.) and people packaging (plastic wrap, aluminum foil, bubble wrap, etc.). Why is nature's packaging useful to the earth?

E. Visit a co-op and a grocery store and compare packaging.

F. Look for food products made from recycled materials. Write letters/ emails to companies thanking them for using recycled materials or asking them to use recycled packaging.

How Does Packaging Contribute to Waste?

"How the Trash Pile Grows"

Buy it,
try it,
throw the trash away!

Take it, break it,
throw the trash away!

Get it,
use it,
finish it, lose it.
Wear it, tear it,
throw the trash away!

Soda pop, box top,
once you start you can't stop.
Buy it,
show it,
nothing left but throw it:
Throw the trash away!

(Oh, no, where is "away"?)

Unwrapping and Unwrapping

(A 15 minute project)

Try this when someone in your family has come home from the store with lots of groceries.

1. Put an empty wastebasket near the table.
2. Now start unwrapping the groceries before you put them away.
3. Put every piece of wrapping in the waste basket, such as:
    - Cardboard boxes
    - Ice cream bags
    - Plastic bags
    - Paper bags
    - Cardboard cartons
4. Did you collect a wastebasket full of wrappings?
5. Do you think all those wrappings were really necessary?

Are There Hazardous Wastes in our Solid Waste?

Concept
Many household products are hazardous in the home and after They must be carefully separated from regular waste.

Objectives
Students will be able to define household hazardous waste, poison, toxic and identify examples of these products and places they are found.

Method
Students to study pictures of common household hazardous products and match pictures to places found.

Materials
Pictures of common household hazardous wastes, Mr. Yuk Stickers, magazines, hazardous materials containers examples and worksheet

Subjects
Science, Social Studies, Health, Language Arts

Skills
Communicating, defining problems, gathering information, sharing research and writing

Time
One class period

Vocabulary
Poison, toxic, household hazardous waste

Resources
Poison Control, Art and Creative Materials Institute; Stan Berenstain, *The Berenstain Bears Don't Pollute (Anymore)*; Melissa Stewart, National Geographic Readers: Water; Recycleman and the Dumpster Divers, *Household Hazardous Waste* (From the Album Every Day is Earth Day); Nuria Roca, *The Three R's: Reuse, Reduce, Recycle;* Sabbithry Persad, *Where Do Recyclable Materials Go?*

3R's of the Common Core
Parallel Activities
9-12, Toxic Waste in the Lab
Information
Components of the Waste Stream
Hazardous Materials
Packaging
Resources
Household Hazardous Waste

Background

Almost every home in the United States contains a number of hazardous chemicals stored in their garages, basements, bathrooms and kitchens. Oven and drain cleaners, auto cleaners and lubricants, paints, thinners, strippers and varnishes, bathroom cleaners, metal cleaners and polishes, pesticides, used motor oil and gasoline are just some of the items estimated to amount to the three to ten gallons of hazardous substances in the average home. These products range from poisonous and cancer-causing to flammable and corrosive; if not disposed of properly, they may contaminate groundwater, which supplies drinking water to 40-50% of Americans.

Leading Question

What does toxic mean?

Procedure

1. Discuss the meaning of the words poison, toxic and hazardous. Explain that many of the products we use every day are toxic and must be used and disposed of carefully.
2. Display different examples of household hazardous materials, explain why they are potential problems. Ask the students to identify some places these products might be found. Pictures or labels of rooms in a house posted on a bulletin board will aid students in classifying.
3. Students bring handout home to their families. Report on discussion with their parents.

Evaluation

Students should be able to name some toxic products they found in their homes that should not be placed with regular waste.

Classroom Activities

A. Students can make collages of household hazardous wastes from pictures found in housekeeping magazines and paste Mr. Yuk stickers to each of the objects/pictures in the collage.
B. Class could make a display of common toxic and non-toxic household products and identify the toxics with Mr. Yuk stickers.
C. Order enough Mr. Yuk stickers from Poison Control (based in Pittsburgh, PA) and available at http://www.upmc.com/Services/poison-center/Pages/store.aspx. Compose a class letter or write individual letters for parents telling what the class has learned and

Common Core Alignments

KINDERGARTEN

CC.RI.K.4
Reading Informational Text:
Craft & Structure

CC.SL.K.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.K.2
Writing:
Text Types & Purposes

GRADE 1

CC.RI.1.4
Reading Informational Text:
Craft & Structure

CC.SL.1.1
Speaking & Listening:
Comprehension & Collaboration
CC.W.1.2

Writing:
Text Types & Purposes

GRADE 2

CC.RI.2.4
Reading Informational Text:
Craft & Structure

CC.SL.2.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.2.2
Writing:
Text Types & Purposes

GRADE 3

CC.RI.3.4
Reading Informational Text:
Craft & Structure

CC.SL.3.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.3.2
Writing:
Text Types & Purposes

asking parents to help the student identify the hazardous products in their home with a Mr. Yuk sticker. The students could make a list of all the products in their home to bring back to class to discuss.

D. Take a survey of classroom art supplies to make sure you aren't using anything dangerous. Obtain a list of products authorized to bear the CP Certified Products Seal, the AP Approved Product Seal and the HL/NT Health Label/Non-Toxic Seal of the Art and Creative Materials Institute at http://www.acminet.org/. These products are certified in a program of toxicological evaluation by a medical expert to contain no materials in sufficient quantities to be toxic or injurious to humans or to cause acute or chronic health problems. You may want to reconsider using any products which are not on this list.

Name:____ **Date:** _______________________

Dear Family:

Today we learned that many of the products we use every day at home contain things that can make our water, earth and air dirty and could make us and other living things sick. Did you know that toilet bowl cleaner, furniture polish, flea powders, moth balls, drain openers, paints and varnishes, automobile oil and antifreeze, rug cleaners, rat poison, room deodorizers, oven cleaners, car and household batteries, bug and weed killers and even scouring powders and window cleaners can all be dangerous? If we left some of these products where babies or small students could reach them, they might get poisoned or burned. And if we throw them away improperly, they might hurt trash handlers or poison our environment.

For many years we didn't understand that these products might be dangerous. Many of our dumps have been filling up and contaminating our soil and water and air. But now state and regional solid waste districts and municipal transfer stations are working very hard to make sure that the places we send our trash in the future will be safe and clean. New landfills will be lined to keep toxics out of our soil. Leachate (the dirty water from landfills) will be collected and cleaned before it can get into our streams and wells. We can help.

Let's be careful to read labels and store, handle and use these products properly. Using less or using non-toxic alternatives is the best way to help keep our environment clean and disposing properly of products we already have is important! Let's call our solid waste district office or local transfer station at ________________ for more information on hazardous household waste collections in our area!

Where Does Solid Waste Come From?

Concept
The earth is the ultimate source of everything we make use or throw away.

Objective
Students will develop an awareness of the natural origins of many products and will realize the limited availability of natural resources.

Method
Students will pretend they are machines making objects.

Materials
4 bulletin boards, common objects or pictures from magazines (see bulletin board illustration), some recyclable objects and an end product that it could turn into (e.g. newspaper turns into a cereal box)

Subjects
Science, Language Arts

Skills
Analyzing, asking questions, communicating, problem solving

Time
One or more class periods

Vocabulary
Natural resources, machines, mineral, oil, source, nonrenewable resources

Resources
Alison Inches, *The Adventures of an Aluminum Can* (Little Green Books); Alison Inches, *The Adventures of a Plastic Bottle* (Little Green Books)

3R's of the Common Core
Parallel Activities
4-6, What Kind of Waste Am I?
7-8, Resource Protection Game
9-12, Nonrenewable Resources
Information
Waste and Natural Resources
Components of the Waste Stream
Resources
General
Solid Waste and Recycling

Leading Question
Where do the things we use come from?

Procedure
1. Illustrate the following bulletin board ideas showing the four natural resource categories of minerals/oil, minerals/rock, plants and animals and several products which are made from them. Using products from home or pictures cut from a magazine, have kids match the object to the correct resource. Set the bulletin boards up at stations around the room.
2. Set up a machine by draping a sheet over four chairs, two on each side with a crawl space between. Choose two students to play the roles of electricity and gas. When a student enters the machine, electricity and gas will make machine-like noises.
3. Assign the role of one of the four natural resources to each student. (For younger students, use only one of the resource categories at a time.) As each student comes to the back of the machine and is hidden from the class, the teacher hands the student a finished product made from the resource. The student enters the machine (which begins to make machine noises) and comes out holding the finished product, which is then deposited at the proper station.
4. After each student has gone through the machine, the class will discuss renewable and nonrenewable natural resources.
   a. Where does the oil and gas come from?
   b. Can we grow more oil?
   c. If we buried the plastic doll, would it go back to oil?
   d. Can we grow more trees? Animals? Minerals?
   e. What can we do to avoid using up all our resources?

Evaluation
What is the source of everything we use? What can we do to help save limited natural resources?

Common Core Alignments

KINDERGARTEN

CC.L.K.1d
Language:
Conventions of Standard English

CC.RI.K.3
Reading Informational Text:
Key Ideas & Details

CC.SL.K.2
Speaking & Listening:
Comprehension & Collaboration

GRADE 1

CC.L.1.6
Language:
Vocabulary Acquisition & Use

CC.RI.1.3
Reading Informational Text:
Key Ideas & Details

CC.SL.1.2
Speaking & Listening:
Comprehension & Collaboration

GRADE 2

CC.L.2.5a
Language:
Vocabulary Acquisition & Use

CC.RI.2.1
Reading Informational Text:
Key Ideas & Details

CC.SL.2.3
Speaking & Listening:
Comprehension & Collaboration

GRADE 3

CC.L.3.5b
Language:
Vocabulary Acquisition & Use

CC.RI.3.7
Reading Informational Text:
Integration of Knowledge & Ideas

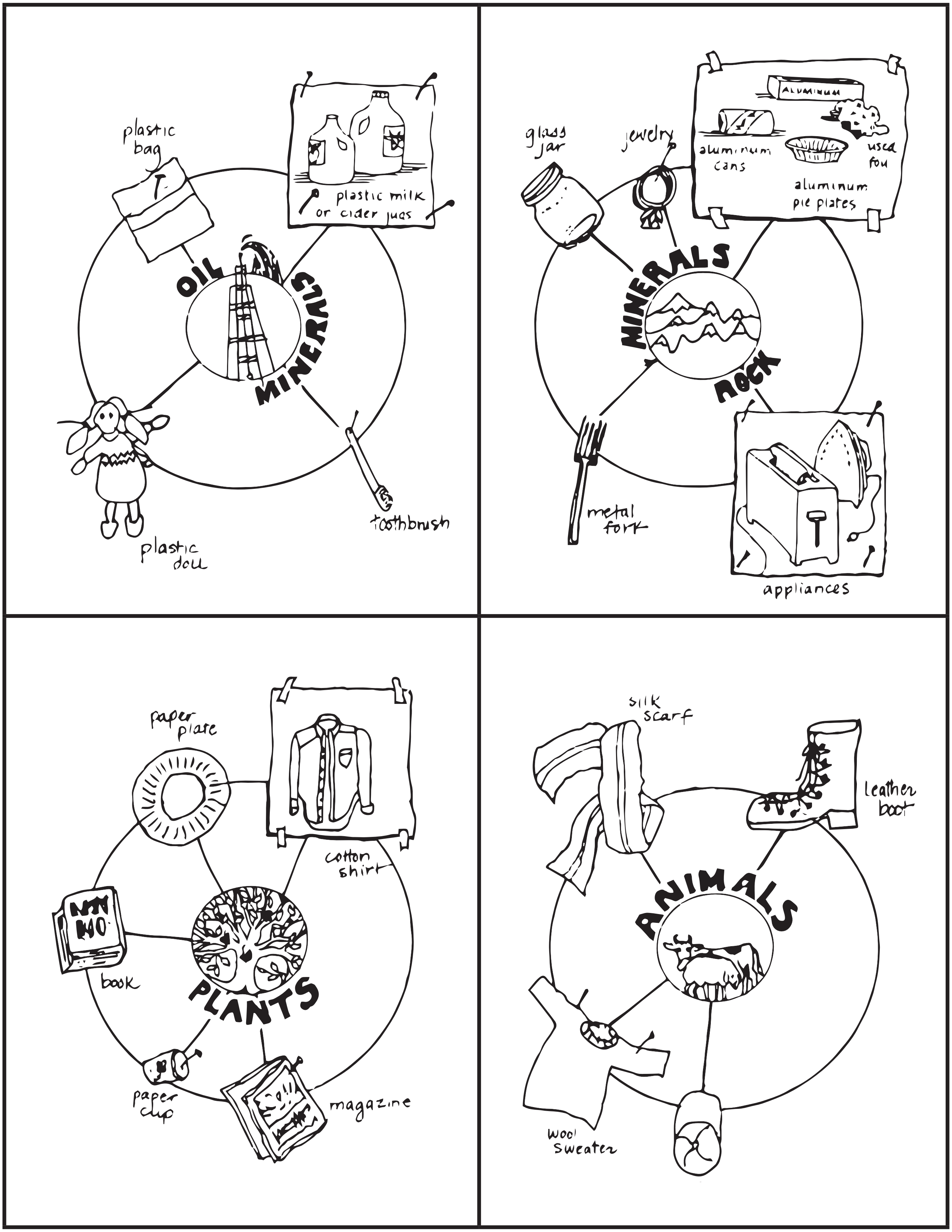
CC.SL.3.3
Speaking & Listening:
Comprehension & Collaboration

Classroom Activities

A. Show kids how natural resources can be recycled by taking finished products through the machine and recycling them into different new products. For example, a newspaper becomes a cereal box. A plastic soda bottle becomes a ski jacket.

B. Explain that there are three ways that we dispose of the things we don't want any more: we burn things, we put them into a landfill to be buried, or we reuse/recycle them. Give students small portions of clay. Ask students to make one object from each category of natural resource (see poster). When they are finished, have them put the clay objects into one of three boxes labelled BURN, BURY and REUSE/RECYCLE. Which objects did students choose to burn? Bury? Reuse or recycle? Discuss the similarities between the clay and our earth. How can we prolong the life of our earth and its resources?

Natural Resource Bulletin Board



How Has Solid Waste Changed Over Time?

Concept
Solid waste contains more mass produced objects & synthetic materials.

Objectives
Students will become familiar with changes in amount and types of materials used to make things and relate these changes to our solid waste disposal problems.

Method
Students interview older person

Materials
Pictures or examples of antique toys, children's favorite toys

Subjects
Language Arts, Social Studies

Skills
Comparing multiple solutions, communicating, interviewing, sharing research and writing

Time
One class period; outside class interviewing time; one class follow up.

Vocabulary
Plastic, natural materials, whirligigs

Resources
Books on making old-fashioned toys, local historical societies, antique shops, Children's' museums in your state.

3R's of the Common Core
Parallel Activities
4-6, Then and Now
7-8, Trash Timeline
9-12, The Dump Ground
Information
Waste and Society
Reuse Ideas
Resources
Environmental Education and Educational Resources
Green Consumption, Consumerism and Sustainable Development

Background

Toys have changed through the years. At one time, most were made of natural objects. Then they were made of papier-mache or were handmade toys like whirligigs, bean shooters, yo-yos, limberjacks and tops. Over time, commercially manufactured toys became available, like wooden Lincoln Logs and Tinkertoys and metal Erector Sets. Then plastic toys came on the market, such as toy guns, Frisbees, Hula-Hoops and plastic models. Now, battery-operated and electronic toys, pinball games, video games, cell phones and computers are popular.

Leading Question

Do you have a favorite toy at home?

Procedure

1. Have you ever had a favorite toy that didn't last very long? What happened to it? What was it made of? Have students bring in toys that are broken and might be thrown out. What are they made of? How long did they last? How would the students redesign the toys to last longer? How might these broken toys be fixed or made into new toys?
2. Ask them if they've seen any of their grandparents' or other old toys. Discuss the change in materials that toys are made from, how they are made, etc. Discuss toys made in other cultures and at other times in history. Examples of old-fashioned toys such as whirligigs or wooden blocks would be most helpful here. How are they different from modern toys? How are toys made in other cultures or at other times in history different from our toys?
3. Develop a list of questions with the students that they might ask an older person about old toys. Have the class write out the questions as a group or individually. Have them create /write their interview format. Questions might include: (1) What were your favorite toys when you were little? (2) How many toys did you have? (3) What were your toys made of? (4) Who made them? (5) How long did your toys last? (6) Could they be fixed if they broke? (7) Would it have been cheaper to fix the toy or get a new one? Why? (8) If broken toys could not be repaired, what did you do with them?
4. How are toys sold today different from those you had?
5. Have each student interview an older person at home or in the neighborhood, have an older person come to the class, or take a field trip to a nursing home or senior citizen center to interview people. Taping would allow the rest of class to learn and share. After

Common Core Alignments

KINDERGARTEN

CC.SL.K.1
Speaking & Listening:
Comprehension & Collaboration

CC.SL.K.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.K.8
Writing:
Research to Build & Present Knowledge

GRADE 1

CC.SL.1.1
Speaking & Listening:
Comprehension & Collaboration

CC.SL.1.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.1.8
Writing:
Research to Build & Present Knowledge

GRADE 2

CC.SL.2.1
Speaking & Listening:
Comprehension & Collaboration

CC.SL.2.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.2.8
Writing:
Research to Build & Present Knowledge

GRADE 3

CC.SL.3.1
Speaking & Listening:
Comprehension & Collaboration

CC.SL.3.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.3.4
Writing:
Production & Distribution of Writing

their interviews and research are completed the student can present their findings to the class. They can produce a written presentation and/or share the taped interview.

6. Discuss the differences discovered. How might these differences affect our natural resources and what we throw away? What has happened to the toys that our grandparents threw away? What will happen to our own toys when we throw them out?

Evaluation

What kinds of toys are better for our environment?

Classroom Activities

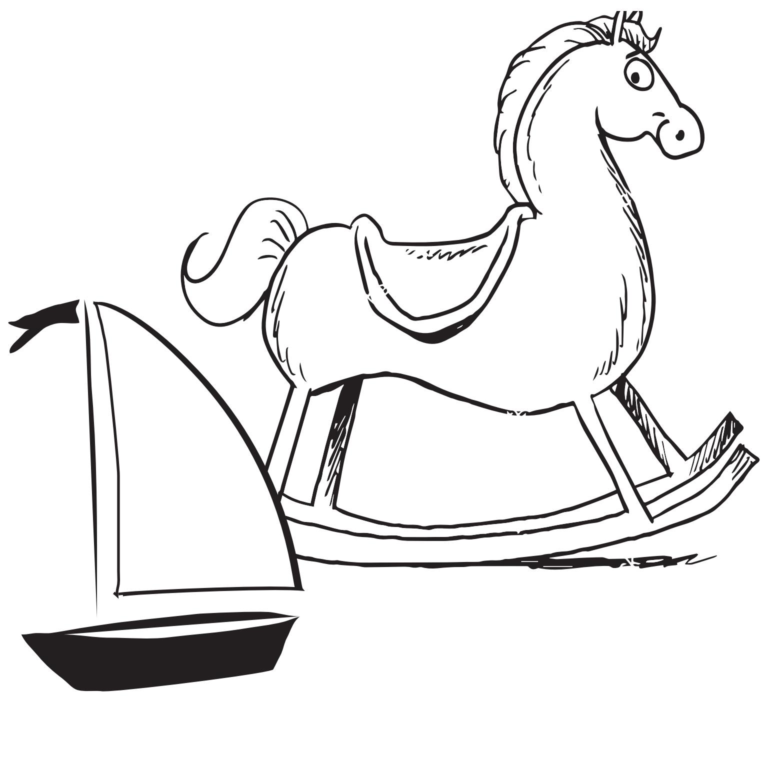
A. Take a field trip to a local museum, library or historical society to look at their old toys collection.

B. Find out how some of the old toys were made (e.g.: corn husk dolls, whirligigs) and make some in class.

C. Have each student choose and write a report about a toy that was popular in a different time and culture, such as a local Native American toy, Ancient Chinese toy, or Egyptian toy.

D. Have students design and make their own toy from natural objects. They can make one and give it to another student.

E. Make paper hats, boats, etc, from paper.



How Do Attitudes Affect Waste?

Concept
By redefining waste as a resource, we can help solve our solid waste problems.

Objectives
Students will listen and respond to excerpts from stories, will predict story outcome, will define garbage and evaluate their first impression of it and develop reasoning skills by looking for more productive alternatives.

Method
Students will listen to excerpts from E.B. White's *Charlotte's Web* and *Stuart Little.*

Materials
Copies of E.B. White's *Charlotte's Web* and *Stuart Little*, picture of Stuart, picture of Wilbur, Litter in a Lake Experiment Handout, copy of Lawrence Pringle, *Throwing Things Away*

Subjects
Language Arts, Social Studies

Skills
Analyzing, predicting, communicating, applying ideas to solve problems

Time
One class period

Vocabulary
Garbage, impression, redefine, misfortune, trough, scow

Resources
Lawrence Pringle, *Throwing Things Away*; garbage barge articles

3R's of the Common Core
Parallel Activities
4-6, Then and Now
7-8, Art Reflecting the Environment
9-12, Shopper Survey
9-12, GNP(P
Information
Waste and Society
Public Planning and Policy
Resources
Environmental Education and Educational Resources

Background

The terms waste and resource are relative and reflect our own needs and values rather than any objective quality of an object. How we feel about garbage will have a lot to do with how we take care of it. By redefining their view of the way waste created in making ice cream, Ben and Jerry's was recently able to alleviate a waste disposal problem as well as to provide a local farmer with pigs and a steady supply of food for them.

Leading Question

What do you think of when I say garbage?

Procedure

1. There will probably be a negative reaction. Explain that the class is going to read about someone who probably feels the same way they do about trash. Show the book *Stuart Little*. Show a picture of Stuart. Stuart Little is a mouse who lives in the city and is always getting into trouble. This is about one of Stuart's misfortunes, when he accidentally gets caught in a garbage can. Read the following quote from *Stuart Little*:

   "The men threw the can with a loud bump into the truck, where another man grabbed it, turned it upside down and shook everything out. Stuart landed on his head, buried two feet deep in wet slippery garbage. All around him was garbage, smelling strong. Under him, over him, on all four sides of him–garbage. Just an enormous world of garbage and trash and smell. It was a messy spot to be in. He had egg on his trousers, butter on his cap, gravy on his shirt, orange pulp in his ear and banana peel wrapped around his waist.

   Still hanging on to his skates, Stuart tried to make his way up to the surface of the garbage, but the footing was bad. He climbed a pile of coffee grounds, but near the top the grounds gave way under him and he slid down and landed in a pool of leftover rice pudding. 'I bet I'm going to be sick to my stomach before I get out of this,' said Stuart."

2. Discuss how Stuart felt about garbage. Why didn't he like it? How do you know? What evidence from the text helped you determine that Stuart did not like garbage? Explain that what was unpleasant for Stuart, might be enjoyable for someone else. Show

the book *Charlotte's Web*. Show a picture of Wilbur. Wilbur is a pig who lives on a farm. Lurvy works at the farm feeding the animals. Read the following quote from *Charlotte's Web*:

"Lurvy dragged Wilbur's trough across the yard and kicked some dirt into the rat's nest burying the broken egg and all Templeton's other possessions. Then he picked up the pail. Wilbur stood in the trough drooling with hunger. Lurvy poured. The slops ran creamily down around the pig's eyes and ears. Wilbur grunted. He gulped and sucked and gulped, making swishing and swooshing noises, anxious to get everything at once. It was a delicious meal: skim milk, wheat middlings, leftover pancakes, half a doughnut, the rind of a summer squash, two pieces of stale toast, a third of a gingersnap, a fish tail, one orange peel, several noodles from a noodle soup, the scum off a cup of cocoa, an ancient jelly roll, a strip of paper from the lining of the garbage pail and a spoonful of raspberry Jello."

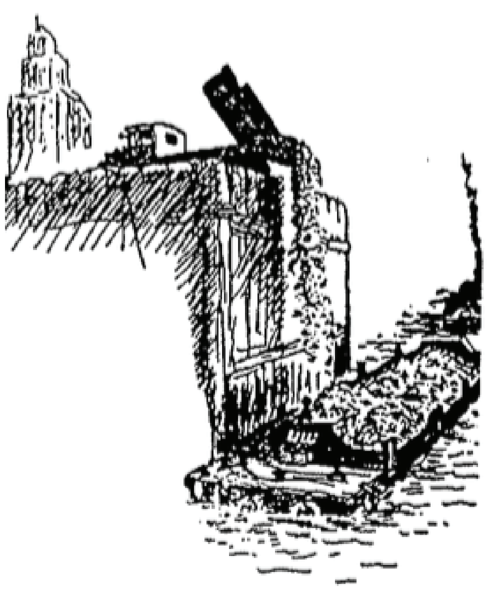
How did Wilbur feel about garbage? How do you know? What evidence from the text helped you determine that Wilbur liked garbage? Point out that Wilbur's garbage was useful and not wasted. Our own garbage can also be a resource. Brainstorm possibilities, including composting, pet pigs, tree houses out of construction debris, fixing broken toys, etc.

3. Bring the students back to *Stuart Little* to find out what happens to him.

"There was no way for him to get out of the truck, the sides were too high. He just had to wait. When the truck arrived at the East River, the driver drove out onto the pier, backed up to a garbage scow and dumped his load. Stuart went crashing and slithering along with everything else and hit his head so hard he fainted and lay quite still, as though dead. He lay that way for almost an hour and when he recovered his senses, he looked about him and saw nothing but water.

The scow was being towed out to sea. 'Well,' thought Stuart, 'this is about the worst thing that could happen to anybody. I guess this will be my last ride in this world.' For he knew that the garbage would be towed twenty miles out and dumped into the Atlantic Ocean."

4. Discuss what happens not only to Stuart but to all the garbage. Are they really going to dump it in the ocean? What effect will this have on the water and the creatures living in it? Brainstorm positive alternatives which would treat garbage as a resource like in Charlotte's Web.



Garth Williams, 1973

Evaluation

Have students write and illustrate their own ending to Stuart's story. What does it mean to redefine waste? How can redefining waste as a resource help solve our solid waste problems? What are our solid waste problems?

Classroom Activities

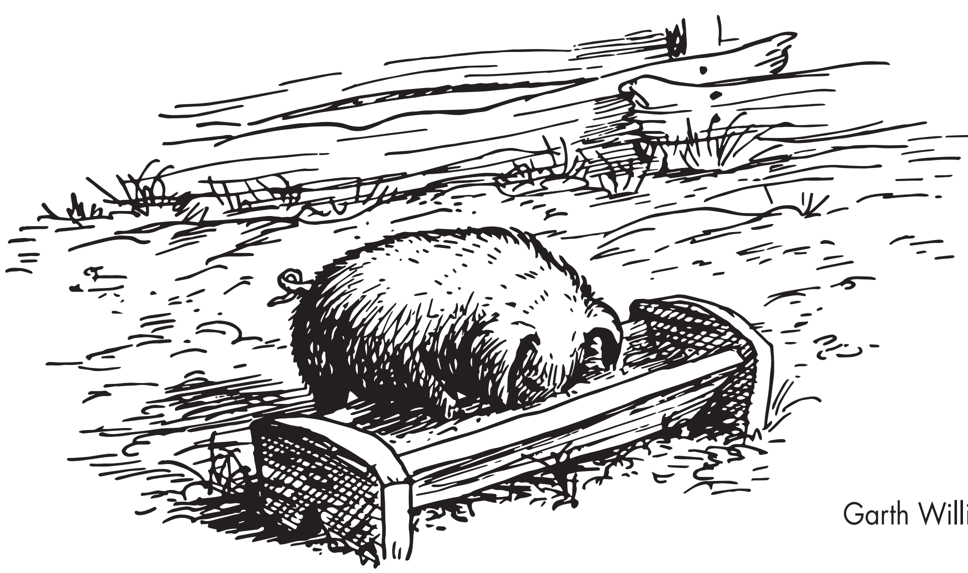
A. Explore the different interactions between animals and garbage. What effect does human waste disposal have on animals? Consider skunks, bears, polar bears, raccoons, rats, seagulls, etc. (Read Lawrence Pringle)

B. Write your own adventure story about an animal and solid waste.

C. Do the Litter in a Lake Experiment Handout. (K-3, II.A.2, Come Back to Me)

D. Start a class compost.

   - See K-3, III.C.l, Take Me Out To The Compost
   - 4-6, III.C.l., Mini Compost



Garth Williams, 1980

Where Does Waste Go?

Concept
Trash has to go somewhere and there are limited disposal options.

Objective
Students will recognize the importance of taking trash away and learn where their trash goes.

Method
Students interview school custodians and trash collectors, observe trash removal and create a mural depicting waste collection and disposal.

Materials
Large roll of mural paper, drawing materials, a few trash samples, Shel Silverstein, *Where the Sidewalk Ends*

Subjects
Language Arts, Science, Social Studies, Art, Mathematics

Skills
Collecting data, collaborating, interviewing, sharing research and writing, applying mathematical concepts

Time
One prep class to develop questions, a class period to interview, a class follow-up activity.

Vocabulary
Trash, garbage, trash hauler

Resources
Local waste haulers, school custodian;
Patricia Lauber, *Too Much Garbage*;
Paul Showers, *Where Does the Garbage Go?*;
Sabbithry Persad, *Where Do Recyclable Materials Go?*

3R's of Common Core
Parallel Activities
K-3, Come Back to Me
4-6, Hauling it Away
7-8, Trash Haulers
Information
Transportation and Processing
Resources
General

Leading Questions

Why do we have to take the trash away? Where does it go?

Procedure

1. Read and discuss the attached poem, "Sarah Cynthia Sylvia Stout" by Shel Silverstein. What do you think happened to Sarah Cynthia Sylvia? Why is it important to take the garbage out? Once it's out, where does it go?
2. Invite the school custodian to class and ask him about his/her trash removing duties: How much of his/her day is devoted to removing trash? Where does he/she take it? How often is it picked up? What is most of the trash composed of? How much do we throw out each week? (Ask the custodian to draw a picture of a trash bag; one picture for each bag thrown away every day.) Ask students to count the bags to determine the weekly trash amount. What does it cost to throw it out? Students will take notes on the interview answers to assist them in writing /drawing about it for the mural and bulletin board in step 4.
3. Arrange a short interview with the school's trash hauler for the next time they are scheduled for a pick up. When the trash truck comes, have the class watch the removal process. Then ask the trash collector about his/her business and take notes of the interview.

   Questions to ask:
   (1) When do you start working in the morning and finish at night?
   (2) How many truckloads of trash do you collect each day?
   (3) Why is your truck designed the way it is and how does it work?
   (4) How many houses and or businesses do you collect from?
   (5) How many miles do you drive each day?
   (6) Do you ever pick up recyclables separately? Why/why not?
   (7) Where do you take the trash? What happens to it then?
4. On the basis of the interviews, have the class construct a mural depicting all the stages in creation, collection and disposal of waste. Students will add specific facts learned in the interviews and display the mural in the school to teach others. Students should label the mural with clocks telling time, totals of trash amounts collected, miles driven each day, etc.

Common Core Alignments

KINDERGARTEN

CC.RL.K.1
Reading Literature: Key Ideas & Details
CC.SL.K.1
Speaking & Listening: Comprehension & Collaboration
CC.W.K.8
Writing: Research to Build & Present Knowledge
CC.K.CC.5
Mathematics:Counting & Cardinality

GRADE 1

CC.RL.1.1
Reading Literature: Key Ideas & Details
CC.SL.1.1
Speaking & Listening:
Comprehension & Collaboration
CC.W.1.8
Writing: Research to Build & Present Knowledge
CC.1.MD.3
Mathematics: Measurement & Data

GRADE 2

CC.RL.2.1
Reading Literature: Key Ideas & Details
CC.SL.2.1
Speaking & Listening:
Comprehension & Collaboration
CC.W.2.8
Writing: Research to Build & Present Knowledge
CC.2.MD.10
Mathematics:
Measurement & Data

GRADE 3

CC.RL.3.3
Reading Literature:
Key Ideas & Details
CC.SL.3.3
Speaking & Listening:
Comprehension & Collaboration
CC.W.3.4
Writing: Production & Distribution of Writing
CC.3.MD.3
Mathematics: Measurement & Data

5. Count the hours that the custodians and/or the trash haulers work or count how many bags of trash are collected. Older students can graph their findings of how much trash, recycling, reuse is collected each day. Does it vary on some days? Create other graphs to be used with the data collected.

Evaluation

Why are trash haulers so important? Where do they take our trash?

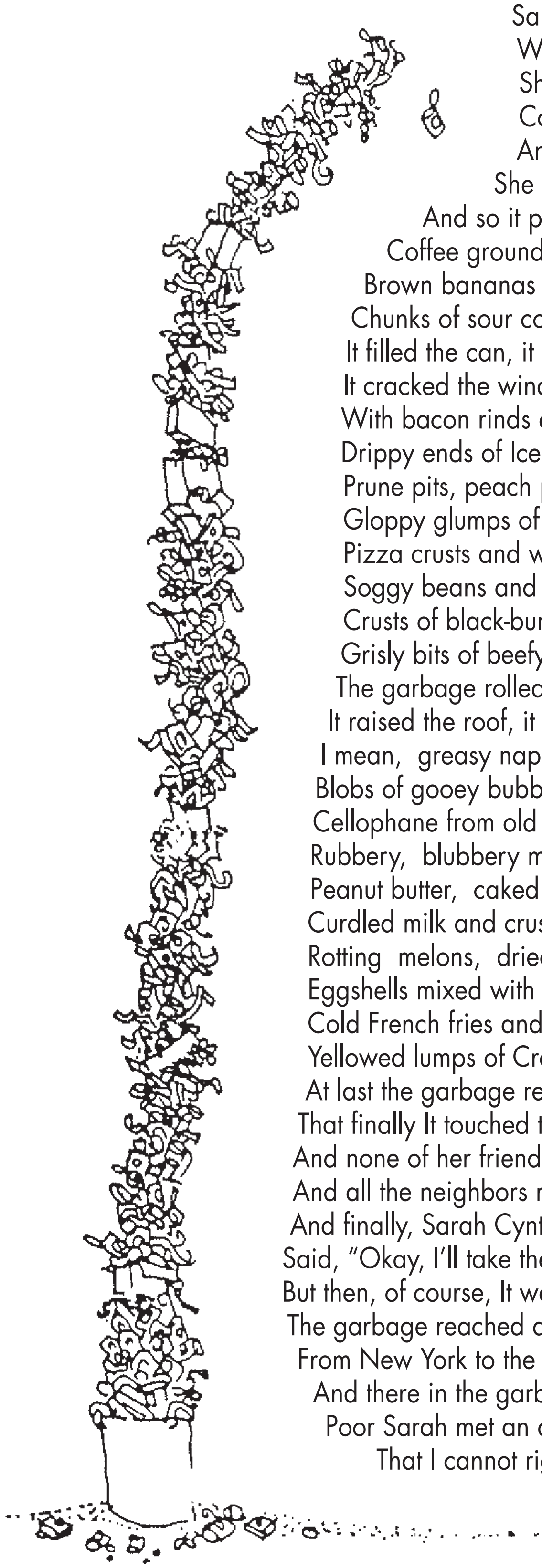
Classroom Activities

A. Take a field trip to a landfill.

B. Have students conduct similar survey/interviews at home or with kitchen staff at school.

C. Determine costs for waste disposal for the school for a year. Determine how much paper and/or organic wastes the school produces and devise a recycling or composting program which will help the school save money.

"SARAH CYNTHIA SYLVIA STOUT" *by Shel Silverstein*



Sarah Cynthia Sylvia Stout
Would not take the garbage out,
She'd wash the dishes and scrub the pans
Cook the yams and spice the hams,
And though her parents would scream and shout,
She simply would not take the garbage out.
And so it piled up to the ceiling:
Coffee grounds, potato peelings,
Brown bananas and rotten peas,
Chunks of sour cottage cheese.
It filled the can, it covered the floor,
It cracked the windows and blocked the door,
With bacon rinds and chicken bones,
Drippy ends of Ice cream cones,
Prune pits, peach pits, orange peel,
Gloppy glumps of cold oatmeal,
Pizza crusts and withered greens,
Soggy beans and tangerines,
Crusts of black-burned buttered toast,
Grisly bits of beefy roast.
The garbage rolled on down the halls,
It raised the roof, it broke the walls,
I mean, greasy napkins, cookie crumbs,
Blobs of gooey bubble gum,
Cellophane from old bologna,
Rubbery, blubbery macaroni,
Peanut butter, caked and dry,
Curdled milk and crusts of pie,
Rotting melons, dried-up mustard,
Eggshells mixed with lemon custard,
Cold French fries and rancid meat,
Yellowed lumps of Cream of Wheat.
At last the garbage reached so high
That finally It touched the sky,
And none of her friends would come to play,
And all the neighbors moved away;
And finally, Sarah Cynthia Stout
Said, "Okay, I'll take the garbage out!"
But then, of course, It was too late,
The garbage reached across the state,
From New York to the Golden Gate;
And there in the garbage she did hate
Poor Sarah met an awful fate
That I cannot right now relate
Because the hour is much too late
But students, remember Sarah Stout
And always take the garbage out.

Shel Silverstein, 1974

Where Will Our Trash Go?

Concept
Nowhere is away.

Objective
Students will understand the problem society is having with proper placement of solid waste and that nowhere is away. Students will recognize the importance of taking trash away.

Method
Students will sing a song and discuss its meaning.

Materials
Chart with words of song on it, copies of poems, lab sheet, computer and screen to show YouTube video

Subjects
Music, Language Arts, Science, Social Studies

Skills
Collaborating, communicating solutions, defining problems, problem solving

Time
35-40 minutes

Vocabulary
Pollution, solid waste, garbage

Resources
Landfill and dump YouTube videos

3R's of the Common Core
Parallel Activities
K-3, Taking Trash Away
4-6, Hauling it Away
9-12, Trash Haulers
Information
Transportation/Processing
Landfills
Resources
General

Background

Because landfill space is becoming scarce in all communities and disposal costs are rising, people need to find new solutions which won't harm the environment. Some people believe that the ocean is big enough to handle the garbage without polluting it. People are now discovering that this is not true, that 'nowhere is away' and they must find other ways to dispose of their waste.
Leading question
When we throw things away, where do they go?

Procedure

1. Sing this song with your class to the tune of "My Bonnie Lies Over the Ocean."

   "My Garbage Floats In the Ocean"

   "My garbage floats in the oceans,
   My garbage floats in the sea,
   My garbage floats in the ocean,
   My garbage comes back to me.
   Come back, come back, my garbage to me…"

2. Afterwards, discuss with them how communities are running out of landfill space. Brainstorm solutions. Students will write and/or draw their solutions to be put up on a Solutions to Pollution bulletin board.

Evaluation

In what ways does the garbage come back? How can these communities solve their landfill space problem?

Extensions

A. Discuss the issue of garbage on barges looking for a place to go.

B. Take the class out to a lake or river shore and look for litter. Identify types.

C. Read and discuss the attached poems, written by Betty Miles, *Save the Earth: An Ecology Handbook for Kids,* "Everywhere is Somewhere" and "The Dirty Water Blues."

D. Do the following Litter in a Lake experiment.

E. Take a field trip to a waste treatment and water treatment plant.

Common Core Alignments

KINDERGARTEN

CC.RI.K.1
Reading Informational Text:
Key Ideas & Details
CC.RL.K.5
Reading Literature:
Craft & Structure
CC.SL.K.2
Speaking & Listening:
Comprehension & Collaboration
CC.W.K.2
Writing:
Text Types & Purposes

GRADE 1

CC.RI.1.1
Reading Informational Text:
Key Ideas & Details
CC.RL.1.10
Reading Literature:
Range of Reading & Level of Text Complexity
CC.SL.1.2
Speaking & Listening:
Comprehension & Collaboration
CC.W.1.2
Writing:
Text Types & Purposes

GRADE 2

CC.RI.2.1
Reading Informational Text:
Key Ideas & Details
CC.RL.2.1
Reading Literature:
Key Ideas & Details
CC.SL.2.2

GRADE 3

CC.RI.3.1
Reading Informational Text:
Key Ideas & Details
CC.RL.3.1
Reading Literature:
Key Ideas & Details
CC.SL.3.2
Speaking & Listening:
Comprehension & Collaboration
CC.W.3.4
Writing:
Production & Distribution of Writing

The Dirty Water Blues

Pure water gurgles
and splashes along
until pollution
flows into the song:
oil,
tar,
paint,
dye,
mud and muck
come splashing by.
Cans,
jars,
bottles,
cars.
Old shoes, old news -
that's the dirty water blues.
Sweet, fresh water
rolls away from this song,
while dirt and pollution
keep flowing along
and along,
and along…

Claire A. Nivola, 1974

Everywhere Is Somewhere

When you rinse garbage down the drain of a sink
or flush trash down the toilet,
it does not go away;
it goes somewhere.
Sewage and waste go into big pipes.
The pipes go into the river;
The river runs into a bigger river.
The big river flows to the sea.

Far, far away
in the middle of the ocean,
garbage and trash float on the sea water.
Pollution does not float away;
it floats somewhere.
And it will stay there,
floating and sinking under the sun
for years and years.

When you rinse something down the drain,
it does not go away –
it goes somewhere.
In the water, everywhere is somewhere.

Claire A. Nivola, 1974

Name:____ Date: ______________________

Litter in a Lake Experiment

Materials Needed

- One large glass jar
- Small pieces of typical litter items such as fruit peeling
- Iron
- Glass
- Paper
- Plastic wrap
- Styrofoam
- Aluminum
- Lid from a tin can
- Fabric

Directions

1. Fill the glass jar with water and add the litter ingredients. Let stand and observe every day for two weeks.

2. What happened to the water?

3. What happened to the pieces of litter?

4. Would you want to swim in water like that? Why or why not?

5. What might happen to plants and animals who lived in the water?

6. Is the ocean big enough to take all our garbage without poisoning the creatures who live in it?

Why is Litter a Problem?

Concept
Littering, decomposition, human made and natural objects.

Objectives
Students will compare decomposition rates of different objects and discuss the effects of littering on the environment.

Method
Students will place objects in soil, add water and record results over time.

Materials
Two 6" deep waterproof trays; small pieces of several different solid waste test samples (e.g.: glass, rubber band, paper, wool, nylon); soil (not potting soil); water spray bottle; lab sheet

Subject
Science, Language Arts

Skills
Analyzing, developing models, investigating, sharing research and writing

Time
40 minutes to start, 40 minutes at end, minutes each day in between 2 months.

Vocabulary
Decomposition, litter, natural, human-made, environment, biodegradable

Resources
Enduring Litter handout (Information chapter, section II); Dare Wright, *Edith and Little Bear Lend A Hand;* Norah Smaridge, *The Dead Tree;* Mary McKenna Siddals, *Compost Stew: An A to Z Recipe for the Earth*

3R's of the Common Core
Parallel Activities
4-6, Landfills
7-8, Mini-Landfills
9-12, New Landfills
Information
Litter
Landfills
Resources
General
Solid Waste and Recycling Waste Management Agencies by State

Background

Much of the packaging we use today, though convenient and useful for a very short time, causes environmental problems because it is not biodegradable. Nature cannot break it down or use it again and some substances poison the environment. The varying decomposition rates of human-made and natural materials are highly visible in litter. By taking a closer look at what comprises our litter stream we can begin to understand and change some harmful producing, using and disposal habits.

Leading Question

What happens to our trash after we throw it out?

Procedure

1. Collect samples of litter. Review the concept of decomposition and the difference between natural and human-made material (See K-3, I.A.2, Litter Walk). Discuss littering and decomposition. Which kinds of materials do you think will decompose and which will not? Make predictions. Students can complete the worksheet. They will write and/or draw their predictions.
2. Add a two-inch layer of soil. Arrange the samples leaving room between each one. Put a marker in the soil identifying what is in each spot. Cover the samples with two more inches of soil and sprinkle with enough water to make it moist. Add a little water daily.
3. Uncover the samples periodically and record what has happened to each one. Discuss the results over a two-month period.

Option: Bury natural materials in one box and human-made in another. When the experiment is finished the two containers of soil can be used to grow seeds. Is there a difference in the rate of growth?

Common Core Alignments

KINDERGARTEN

CC.RI.K.4
Reading Informational Text:
Craft & Structure

CC.SL.K.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.K.8
Writing: Research to Build & Present Knowledge

GRADE 1

CC.RI.1.4
Reading Informational Text:
Craft & Structure

CC.SL.1.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.1.8
Writing: Research to Build & Present Knowledge

GRADE 2

CC.RI.2.4
Reading Informational Text:
Craft & Structure

CC.SL.2.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.2.8
Writing: Research to Build & Present Knowledge

GRADE 3

CC.RI.3.4
Reading Informational Text:
Craft & Structure

CC.SL.3.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.3.7
Writing: Research to Build & Present Knowledge

Evaluation

How are the results important to how we handle waste? Were the predictions accurate? What does this teach us about littering? What about landfills?

Classroom Activities

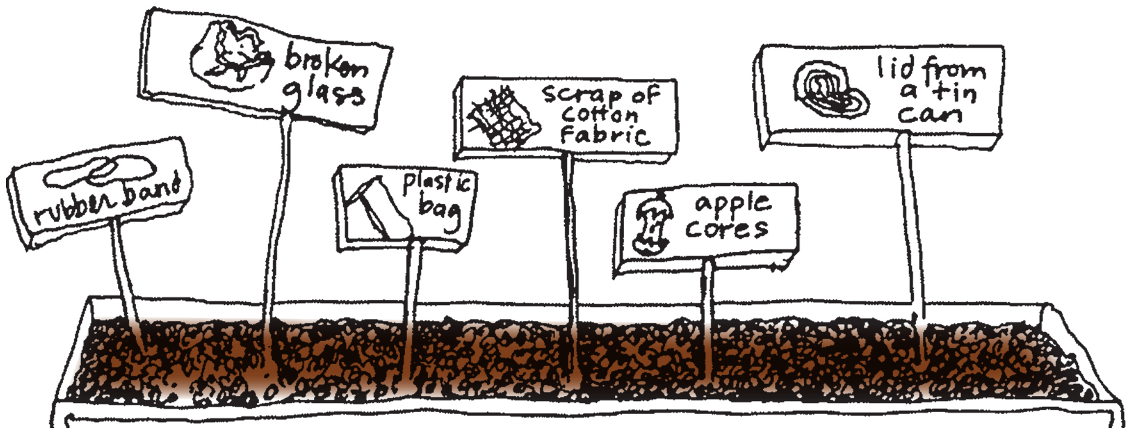
A. Discuss decomposition at landfills.

B. Create a class compost and use both compost material and litter garden soil to make a real garden. Test the effects of the different soils on plant growth.

C. Make a time-line or bar graph with student drawings of decomposition rates.

D. Draw pictures of different litter objects; sequence with numbers which will decompose first.

Name:______________________________________ **Date:** ____________________



1. Which objects do you think will decompose first?

2. Which will take the longest to decompose?

3. Which might never decompose?

4. Which will be the best for the soil?

5. Which might harm the soil?

How Can We Revise Our Habits to Waste Less?

Concept
Some packaging is better for the environment than others.

Objectives
Students will recognize that certain products entering the waste stream are more harmful to the environment than others and that they can make a difference by carefully choosing what they use.

Method
Students will compare Styrofoam and paper egg cartons and will reuse both items in craft projects.

Subjects
Art, Social Studies, Health, Language Arts

Skills
Communicating solutions, researching, inventing, collaborating

Time
One class period

Vocabulary
Choice, reusable, recyclable, environment, Styrofoam, petroleum

Resources
Carolyn Jabs, *RE/USES*; Anna Alter, *What Can You Do with an Old Red Shoe?: A Green Activity Book About Reuse;* Kevin Henkes, *Lilly's Purple Plastic Purse;* Mary Solomon, *Recycle, Reuse, Renew: Upcycle with DIY Crafts*; Nuria Roca, *The Three R's: Reuse, Reduce, Recycle*

3R's of the Common Core
Parallel Activities
4-6, Pondering Packaging
7-8, Packaging Design
Information
Components of the Waste Stream
Packaging
Redesign and Reuse
Resources
Solid Waste and Recycling

Background

Paper egg cartons are made from waste paper which is turned back into pulp and formed into the new egg carton shape. Styrofoam egg cartons are made from nonrenewable fossil fuels. Styrofoam is a trade name for polystyrene, which is used to make insulated disposable cups, housewares, fast food containers and packing material. It is not easily recycled, most of it ending up in our landfills, along roadsides or waterways. Many cities such as Seattle, San Francisco, Portland OR and Amherst MA have enacted polystyrene bans. As of 2016, California is considering a statewide ban. However, despite the difficulty of recycling this material, recycling rates for this product have improved greatly since the 1980s and 1990s. In 2007, 65 million pounds of polystyrene were recycled and in 2008 that number rose to 69 million pounds. When we use and throw out plastic we waste the valuable petroleum which was used to make it. You can find out where to recycle your Styrofoam by visiting http://www.epspackaging.org/ and looking at their EPS recycling locations map.

Leading Question

Is some packaging better than others?

Procedure

1. Divide students into small groups. Give each group a Styrofoam carton and each a paper carton. What differences do they notice? Have each group write down the differences they notice. Discuss the differences that we don't immediately notice. For example, one is made from nonrenewable resources and one is made from renewable resources. One has already been recycled and one was made from virgin material.
2. Discuss what happens to the egg cartons when we throw them out. For example, one can be recycled and one cannot. One is biodegradable and one is not.
3. Brainstorm ways to reuse the egg cartons, such as jewelry boxes, holiday ornaments, etc. Students will write and/or draw a list of ways to reuse both egg cartons. Explain that when we make crafts, we often combine different recyclables into a form which is not recyclable, like composite packaging. Discuss ways to avoid this. Students will complete the 'Egg Carton' worksheet.
4. Students can make permanent decorative or functional items from the Styrofoam containers, combining other non-recyclable materials with them. The paper egg cartons should be reused In ways that will not preclude their being recycled. For instance, as seed planters which can be buried in the ground and will

Common Core Alignments

KINDERGARTEN

CC.RI.K.4
Reading Informational Text:
Craft & Structure

CC.SL.K.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.K.2
Writing:
Text Types & Purposes

GRADE 1

CC.RI.1.4
Reading Informational Text:
Craft & Structure

CC.SL.1.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.1.8
Writing:
Research to Build & Present Knowledge

GRADE 2

CC.RI.2.4
Reading Informational Text:
Craft & Structure

CC.SL.2.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.2.8
Writing
Research to Build & Present Knowledge

GRADE 3

CC.RI.3.1
Reading Informational Text:
Key Ideas & Details

CC.SL.3.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.3.7
Writing:
Research to Build & Present Knowledge

decompose. Older students may read more about Styrofoam in *50 Simple Things Kids Can Do To Save The Earth*, by The Earthworks Group.

5. Make a collage or display of nature's packaging (orange rind, nutshell, banana peel, seed pod, vegetable peel, etc.) and people packaging (plastic wrap, aluminum foil, plastic bag, cardboard box, packing peanuts, bubble wrap, etc.) Have students create a PowerPoint showing pictures of nature's packaging vs. human-made packaging and explain the difference between the two, ending with a persuasive message to grow awareness. Older students can research the health hazards of using Styrofoam and include it in their slide show. According to earthresource.org, toxic chemicals leach out of these products into the food that they contain (especially when heated in a microwave). These chemicals threaten human health and reproductive systems.

Evaluation

Which type of egg carton should we use? From what kind of paper are paper egg cartons made? From what nonrenewable natural resources are Styrofoam egg cartons made?

Classroom Activities

A. Recycle the egg cartons into planting cups.

B. Students can make a list of personal choices they make on a daily basis (see Egg Carton worksheet for ideas). Ask them to list eco-friendly alternatives or ways they can change their behavior. Students can create songs, poems, or videos to raise awareness and encourage change in others.

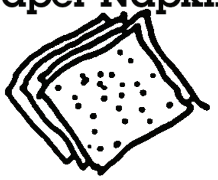
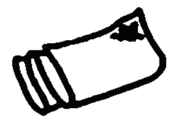
C. Show the students how to cut Styrofoam into rectangles, draw simple pictures onto it with a pencil and then use them as stamps with an ink pad. They can make cards for nursing homes, military overseas, or sick children.

Name:______________________________ Date: ____________________

We can make choices every day to help protect our environment.
Circle the picture of the item you would choose to use.

Write the name of the resource used to make it underneath the picture.

OIL	PLANTS	ANIMAL	SAND
			

1.	Paper Napkins 	Cloth Napkins 
2.	Paper Cup 	Plastic Cup 
3.	Plastic Milk Jug 	Cardboard Milk Jug 
4.	Ice Cream Cone 	Ice Cream in a Cup with a Spoon 
5.	Ketchup in a Plastic Bottle 	Ketchup in a Glass Bottle 

How Can We Reuse Things to Make Less Waste?

Concept
Reusing materials help conserve resources and landfill space.

Objective
Students will use brainstorming skills to look at different uses for things we normally throw away.

Method
Students will read a poem and make something new from an old box.

Materials
Large boxes, junque supply box, paint, markers, Jack Prelutsky, *Read Aloud Rhymes for the Very Young*

Subjects
Social Studies, Art, Language Arts

Vocabulary
Reuse, recycle, inventor, litter

Skills
Designing, sharing research and writing, collaborating, applying ideas to solve problems

Time
30 minutes, ongoing reuse projects

Resources
Carolyn Jabs, *RE/USES;* Robin Simons and Bob Graham, *The Junk Book*; Betsy Pflug, *You Can;* Holt Basal, *Christina Katerina and The Box*

3R's of the Common Core
Parallel Activities
K-3, Trash or Treasure
4-6, Wise Use of Paper
Information
Redesign and Reuse
Recycling
Resources
Environmental Education and Educational, Green Consumption, Consumerism and Sustainable Development

Leading Question

What can we make of this box?

Procedure

1.As a choral reading activity, children read, "Johnny." Afterwards, the children can brainstorm more ideas of how a box can be used.

2.As a class project, you may want to assign a theme so that the boxes can be a part of the classroom. If you are working on a space unit, you may want them to make space shuttles. If you are working on trains, you may want to make one for the classroom.

Evaluation

Why is it important to reuse things?

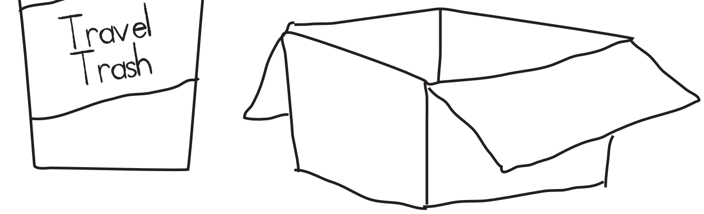
Classroom Activities

A. Have students build a 'Recycle City ' using various boxes and other recyclables (cans, plastic, paper, etc.). The students will discuss and plan their city buildings and the layout. They will provide a written, mini-report on the important role of their building. They will also explain how they created it.

B. Challenge students to see how long they can keep using (and reusing) one reusable object such as a piece of paper or a plastic bag. Results could be graphed.

C. Decorate an old paper bag as a litter bag for the family car.

D. Have an 'Invention Convention.' Students create a new use or object from their box. Students write and/or draw about their new invention. They will share and demonstrate its use with the class. A bulletin board can be created with ads for their new inventions. For more information about participating in the Young Inventor's Program in NH visit http://www.aas-world.org/YIP/.



Common Core Alignments

KINDERGARTEN

CC.SL.K.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.RL.K.5
Reading Literature:
Craft & Structure

CC.W.K.2
Writing:
Text Types & Purposes

GRADE 1

CC.RL.1.1
Reading Literature:
Key Ideas & Details

CC.SL.1.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.1.2
Writing:
Text Types & Purposes

GRADE 2

CC.RL.2.4
Reading Literature:
Craft & Structure

CC.SL.2.2
Speaking & Listening
Comprehension & Collaboration

CC.W.2.1
Writing:
Text Types & Purposes

GRADE 3

CC.RL.3.5
Reading Literature:
Craft & Structure

CC.SL.3.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.3.2
Writing:
Text Types & Purposes

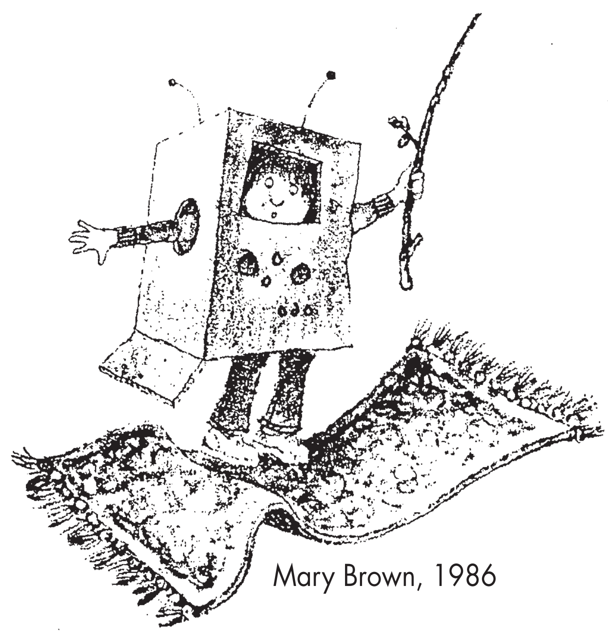
"Yesterday's Paper" by Mabel Watts

Yesterday's paper makes a hat,
Or a boat,
Or a plane,
Or a playhouse mat.
Yesterday's paper makes things
Like that -
And a very fine tent
For a sleeping cat.

"Johnny" by Marci Ridlon

To Johnny a box
is a house
or a car
or a ship
or a train
or a horse.

A stick
is a sword
or a spear
or a cane,
and a carpet
is magic,
of course.



Mary Brown, 1986

How Can We Revise Our Habits to Reduce Waste?

Concept
One person's trash is another person's treasure

Objective
Students redefine waste as a resource by identifying what trash is their treasure.

Method
Students create a class treasure trunk.

Materials
Teacher's own reuse treasure, used objects from students home, attached poem, Shel Silverstein, *Where the Sidewalk Ends*

Subject
Language Arts, Mathematics, Art, Social Studies

Skills
Applying mathematical concepts, inventing, explaining, communicating

Time
Can be set up and added to indefinitely.

Vocabulary
Treasure, junk, trash, value

Group Size
Whole class

Resources
Carolyn Jabs, *RE/USES;* Robin Simons, *Recyclopedia;* Nuria Roca, *The Three R's: Reuse, Reduce, Recycle'*

3R's of the Common Core
Parallel Activities
K-3, Yesterday's Paper
4-6, New Things from Old
Information
Redesign and Reuse
Recycling
Resources
Environmental Educational Resources
Green Consumption, Consumerism and Sustainable Development

Leading Question

Does everybody agree what might be trash and what might be treasure? What is the difference between trash and treasure? Do people always have the same opinion about what might be trash or what might be treasure?

Procedure

1. Introduce the lesson by reading the attached poem, "Hector the Collector" by Shel Silverstein. Enjoy the words and rhythm and discuss Hector's relationship to reuse.
2. Show the class two examples of reuse objects: (a) an object you are reusing for its original purpose and (b) one for which you have created a new use.
3. Ask the students to bring from home a treasured object that they have rescued from the trash. It can be something they have reused either for the same or for a new purpose. If they cannot find one, ask them to bring an item for which they have a reuse idea.
4. Have the students show and tell about their objects, describing to the class why they are treasured. Have the students create and write a list of things they might use the 'trash' for - they can be zany or practical things.
5. Discuss the benefits of reusing things, such as it being fun and creative, saves money because we don't have to buy something new and not having to pay to get rid of it, it saves space in our landfills, helps reduce pollution and saves the natural resource which was used to make the original object.
6. Use an old box to create a class treasure trunk. Decorate it with salvaged paper or fabric scraps and fill it with the collected treasures.
7. Have the younger students count the treasure objects they have as a class. Sort the objects by size, color, shape or other attributes. Older children can measure the length of the objects as appropriate for their grade level.
   - Take three different length objects. Use the smallest length object to compare the lengths of the other two objects. (e.g. Use a paperclip to measure the length of the pencil. The pencil is 4 paper clips long.)
   - Measure the length of the objects using different tools such as rulers, yardsticks, meter sticks or measuring tape.
   - Measure the length of each object using rulers which show halves and fourths of an inch. They can show their measurement data on a bar graph.

Common Core Alignments

KINDERGARTEN

CC.RL.K.5
Reading Literature:
Craft & Structure

CC.W.K.2
Writing:
Text Types & Purposes

CC.K.CC.5
Mathematics:
Counting & Cardinality

GRADE 1

CC.RL.1.1
Reading Literature:
Key Ideas & Details

CC.W.1.2
Writing:
Text Types & Purposes

CC.1.MD.2
Mathematics:
Measurement & Data

GRADE 2

CC.RL.2.4
Reading Literature:
Craft & Structure

CC.W.2.3
Writing:
Text Types & Purposes

CC.2.MD.1
Mathematics:
Measurement & Data

GRADE 3

CC.RL.3.5
Reading Literature:
Craft & Structure

CC.W.3.3
Writing:
Text Types & Purposes

CC.3.MD.4
Mathematics:
Measurement & Data

Evaluation

What does is mean to redefine waste as a resource? Describe the benefits of reusing things. Name three things that your classmates showed as treasures.

Classroom Activities

A. Imagine and describe a planet full of creatures who consider the things we throw away as their most treasured possessions.

B. Have each student write a poem or story about an item they treasure that others consider junk. Younger students can make a collaborative 'ABC' book about their class treasures.

C. Have a class or school swap day so that people can exchange trash for treasure.

D. Use old greeting cards to make new ones and as story starters.

"Hector The Collector"

by Shel Silverstein

Hector the Collector
Collected bits of string,
Collected dolls with broken heads
And rusty bells that would not ring.
Pieces out of picture puzzles,
Bent-up nails and ice-cream sticks,
Twists of Wires, worn-out tires,
Paper bags and broken bricks.
Old chipped vases, half shoelaces,
Gatlin' guns that wouldn't shoot,
Leaky boats that wouldn't float
And stopped-up horns that wouldn't toot.
Butter knives that had no handles,
Copper keys that fit no locks,
Rings that were too small for fingers,
Dried up leaves and patched-up socks.

Worn-out belts that had no tracks,
Airplane models, broken bottles,
Three-legged chairs and cups with cracks.
Hector the Collector
Loved these things with all his soul
Loved them more than shining diamonds,
Loved them more than glistenin' gold.
Hector called to all the people,
"Come and share my treasure trunk!"
And all the silly sightless people
Came and looked ...and called it junk.

How Does Recycling Work?

Concept
Nature works In cycles.

Objective
Students will trace the lifecycle of a familiar object from production to disposal and will recognize the difference between disposing of the object and recycling it as a resource.

Method
Students will act out a cycle and draw pictures.

Materials
Paper, crayons/pencils, blackboard and chalk, common object such as a piece of paper or a can, a piece of string/yarn long enough for everyone in the group to hold

Subjects
Art, Language Arts, Social Studies, Science

Skills
Collaborating, communicating, gathering information, predicting, using mathematics (Kindergarten only)

Time
One class period

Vocabulary
Cycles, recycling, resources, waste

Resources
Anne Shanks, *About Garbage and Stuff;* http://www.youtube.com/watch?v=7nZXyjrBraY; EPS Packaging, *"Styrofoam Recycling Locations,"* http://www.epspackaging.org/index.php?option=com_content&view=article&id=37&Itemid=38, Earth911 *"How to Recycle Paper,"* http://earth911.com/recycling-guide/how-to-recycle-paper/

3R's of the Common Core
Parallel Activities
4-6, Where From, Where To?
7-8, Destination Recycle
Information
Components of the Waste Stream
Recycling
Resources:
Solid Waste and Recycling

Background

Everything we make, use and throw away originates from and returns to the earth; nature works in cycles. Thinking in cycles can help us to remember that energy, natural resources and money are all used up in bringing everyday objects to us. By reusing and recycling our resources we can save what would normally be lost in a landfill.

Leading Question

What happens to things after we throw them out?

Procedure

1. Select an object such as a can or piece of paper, plastic #2 or a plastic bag. With the class, research then list all the steps used in bringing that item to us. Then add all the steps required to recycle it. Older students will take notes on the steps on index cards. Younger ones can draw and illustrate the steps. Younger students (K) will count the steps involved for mathematics.
2. Assign one of the steps to each student. Have the students arrange themselves in the correct order in a circle.
3. Tie the string so that it forms a circle. Have each student in the circle take hold of the string so that students are bound in a circle.
4. To illustrate the benefits of recycling and resource conservation, remove parts of the cycle. What happens if we send the object to the dump instead of recycling it? What would happen if there were no more resources to start the cycle? Why is it important to keep resources recycling? After removing parts of the circle and discussing the three questions above, have the students work in three groups (one question per group) to collaborate and write/draw a group answer to each question.
5. Give students a choice of writing and illustrating an informational or a creative narrative about My Life As A Paper Bag, or another object that can be recycled. The writing should describe the creation of the item all the way through its end of use to recycling it.

Options: Have the students role play the item, explain the sequence of recycling on a large chart, or make their own recycling chart on paper plates. Students could tell a story about the picture on the paper plate.

Evaluation

Can we keep taking resources out of the earth forever? Why is it important to recycle?

Common Core Alignments

KINDERGARTEN

CC.SL.K.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.K.2
Writing:
Text Types & Purposes

CC.K.CC.5
Mathematics:
Counting & Cardinality

GRADE 1

CC.SL.1.1
Speaking & Listening:
Comprehension & Collaboration

CC.SL.1.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.1.3
Writing:
Text Types & Purposes

GRADE 2

CC.SL.2.1
Speaking & Listening:
Comprehension & Collaboration

CC.SL.2.6
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.2.8
Writing:
Research to Build & Present Knowledge

GRADE 3

CC.SL.3.3
Speaking & Listening:
Comprehension & Collaboration

CC.SL.3.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.3.3
Writing:
Text Types & Purposes

Classroom Activities

A. Role play the cycle of a paper plate vs. the cycle of a Styrofoam plate (recyclable vs. not widely recyclable.)

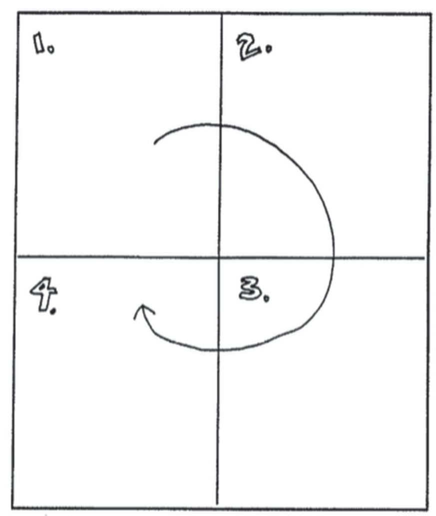
B. Take the class out to a stream. Mentally trace the flow of water upstream as far as you can. Travel to a spring, or runoff from a rainstorm, from the sky, from clouds, evaporation, ocean, etc. all the way back to downstream from where you sit. Look for a piece of litter nearby and try to do the same.

C. How many trees worth of paper do you think the average family uses each year (Answer: six trees)? Discuss ways to recycle paper. What does your family do with its cardboard, newspaper, and other paper products? How does your family reuse paper creatively? How can we use our scrap paper in the classroom?

D. Have each student divide two pieces of paper into four parts, label as follows and then illustrate.

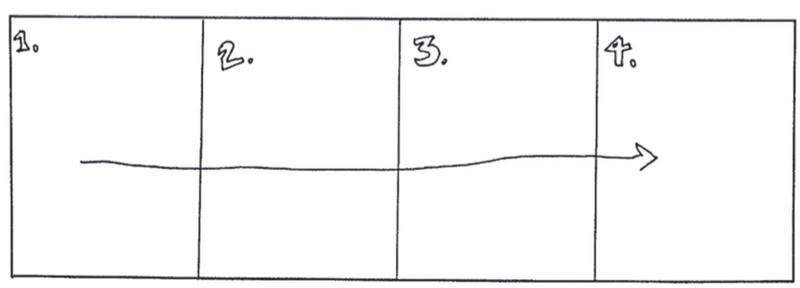
Recycling

1. **MAKING** a picture of the item.
2. **USING** a picture of the student using it.
3. **SAVING**, separating, storing and bringing to recycling center.
4. **RECYCLING**, making it into something new.



Throwing Away

1. **MAKING**, a picture of the item.
2. **USING**, a picture of the student using it.
3. **THROWING AWAY**, where they throw it away.
4. **DUMPING**, at the landfill



What's Recyclable?

K-3, III.B.2

How Can We Recycle Our Resources?

Concept
Some materials are easier to recycle than others.

Objective
Students will distinguish recyclable from non-recyclable materials and will know how to prepare them for recycling.

Method
Students will select pictures from magazine and will sort and prepare materials for recycling.

Materials
Old magazines, magnets, scissors, glue, What's Recyclable handout

Subjects
Social Studies, Science, Language Arts

Skills
Sharing research and writing, analyzing, investigating, problem solving

Time
Two class periods, ongoing station activities

Vocabulary
Magnetism, aluminum, steel, recycle

Resources
Dare Wright, *Edith and Little Bear Lend a Hand;* Ann Zane Shanks, *About Garbage and Stuff;* Alison Inches, *The Adventures of a Plastic Bottle* and *The Adventures of an Aluminum Can*

3R's of the Common Core
Parallel Activities
4-6, Where to Recycle
7-8, Source Separating
9-12, Collecting and Sorting
Information
Components of the Waste Stream
Resources:
Solid Waste and Recycling

Background

Virtually all things could be recycled in one manner or another. But some are more easily recyclable than others. And many objects, while recyclable, may not be collected in our area.

Leading Questions

What objects can be recycled?

Procedure

1. After reading your local landfill recycling information with the class, share a list of recyclable materials. Distribute handout (at end of lesson) to each student. Ask students to circle the items that they know they can recycle in their town.
2. Ask each student to select a picture of an object that is reusable or recyclable from an old magazine. Each student will write out how this item is recyclable. Younger students can match their item to a recyclable category you provide for them. Each student will explain to the class why his or her object is recyclable. Make a collage of the pictures. Place the students notes about the items along the collage borders.
3. Recyclable materials include newspaper, corrugated cardboard, ledger paper, steel cans, aluminum, three colors glass (brown, green, clear), plastic milk, water or juice jugs [HDPE] and soda bottles (PET). Demonstrate how to prepare each of the sample materials for recycling and set up a recycling station where students can properly sort the materials. After your demonstration, students will look over 'trash ' and locate and identify information on it that may help to sort it such as : #1, #2, or the letters (HDPE) and (PET) on plastics.

Common Core Alignments

KINDERGARTEN

CC.SL.K.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.K.2
Writing:
Text Types & Purposes

CC.K.CC.5
Mathematics:
Counting & Cardinality

GRADE 1

CC.SL.1.1
Speaking & Listening:
Comprehension & Collaboration

CC.SL.1.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.1.3
Writing:
Text Types & Purposes

GRADE 2

CC.SL.2.1
Speaking & Listening:
Comprehension & Collaboration

CC.SL.2.6
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.2.8
Writing:
Research to Build & Present Knowledge

GRADE 3

CC.SL.3.3
Speaking & Listening:
Comprehension & Collaboration

CC.SL.3.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.3.3
Writing:
Text Types & Purposes

Evaluation

What are the easiest materials to recycle?

Classroom Activities

A. Magnets are pieces of iron or steel which attract other ferrous metal (containing iron or steel). Magnets will not attract aluminum. Have each student demonstrate the use of magnets in telling the difference between aluminum and steel objects. Examples may include the following:

Aluminum	**Steel**
Soda can	Soup can
Lasagna pan	Scissors
Foil wrap	Paperclip
Cookware	Nail
Airplane	Spoon
	Ships
	Cars

B. Note other differences between the two, such as weight, presence or lack of seams, ribbing and paper labels.

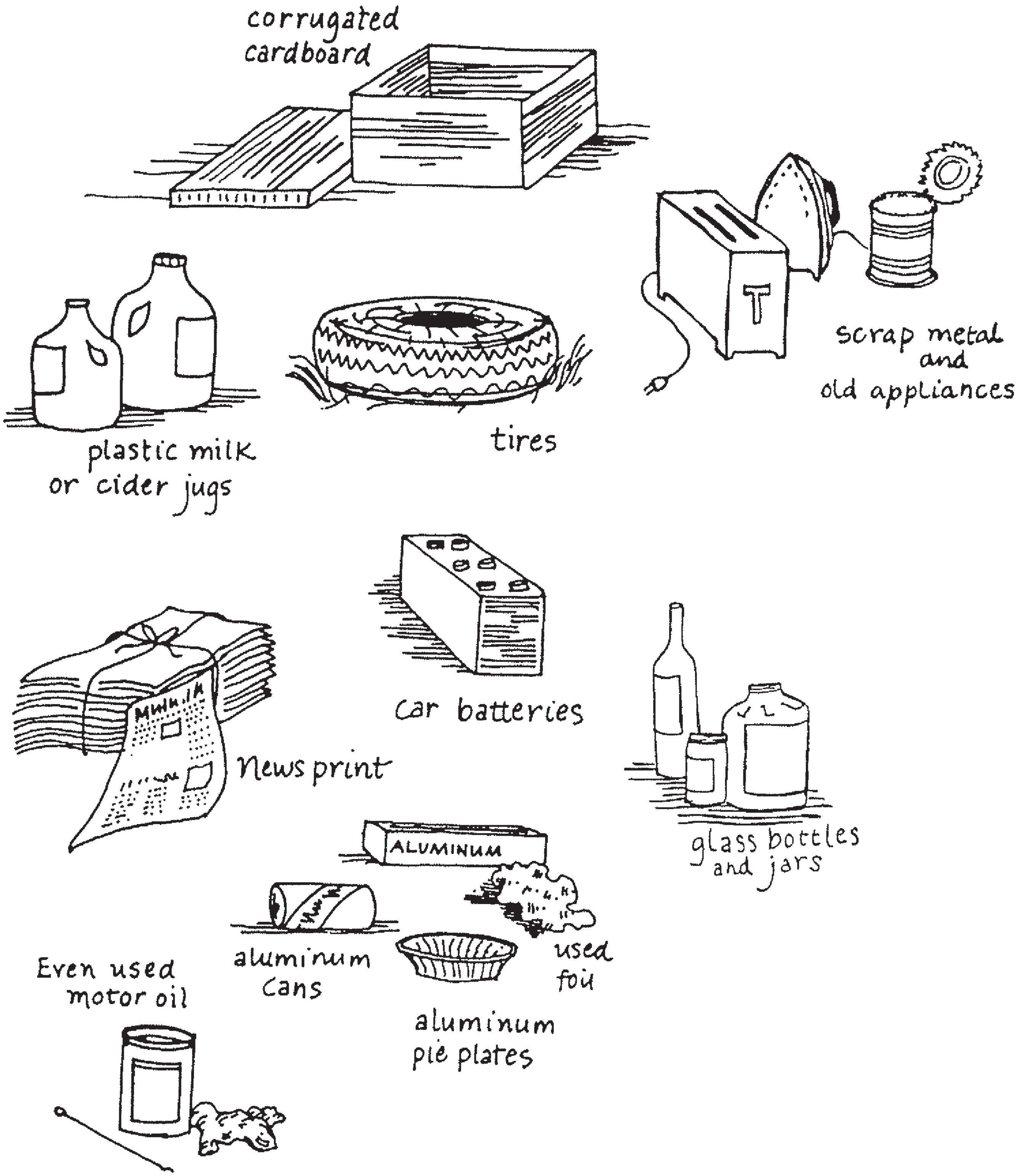
C. Have students make a *How to Recycle book* to bring home for their families. Encourage students to use the handout from step one to provide visuals for their book.

D. Take collected recyclables on a field trip to a recycling center. Students may also read and learn about Preserve, a company whose mission is "to help reduce the harm caused by the industrial age by demonstrating that consumer products can be both fabulous and lighter on the earth." "Mission," Preserve, accessed June 12, 2016, https://www.preserveproducts.com/explore/preserve-101/mission. Students can learn how they can help collect #5 plastics that can be turned into toothbrushes and other products.

E. Older students may play a recycling relay race. Divide class into teams. Each student picks an object from a bag of mixed clean trash and delivers it to a box or bag labelled non-recyclable (landfill) or with the type of recyclable (metal, paper, plastic, reuse).

F. Students design a recycling center for their home.

See 7-8, III.B. I, Source Separating


corrugated cardboard
plastic milk or cider jugs
tires
scrap metal and old appliances
car batteries
News print
glass bottles and jars
ALUMINUM
aluminum cans
used foil
aluminum pie plates
Even used motor oil

How Does Composting Work?

Concept
Organic waste can be recycled to enrich soil.

Objective
Students will understand the cycles of a compost pile and how it is beneficial.

Method
Students will sing a song and analyze its meaning.

Materials
Chart with words of song on it, compost cycle poster, carbon and nitrogen sorting activity, blank cycle template

Subjects
Language Arts, Science, Music

Skills
Communicating, explaining, researching, synthesizing

Time
20 minutes a day for several days

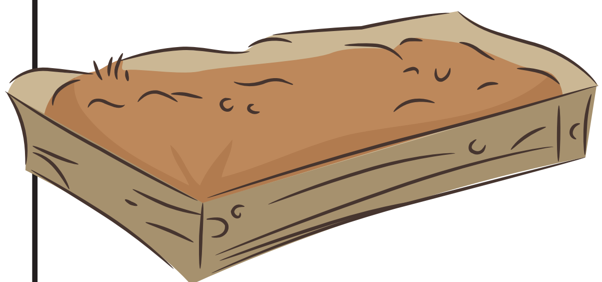
Vocabulary
Compost, cycles, microbes, humus

Resources
Jenepher Lingelbach, *Hands-On Nature;* Vicki Cobb, *Lots of Rot;* Harlow Rockwell, *The Compost Heap;* Alvin Tressalt, *The Dead Tree,* Wen-Chia Tsai Parker, *Kids Can Compost;* Mary Appelhof, *Worms Eat My Garbage: How to Set Up and Maintain a Worm Composting System*; Bonnie Bright, *Casey's Compost*

3R's of the Common Core
Parallel Activities
4-6, Mini Compost
7-8, Making Good Compost
9-12, Microorganisms
9-12, Effective Fertilizers
Information
Composting
Resources
Environmental Education and Educational Resources
Green Consumption, Consumerism and Sustainable Development

"Take Me Out To The Compost"

Take me out to the compost;
Take me out to the heap.
Grind me up in a food grinder;
I don't care if I'm chopped into bits,
'Cause it's root root root for the microbes;
If they don't live it's a shame.
For it's 2, 4, 6 months I'm out to the old garden!



Leading Question

How does composting work?

Procedure

Show the poster about the cycle of compost. Ask students to try to find the connections as they sing the song. Sing "Take Me Out To The Compost" to the tune of "Take Me Out To The Ballgame." Discuss the sequence of events in the song and how they work to produce humus. Practice the song once a day at a convenient time. Each time the class sings it, they may address a different question about composting. Review the vocabulary in the song (microbes, compost, food grinder, humus). List synonyms for the words. Younger students may draw or illustrate their synonyms and vocabulary words.

1. How does the production of humus start the cycle over again?
2. Why is a food grinder beneficial?
3. Why would it be a shame if microbes didn't live?
4. How can we make sure they will thrive?
5. What kinds of things can you compost? (Make a list on the board.)

Evaluation

When you believe the students know the song, they can unscramble the sentences on the worksheet so that they are in order. Have the students write the answers to the questions regarding composting, that have been discussed.

Common Core Alignments

KINDERGARTEN

CC.L.K.4
Language:
Vocabulary Acquisition & Use

CC.RI.K.1
Reading Informational Text:
Key Ideas & Details

CC.W.K.2
Writing:
Text Types & Purposes

GRADE 1

CC.L.1.5
Language:
Vocabulary Acquisition & Use

CC.RI.1.2
Reading Informational Text:
Key Ideas & Details

CC.W.1.8
Writing:
Research to Build & Present Knowledge

GRADE 2

CC.L.2.5
Language:
Vocabulary Acquisition & Use

CC.RI.2.4
Reading Informational Text:
Craft & Structure

CC.W.2.8
Writing:
Research to Build & Present Knowledge

GRADE 3

CC.L.3.5
Language:
Vocabulary Acquisition & Use

CC.RI.3.2
Reading Informational Text:
Key Ideas & Details

CC.W.3.3
Writing:
Text Type and Purpose

CC.W.3.6
Writing:
Text Type and Purpose

CC.W.3.7
Writing:
Research to Build & Present Knowledge

Classroom Activities

A. Read the list of compostable items in the sorting activity. Decide which category the item belongs in: carbon or nitrogen. Talk about the importance of layering these two ingredients, plus adding water to build a successful compost.

B. Paste the blank cycle template (at the end of this lesson) onto a poster-sized paper. Ask students to paste the pictures of the missing steps to the cycle of compost. Have them label the diagram using the words from the word bank.

C. (Challenge activity) Cut and paste the mixed-up words to the song near the picture that illustrates that step.

D. Make a compost pile for the classroom.

See 4-6, III.C. I, Mini Compost

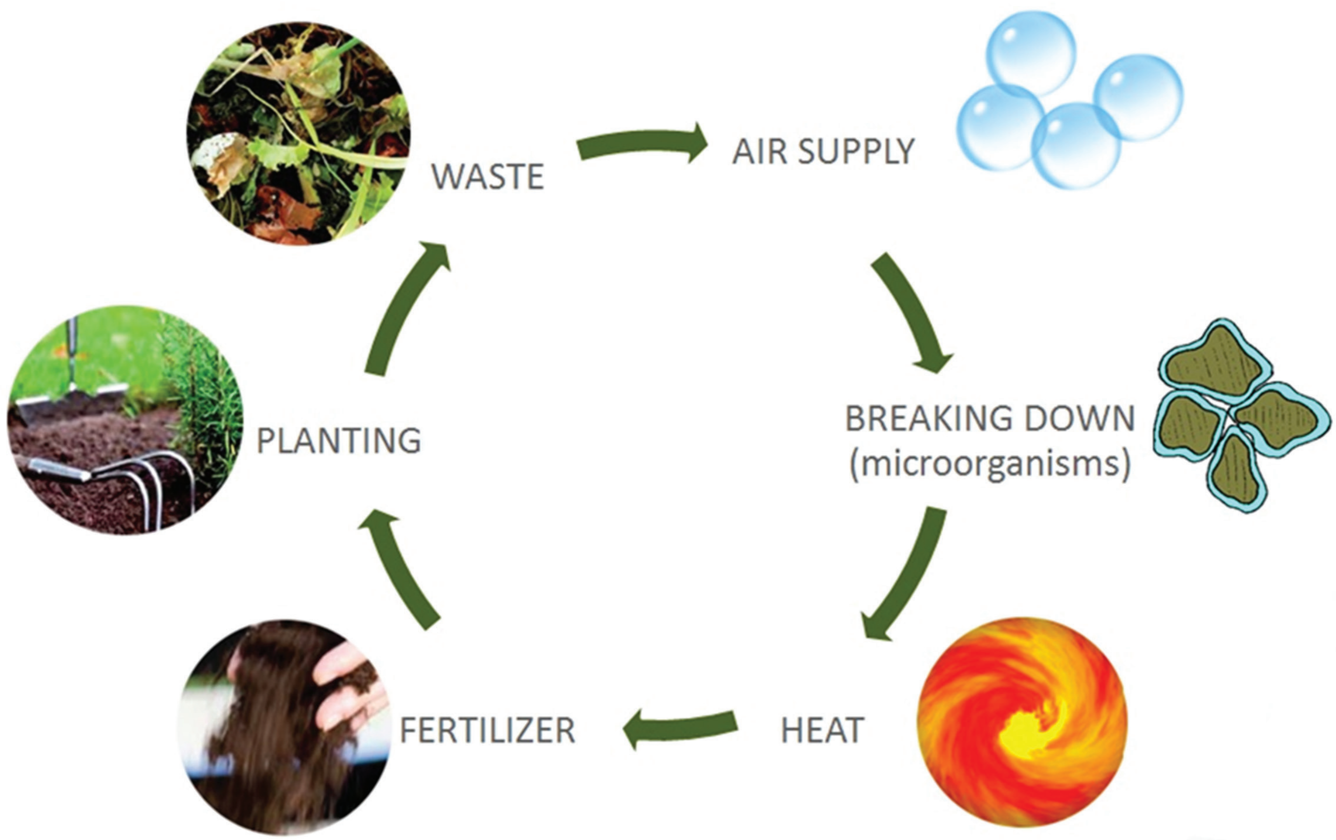
E. Read and research about worms or another compost creatures. Write an informative narrative about it. Draw a picture of your compost creature. Use technology to publish a class book about your compost creatures.

F. Watch "Rotting Watermelon Decomposition Time Lapse Footage" on YouTube, link https://www.youtube.com/watch?v=S12zZhdOckc.

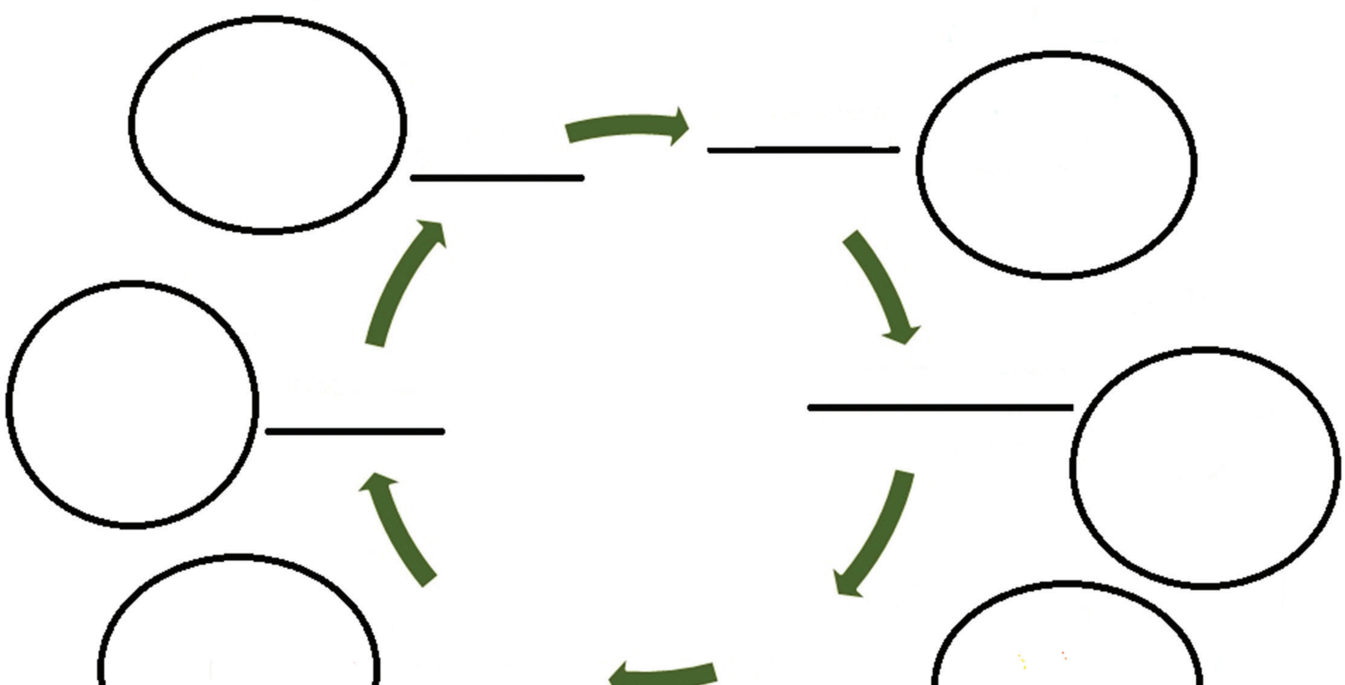
G. Look at a copy of the school lunch menu. Highlight all the items that could be composted (fruits, vegetables and bread; no meat, cheese or dairy). Create awareness posters for the cafeteria.

H. Have students work in small groups to design a plan that would work in the cafeteria. Where would the compost be collected? How would you make sure the students put the proper foods into the compost bucket? Who will take the compost bin outside? Who will turn the compost?

I. Have students write letters or create a PowerPoint to the Principal or the school's Food Service Director about starting a composting program in the lunchroom. Encourage them to apply all the knowledge they've acquired in this lesson to convince their audience. Use technology to produce and publish.



Compost Cycle Poster



Name:____ **Date:** _______________________

Write the words from the text box onto your compost cycle poster. Cut out the pictures below and glue them to your poster in the proper order.

Text box:

HEAT

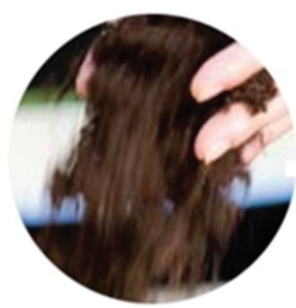
PLANTING

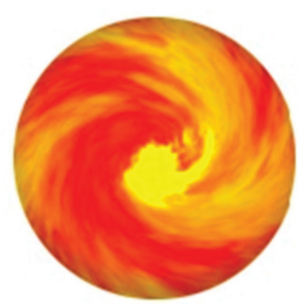
AIR SUPPLY

WASTE

BREAKING DOWN

FERTILIZER





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2101 Dover Rd | Epsom, NH 03234
www.nrra.net | info@nrra.net
800-223-0150

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www.schoolrecycling.net
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Lesson Matrix Grades 4-6

3R's of the Common Core

Lesson	Leading Question	Objective	Common Core Alignments		Skills
4-6 **Litter Search** **I.A.1**	What kind of trash is found around the school?	Develop awareness of variety, sources and amount of litter Classify litter elements	**Grade 4** CC.L.4.6 CC.SL.4.1 CC.4.MD.4 **Grade 6** CC.L.6.6 CC.SL.6.1 CC.6.SP.4	**Grade 5** CC.L.5.6 CC.SL.5.1 CC.5.MD.2	Communicating results Gathering information Graphing data Investigating
4-6 **Lunch Bags** **I.A.2**	How much of your lunch do you eat and how much do you throw away?	Measure lunch waste Categorize content of lunch waste Identify ways to reduce solid waste	**Grade 4** CC.SL.4.1 CC.SL.4.4 CC.4.OA.3 **Grade 6** CC.SL.6.2 CC.SL.6.5 CC.6.NS.3	**Grade 5** CC.SL.5.2 CC.SL.5.5 CC.5.NBT.7	Analyzing Applying mathematical concepts Collaborating Collecting data
4-6 **The Story of…** **I.A.3**	What kind of container is best for the environment?	Understand resources that make up packaging Determine ways to reuse or recycle packaging	**Grade 4** CC.SL.4.2 CC.SL.4.4 CC.W.4.8 **Grade 6** CC.SL.6.2 CC.SL.6.5 CC.W.6.8	**Grade 5** CC.SL.5.2 CC.SL.5.5 CC.W.5.8	Communicating information Designing Evaluating Gathering information
4-6 **What Kind of Waste Am I?** **I.B.1**	Name one thing we throw away that didn't come from the earth.	Understand the characteristics of waste	**Grade 4** CC.L.4.3a CC.L.4.6 CC.SL.4.1c **Grade 6** CC.L.6.3a CC.L.6.6 CC.SL.6.1c	**Grade 5** CC.L.5.3a CC.L.5.6 CC.SL.5.1c	Designing Developing models Identifying Questioning

Lesson Matrix Grade 4-6

3R's of the Common Core

Lesson	Leading Question	Objective	Common Core Alignments		Skills
4-6 **The Lorax** **I.B.2**	What are some of the consequences of our throw-away habits?	Explore the impact of humans on natural systems Draw conclusions about the environmental impact of human behaviors	**Grade 4** CC.RI.4.3 CC.SL.4.2 CC.SL.4.6 CC.W.4.4 **Grade 6** CC.RI.6.3 CC.SL.6.3 CC.SL.6.4 CC.W.6.4	**Grade 5** CC.RI.5.3 CC.SL.5.3 CC.W.5.3 CC.W.5.4	Communicating solutions Interpreting Problem solving Researching
4-6 **Then and Now** **I.C.1**	How have our lifestyles changed in the past one hundred years? How have these changes affected our waste stream?	Describe ways in which changing domestic habits have intensified human impact on the environment	**Grade 4** CC.SL.4.1 CC.SL.4.3 CC.W.4.4 CC.W.4.7 **Grade 6** CC.SL.6.3 CC.W.6.4 CC.W.6.8	**Grade 5** CC.SL.5.2 CC.SL.5.3 CC.W.5.4 CC.W.5.8	Interviewing Inventing Investigating Synthesizing
4-6 **Hauling it Away** **II.A.1**	How much does waste disposal cost?	Understand that trash must be disposed of, that disposal options are limited, that managing trash can be problematic	**Grade 4** CC.SL.4.3 CC.SL.4.4 CC.W.4.2 CC.4.OA.3 **Grade 6** CC.SL.6.3 CC.SL.6.5 CC.W.6.2 CC.6.NS.3	**Grade 5** CC.SL.5.3 CC.SL.5.4 CC.W.5.2 CC.5.NBT.5	Applying mathematical concepts Communicating information Interviewing Questioning

Lesson Matrix Grade 4-6

3R's of the Common Core

Lesson	Leading Question	Objective	Common Core Alignments	Skills
4-6 **Plastic Litter** **II.A.2**	Is plastic litter a problem?	Recognize the environmental hazards of plastic litter	**Grade 4** CC.L.4.6 CC.RI.4.2 CC.SL.4.2 CC.W.4.3 **Grade 5** CC.L.5.6 CC.RI.5.8 CC.SL.5.3 CC.W.5.3 **Grade 6** CC.L.6.6 CC.RST.6-8.3 CC.RST.6-8.9 CC.W.6.3	Analyzing Carrying out investigations Explaining Observing
4-6 **Landfills** **II.B.1**	Do we take our trash to a sanitary landfill or an open dump?	Understand how sanitary landfills are made and are operated Understand the pollution problems associated with sanitary landfills	**Grade 4** CC.RI.4.7 CC.SL.4.1c CC.W.4.4 **Grade 5** CC.RI.5.7 CC.SL.5.1c CC.W.5.4 **Grade 6** CC.RI.6.7 CC.SL.6.1 CC.W.6.4	Designing Gathering information Observing Questioning
4-6 **Investigating Incineration** **II.B.2**	Is burning a good way to get rid of trash?	Consider advantages and disadvantages of incineration	**Grade 4** CC. RI.4.5 CC.SL.4.1c CC.SL.4.3 CC.W.4.4 **Grade 5** CC.RI.5.5 CC.SL.5.1c CC.SL.5.3 CC.W.5.4 **Grade 6** CC.RI.6.6 CC.SL.6.1d CC.SL.6.3 CC.W.6.4	Analyzing Defining problems Evaluating Questioning
4-6 **Solid Waste Bulletin Board** **II.C.1**	What can I do with this piece of solid waste?	Categorize solid waste items into reusable, recyclable, recoverable or able to be revised	**Grade 4** CC.L.4.6 CC.SL.4.4 CC.W.4.4 **Grade 5** CC.L.5.6 CC.SL.5.4 CC.W.5.4 **Grade 6** CC.L.6.6 CC.SL.6.4 CC.W.6.4	Applying ideas to solve problems Designing Developing models Evaluating

Lesson	Leading Question	Objective	Common Core Alignments		Skills
4-6 **Pondering Packaging** **III.A.1**	What problems does packaging pose?	Examine examples of over or conglomerate packaging Assess the negative impact of overpackaging Brainstorm alternatives to overpackaging	**Grade 4** CC.L.4.6 CC.RI.4.8 CC.SL.4.1c CC.W.4.4 **Grade 6** CC.L.6.6 CC.RI.6.8 CC.SL.6.1c CC.SL.6.6 CC.W.6.4	**Grade 5** CC.L.5.6 CC.RI.5.8 CC.SL.5.1c CC.W.5.4	Designing Developing models Interpreting Problem solving
4-6 **Wise Use of Paper** **III.A.2**	How much paper do you think you use? Do you need to use all of it?	Understand how much paper is wasted Know how to conserve paper	**Grade 4** CC.SL.4.1 CC.W.4.4 CC.4.MD.4 **Grade 6** CC.SL.6.1 CC.W.6.7 CC.6.SP.2	**Grade 5** CC.SL.5.1 CC.W.5.7 CC.5.MD.2	Collaborating Collecting data investigating Researching
4-6 **New Things From Old** **III.A.3**	Why did our grandparents make patchwork quilts?	Understand that materials can be reused to make useful objects	**Grade 4** CC.SL.4.4 CC.RI.4.7 CC.RL.4.2 **Grade 6** CC.SL.6.6 CC.RI.6.7 CC.RL.6.2 CC.W.6.7	**Grade 5** CC.RI.5.7 CC.RL.5.2 CC.SL.5.5 CC.W.5.7	Collaborating Designing Interviewing Sharing research and writing

Lesson Matrix Grade 4-6
3R's of the Common Core

Lesson Matrix Grade 4-6

3R's of the Common Core

Lesson	Leading Question	Objective	Common Core Alignments		Skills
4-6 **Where From, Where To?** **III.B.1**	Where do things we use come from and where do they go to?	Trace lifecycle of objects from source, to consumer, and back again	**Grade 4** CC.SL.4.1c CC.SL.4.5 CC.W.4.4 **Grade 6** CC.SL.6.1d CC.SL.6.5 CC.W.6.4	**Grade 5** CC.SL.5.1c CC.SL.5.5 CC.W.5.4	Analyzing Applying ideas to solve problems Communicating information Researching
4-6 **Papermaking** **III.B.2**	Why should we recycle paper?	Learn how paper is recycled Make recycled paper	**Grade 4** CC.L.4.6 CC.RI.4.3 CC.SL.4.2 CC.W.4.4 CC.4.MD.4 **Grade 6** CC.RI.6.4 CC.RST.6-8.3 CC.SL.6.2 CC.6.RP.3c CC.6.SP.2	**Grade 5** CC.L.5.6 CC.RI.5.3 CC.SL.5.2 CC.5.MD.2 CC.5.NBT.7	Applying mathematical concepts Collecting data Designing Researching
4-6 **Where to Recycle** **III.B.3**	What is recyclable and where can we take our recyclables?	Gather information about where materials can be recycled	**Grade 4** CC.SL.4.1 CC.W.4.1b CC.W.4.6 **Grade 6** CC.SL.6.1 CC.W.6.1b CC.W.6.6	**Grade 5** CC.SL.5.1 CC.W.5.1b CC.W.5.6	Collaborating Communicating information Gathering information Sharing research and writing
4-6 **Mini-Compost** **III.C.1**	What do you do with your food scraps?	Learn about recycling organic matter	**Grade 4** CC.RI.4.1 CC.W.4.4 CC.4.NBT.3 **Grade 6** CC.RI.6.2 CC.W.6.4 CC.6.SP.2	**Grade 5** CC.RI.5.2 CC.W.5.4 CC.5.OA.1	Graphing data Investigating Observing Predicting

What is in Our Solid Waste Stream?

Concept
The solid waste stream can be classified into a number of categories.

Objective
Students will develop an awareness of the variety, sources and amount of litter and will be able to classify its elements.

Method
Students will collect and categorize different litter items from around the school and will dispose of the human-made litter properly.

Materials
Paper bags (preferably reused) for each student, newspaper to spread trash out

Subjects
Social Studies, Science, Language Arts, Mathematics

Skills
Communicating results, gathering information, graphing data, investigating

Time
60 minutes

Vocabulary
Biodegradable, human-made, natural, decompose

Resources
Brad Herzog, *S is for Save the Planet: A How-to-be-Green Alphabet*

3R's of the Common Core
Parallel Activities
K-3, Garbage Bag Recipe
7-8, School Trash Analysis
Information
Components of the Waste Stream
Resources
Environmental Education and Educational Resources

Leading Question
What kinds of trash do you think we'll find around the school?

Procedure
NOTE: Before beginning this activity, make sure there is enough litter outside.

1. Pass out used bags for collecting litter. Discuss some possible items and where they are likely to be found.
2. Take the class outside. Set the boundaries for the litter search. Caution students on cuts from glass, etc. Litter should be collected in their bags. Set a 10 to 15 minute limit for the hunt.
3. Return to the classroom and divide the class into groups of five or so. Combine the group's litter into piles and sort according to categories: (1) glass (2) metal (3) paper (4) plastic, rubber and textiles (5) food and miscellaneous waste. What is the total number of objects found?
4. Count the number of items in each category. Then determine the fraction of the total items for each category (e.g. total items = 25; glass items = 5; glass fraction = 5⁄25).
5. Create a line plot showing the results of each category. Visually compare the items with the highest count to the items with the lowest count using the plot.
6. Discuss the results. Where was most of the litter found? How did it get there (careless people, blown out of trash truck)? Why don't people dispose of waste properly? Which were the fewest items found? What percentage can be reused or recycled? Create a bar graph showing three bars; one for the total items found, one for the items that can be recycled and one for the items that need to be thrown in the trash. This can be repeated for different locations where trash was found (e.g. along the street vs. a playground location).

Option: Half the class could do this using litter, the other half using trash from the trash can. Compare the two.

Evaluation
Were the students able to correctly classify the litter items they collected?

Common Core Alignments

GRADE 4

CC.L.4.6
Language:
Vocabulary Acquisition & Use

CC.SL.4.1
Speaking & Listening:
Comprehension & Collaboration

CC.4.MD.4
Mathematics:
Measurement & Data

GRADE 5

CC.L.5.6
Language:
Vocabulary Acquisition & Use

CC.SL.5.1
Speaking & Listening:
Comprehension & Collaboration

CC.5.MD.2
Mathematics:
Measurement & Data

GRADE 6

CC.L.6.6
Language:
Vocabulary Acquisition & Usage

CC.SL.6.1
Speaking & Listening:
Comprehension & Collaboration

CC.6.SP.4
Mathematics:
Statistics & Probability

Classroom Activities

A. Make displays of the different kinds of litter. Separate the litter into renewable and non-renewable resources, natural and human-made objects, bio- and non-biodegradable objects, etc.

B. Make a timeline poster of the biodegradability of trash found, using the Enduring Litter chart (see Waste Walk 7-8 II.A.1) and pasting pieces of collected trash on the poster.

C. Make litter collages or posters to discourage littering.

D. Design and carry out a behavioral experiment to determine why people litter. Have students offer individually wrapped treats to other students outside of the class and document in what way the subjects dispose of the wrapping:

    1. Putting the wrappers in their pocket
    2. Putting the wrappers in a nearby trash receptacle
    3. Throwing the wrappers on the ground

E. How would the litter search results differ if students examined a different trash can (e.g.: one from the school kitchen, one from home, one from a factory)? Compare the results.

F. Assess the amount of waste produced in other classrooms and the lunchroom. How many classrooms recycle? Do the classrooms use both sides of the paper before recycling? How many trash barrels are in each room? Is there a recycle bin? Are the bins clearly labeled with acceptable waste or recyclables?

G. Do a classroom trash can sort. Try the same activity one month later to see if students have changed any of their behaviors regarding recycling and the consumption of natural resources.

H. Broaden activity to coordinate with community Green-Up Day activities. What areas in the school need the most help? Conduct a waste audit of classrooms, cafeteria, conference rooms, main office, etc. (see Information Section for how to conduct a school waste audit). Work together to think of activities that would help raise awareness at the school and increase recycling. Start a school Green Team to tackle large tasks and to coordinate environmental education activities

How Much Waste Do We Produce?

Concept
Each of us is responsible for the size and composition of the stream. Reusing can help reduce waste.

Objective
Students will measure how much lunch waste they produce as individuals and as a class, will categorize the content of their lunch waste and identify reusing as a way to reduce solid waste.

Method
Students will examine, classify and record the content of their lunches before and after eating.

Materials
Lunches and lunch remains, workshop sheets, scales, chart

Subjects
Mathematics, Health, Social Studies, Science

Skills
Analyzing, applying mathematical concepts, collaborating, collecting data

Time
Two class periods (before and after lunch)

Vocabulary
Organic, renewable, nonrenewable, waste generation

Resources
Betty Miles, *Save the Earth;* Lawrence Pringle, *Throwing Things Away;* Sabbithry Persad, *Where do Recyclable Materials Go?*

3R's of the Common Core
Parallel Activities
7 -8, Throwing It All Away
7 -8, School Trash Analysis
Information
Components of the Waste Stream
Resources
General

Background
Dr. Rathje was an archeologist with the University of Arizona who studied solid waste from the 1970s until the early 2000s. "His study reveals that Tucson's residents throw away 15% of their edible food at an annual cost of $11 to $13 million. Most of this is not in tiny bits but in large, usable amounts, such as whole steaks and half-used packages of soup. Comparing different neighborhoods, the study showed that middle-income people waste more food (and usable tools and appliances) than the poor or rich. Interviews with people in their homes, compared with actual evidence from garbage collected from their neighborhoods, revealed that people throw away much more edible food than they like to admit..."

– Lawrence Pringle, *Throwing Things Away*

Leading Question
How much of your lunch do you eat and how much do you throw away?

Procedure
1. Before lunch, have students examine their lunches and complete the attached worksheet. Each student should record the weight of the lunch on class chart. Compare the different packaging (e.g.: plastic bags, plastic or foil wrap, waxed paper, paper bags) and discuss how much came from non-renewable and how much from renewable resources. Ask students to bring everything they do not eat and all the wrapping back with them after lunch. Make sure they do not change their eating habits just for this experiment.
2. After lunch, have each student weigh the packaging and food remaining from lunch. Working singly or in groups of four or five, add this information to the class chart. Calculate the percentage of lunch actually consumed and the percentage of organic waste. If working in groups, have each summarize their findings and report to the class using a graph, interactive diagram, picture, etc.

Common Core Alignments

GRADE 4

CC.SL.4.1
Speaking & Listening:
Comprehension & Collaboration

CC.SL.4.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.4.OA.3
Mathematics:
Operations & Algebraic Thinking

GRADE 5

CC.SL.5.2
Speaking & Listening:
Comprehension & Collaboration

CC.SL.5.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.5.NBT.7
Mathematics:
Numbers & Operations Base Ten

GRADE 6

CC.SL.6.2
Speaking & Listening:
Comprehension & Collaboration

CC.SL.6.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.6.NS.3
Mathematics:
The Number System

3. Find a class total and calculate the waste generated by the class in a week, a month, the school year. Multiply times the number of classes in the school to get an approximate number for the school lunch waste. There are about 55 million students in public and private schools across the United States. Using an individual average from the class total, have the students figure out how much school lunch waste is generated in the United States each year.
4. Discuss the types of waste produced. What are similarities between individuals in the groups? Which category had the most waste? Discuss ways to reduce the amount of waste produced. How might some of the waste be reused or recycled?

Evaluation

Each student should be able to correctly measure, categorize and chart his or her lunch waste and identify potentials for reduction in waste through recycling or reuse.

Classroom Activities

A. Discuss the pros and cons of using plastic vs. paper grocery bags. Paper bags are made from a recycled renewable resource and can be reused and recycled again. A paper bag is biodegradable. Plastic bags are made from a non-renewable resource, can be reused, but are not recyclable. Most plastics are not biodegradable and when burned, can emit toxic fumes. Which bags are better to use? Encourage students to act in response to their opinions by making conscious choices and requesting the bag they think least harmful to the environment at checkout counters.

B. Discuss alternatives to requesting either bag at the check-out counter. For example, for small purchases choose not to use a bag at all, bring back and reuse the bag you got from your last grocery trip, make a permanent grocery bag from durable fabric which can be refilled and reused every trip to the grocery store.

C. Begin a class or school composting program to recycle organic lunch wastes.

D. Discuss the use of reusable lunch boxes, sandwich containers, thermos bottles, etc., to help reduce the amount of solid waste produced by carrying lunch to school or work.

Name:______________________________ Date: ____________________

School Lunch Waste

ITEM	FOOD	NON-FOOD		
Sample:		*Made of*	Renewable	Non-Renewable

1. Which category had the most waste?

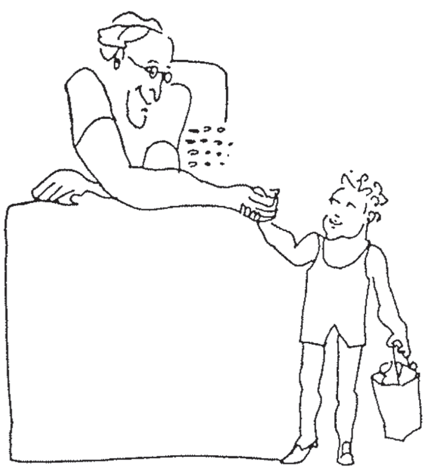
2. Which had the least?

3. Which types of waste were reusable?

4. Which types of waste were recyclable?

5. What can we change to reduce our lunch waste?

Name:______________________________ Date: ______________



"No Bag, Please"

a one-hour project

Everyone knows that when you save paper, you save some trees that would have to be cut down to make new paper.

Everyone knows this. But you can find out how hard it is for people to get used to saving paper.

Try this project when you are going shopping. Take a big shopping bag with you to put things in. When you pay for something watch carefully. Does the person at the counter start to put it in a bag for you?

If this happens, say "I don't need a bag, thanks." Then see how the store person acts. Surprised? Pleased? A little bit angry? Confused?

Then see how you feel. Ordinary? Embarrassed? Good?

It is sometimes easier to try new ways if you can get other people to try them with you. Maybe a friend or two from school would try the "no bag, please" experiment with you.

How Does Packaging Contribute to Waste?

Concept
Some packaging is better for the environment than others.

Objective
Students will gain an understanding of the resources which make up some typical packages and potential ways to reuse or recycle them.

Method
Students will answer questions about different containers.

Materials
Aluminum can, plastic bag, cardboard box, steel can, glass bottle, attached The Story of...

Subjects
Social Studies, Language Arts

Skills
Communicating information, designing, evaluating, gathering information

Time
Several class periods.

Vocabulary
Biodegradable, photodegradable, raw materials, natural resources, reuse, recycle, pollution, processing

Resources
Glass Packaging Institute; Reynolds Aluminum Company; The Aluminum Association; American Forest and Paper Association; Vicki Cobb, *The Secret Life of School*; Brad Herzog, *S is for Save the Planet: A How-to-be-Green Alphabet;* Norman Smith, *If It Shines, Clangs and Bends, Its Metas*; Suzanne Hilton, *How Do They Get Rid Of It?*

3R's of the Common Core
Parallel Activities
K-3, Gum Wrappers
7-8, Potato Cakes
9-12, Packaging Preferences
Information
Components of the Waste Stream
Packaging
Resources
Green Consumption, Consumerism and Sustainable Development
Solid Waste and Recycling

Leading Question
What kind of container do you think is best for the environment?

Procedure
1. Divide the class into five groups, each group representing one of the following common types of packaging:
    a. aluminum can
    b. plastic bag
    c. cardboard box
    d. tin can
    e. glass bottle
2. Each group will do some research into their packaging type using the attached The Story of... questions as guidelines for inquiry.
3. After completing their research, each group will produce a written report and either a multi-media component or visual display to present to the class explaining the discoveries about their type of packaging.
4. As a class, compare reports, discuss advantages and disadvantages of each type of container and decide which are most desirable.
5. Teacher to hold up examples of mixed packaging. Class to discuss problems caused by mixed packaging. See 4-6, III.A.1, Pondering Packaging.

Evaluation
Was the student able to report about a packaging type?

Common Core Alignments

GRADE 4

CC.SL.4.2
Speaking & Listening:
Comprehension & Collaboration

CC.SL.4.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.4.8
Writing:
Research to Build & Present Knowledge

GRADE 5

CC.SL.5.2
Speaking & Listening:
Comprehension & Collaboration

CC.SL.5.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.5.8
Writing:
Research to Build & Present Knowledge

GRADE 6

CC.SL.6.2
Speaking & Listening:
Comprehension & Collaboration

CC.SL.6.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.6.8
Writing:
Research to Build & Present Knowledge

Classroom Activities

A. Try to use reusable containers for your lunch. Keep a tally of how many of the students bring reusable containers each day for a week. Award a prize to the student making the most effort.

B. Collect all the packaging from products you buy for a period of time. Could you have made wiser choices in your product selection? Could the manufacturer have made wiser choices in the package production?

C. Design an environmentally sound package for a product.

D. Write a letter thanking a local restaurant for using recyclable packaging for its takeout containers or a letter requesting that the restaurant consider changing its current packaging.

Name:_______________________________________ Date: ____________________

I am a/an ____________________ container.

Please tell my story by finding answers to the following questions:

1. Describe me.

2. What are some of the things I am used for?

3. What am I made of?

4. What natural resource do I come from?

5. Are large amounts of my raw materials available?

6. How does it affect the earth when companies extract my raw materials?

7. Does it take a large amount of energy to produce me?

8. Am I thrown away after I am used?

9. Am I biodegradable? Am I photodegradable?

10. Do I disintegrate if I am thrown into a river, lake or ocean? If so, by what chemical/ biological means do I disintegrate?

11. What are some ways in which I could be reused?

12. Can I be recycled? Am I recycled? Where am I recycled?

13. What happens to me when I am recycled?

14. Who is responsible for disposing of me?

15. Who pays the cost for disposal?

16. Do you think I am a good container? Why or why not?

What Kind of Waste Am I? 4-6, I.B.1

Concept
The earth is the source of everything we make, use and throw away.

Objective
Students will review different characteristics of waste.

Method
Students will play a game of twenty questions.

Materials
Aluminum can, glass bottle, paper napkin, fruit peel, plastic bag, other trash objects as needed (avoid composite packaging)

Subjects
Language Arts, Science

Skills
Designing, developing models, identifying, questioning

Time
Full period to introduce vocabulary, 10-20 minutes for each guessing game

Vocabulary
Natural resources, fossil fuels, renewable, human-made, containers, compost, biodegradable, recyclable, composite packaging

Resources
Brad Herzog, *S is for Save the Planet: A How-to-be-Green Alphabet*

3R's of the Common Core
Parallel Activities
K-3, Machine
9-12, Sources of Waste
Information
The Solid Waste Stream
Waste and natural resources
Resources
General
Environmental Education and Educational Resources

Background

This activity illustrates that the earth is the source of everything we make, use and throw away. Through the use of classifying skills, the different properties of natural and human-made objects will be reviewed.

Leading Question

Name one thing we throw away that didn't come from the earth.

Procedure

1. Review vocabulary and categories of waste (plants, animals, minerals and fossil fuels) that will occur in the guessing game (see Resource Tree Display handout at the end of this lesson). A bulletin board is suggested.
2. Lay out all the trash objects on the table for students to view them. Distribute the Resource Tree handout to each student.
3. Without letting the class see what you are doing, put one of the trash objects in a brown paper bag. Show the contents to one student, then set the bag aside.
4. The class will then begin asking the student questions to determine what is in the bag. Some suggested questions are as follows:
   - Do I come from the earth?
   - Am I made from a renewable or non-renewable resource?
   - Am I made by a person?
   - Am I made from minerals or fossil fuels?
   - Am I made from animals or plants?
   - Am I biodegradable?
   - Am I packaging?
   - Am I a container?
   - Do I contain food?
   - Am I recyclable?
   - Am I compostable?

Common Core Alignments

GRADE 4

CC.L.4.3a
Language:
Knowledge of Language

CC.L.4.6
Language:
Vocabulary Acquisition & Use

CC.SL.4.1c
Speaking & Listening:
Comprehension & Collaboration

GRADE 5

CC.L.5.3a
Language:
Knowledge of Language

CC.L.5.6
Language:
Vocabulary Acquisition & Use

CC.SL.5.1c
Speaking & Listening:
Comprehension & Collaboration

GRADE 6

CC.L.6.3a
Language:
Knowledge of Language

CC.L.6.6
Language:
Vocabulary Acquisition & Use

CC.SL.6.1c
Speaking & Listening:
Comprehension & Collaboration

5. Ask students to identity the object and label it on their Resource Tree handout. Ask for a volunteer to pin or tape the object on the resource tree display.
6. Repeat the activity until all the trash objects have been identified. The resource tree display can be left intact with new objects added to it each day as a continuing review of concepts.

Evaluation

Students should be able to differentiate between natural and human-made materials, packaged and non-packaged items, animals, plants and minerals, renewable and non-renewable resources and be able to identify compostable and recyclable materials.

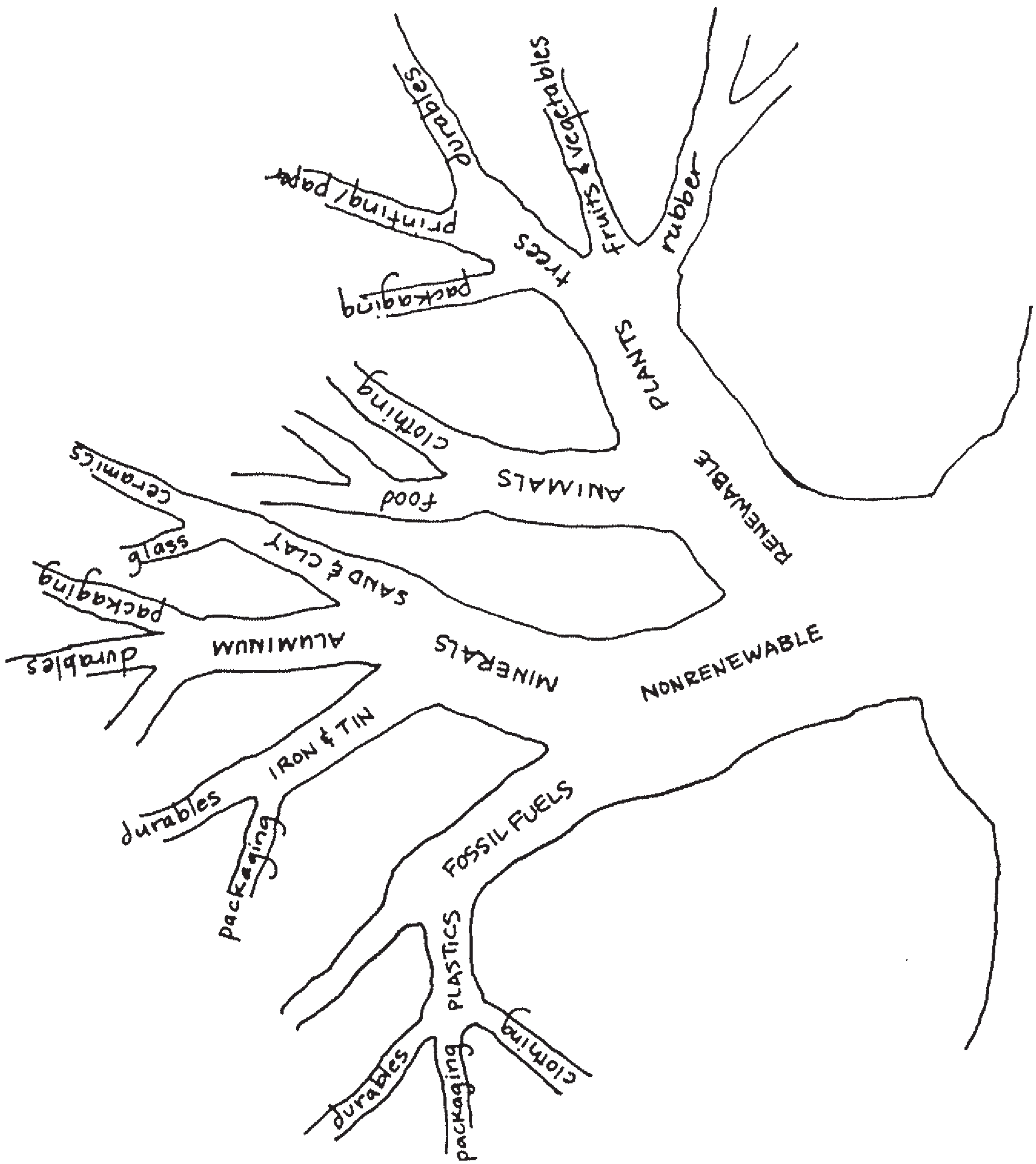
Classroom Activities

A. Make posters, collages or displays of packaging examples from each of the following areas: natural, human-made, from non-renewable resources, from renewable resources, biodegradable, non-biodegradable.

B. Have students trace the life history of a common trash object. (e.g. chicken bone-chicken-grain-earth; bauxite-aluminum-can-recycle-aluminum; cotton plant-socks-give to younger sibling-rag-textile recycler-carpet padding). Did it come from a renewable or non-renewable resource?

Resource Tree Display

The earth is the source of everything we make, use and throw away.



How Does Solid Waste Affect Natural Resources?

Concept
We all contribute to the solid waste problem and we are all responsible for helping to solve it.

Objective
Students will explore the impact of humans on natural systems and will be able to draw conclusions and make predictions about the environmental impact of certain behaviors.

Method
Students will read, listen to, or watch *The Lorax* by Dr. Seuss.

Materials
The Lorax by Dr. Seuss (book or film)

Subjects
Language Arts, Science, Social Studies

Skills
Communicating solutions, interpreting, problem solving, researching

Time
45 minutes

Vocabulary
Natural resources, ecosystem, environmental impact, natural systems

Resources
Shel Silverstein, *The Giving Tree*; Brad Herzog, *S is for Save the Planet: A How-to-be-Green Alphabet*

3R's of the Common Core
Parallel Activities
7-8, Resource Protection Game
9-12, non-renewable Resources
Information
Waste and Natural Resources
Resources
Biodiversity and Wildlife
Environmental Education and Educational Resources

Leading Question

What are some of the consequences of our throw-away habits?

Procedure

1. Read the book or watch the video of *The Lorax*.
2. Discuss the following questions or have the students complete the worksheet.
    - How did each step of the Once-ler's developing business destroy a piece of the ecosystem until the entire system ceased to function?
    - Why was the Super Axe Hacker invented?
    - Why did the Once-ler ignore the Lorax's warnings?
    - What happened to the Lorax?
    - What did the Lorax's message UNLESS mean?

Common Core Alignments

GRADE 4

CC.RI.4.3
Reading Informational Text:
Key Ideas & Details

CC.SL.4.2
Speaking & Listening:
Comprehension & Collaboration

CC.SL.4.6
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.4.4
Writing:
Production & Distribution of Writing

GRADE 5

CC.RI.5.3
Reading Informational Text:
Key Ideas & Details

CC.SL.5.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.5.3
Writing:
Text Types & Purposes

CC.W.5.4
Writing:
Production & Distribution of Writing

GRADE 6

CC.RI.6.3
Reading Informational Text:
Key Ideas & Details

CC.SL.6.3
Speaking & Listening:
Comprehension & Collaboration

CC.SL.6.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.6.4
Writing:
Production & Distribution of Writing

Classroom Activities

A. Have the students write poems about real forests and the wildlife which inhabit them. How can they help preserve these natural resources?

B. Draw before and after pictures of the Truffula-tree forest.

C. Have the students create a collage of Thneeds (things we think we need) from magazine pictures.

D. Create ads for natural resources, modeled after the Once-ler's advertisement for the Thneed:

> "A Thneed's a Fine-Something-That-All-People-Need.
>
> It's a shirt. It's a sock. It's a glove. It's a hat.
>
> But it has other uses. Yes, far beyond that.
>
> You can use it for carpets. For pillows! For sheets!
> Or curtains! Or covers for bicycle seats."

E. The Lorax spoke for trees "for trees have no tongues." What would you choose to speak for and what would you say? Plan a one minute talk on behalf of something which cannot speak for itself.

F. Identify and research real-life examples of the following items in the story: Swomee-Swans, Truffula Trees, Brown Bar-ba-loots, Humming Fish, Thneeds, Once-ler, Super-Axe-Hacker, Smogulous Smoke, Gluppity-Glupp, Schloppity-Schlopp. (For instance, a real-life example of Truffula Trees is tropical rainforests).

G. Put on a play of *The Lorax*.

Name: ______________________________ **Date:** ____________________

1. Why did the Once-ler cut down the Truffula trees?

2. Why do the Brown Bar-ha-loots have to leave?

3. What kinds of problems does the thneed factory cause for the environment? Name at least three.

4. What happens to the Once-ler when there are no more Truffula trees?

5. What happens to the Lorax?

6. Is bigger always better? Give an example to back up your opinion.

7. A "Thneed" is defined as a fine thing that everyone thinks they need. What are some examples of thneeds - things that we think we need?

8. If you were the Once-ler, what would you have done differently to protect the environment?

9. What do YOU think the Lorax's message "UNLESS" means?

How Has Solid Waste Changed Over Time?

Concept
What we throw away has changed with technological advances, increased wealth and changes in lifestyle.

Objective
Students will be able to describe ways in which changing domestic habits have intensified human impact on the environment.

Method
Students will compare present and past lifestyles.

Materials
Pictures, artifacts, history resources

Subjects
Social Studies, Home Economics, Language Arts

Skills
Interviewing, inventing, investigating, synthesizing

Time
One class discussion (outside class research time optional)

Vocabulary
Technology, lifestyles, antiques, natural resources, nonrenewable resource

Resources
Local museums and historical societies, local libraries, antique shops, old farm dumps

3R's of the Common Core
Parallel Activities
K-3, Grandparents' Toys
7-8, Trash Timeline
9-12, The Dump Ground
Information
Waste and Society

Background

"Anyone who has ever excavated an old country garbage dump in order to turn the site into a rose garden perhaps, or to build a shell, will probably have been interested in what was in it. All you will usually find in such dumps are heel irons (those horse-shoe shaped irons that farming men nailed to their boots), the occasional decayed old boot itself, old enameled sauce pans with holes in them, bits of pottery, the almost completely worn out remnants of sickles or scythes or spade blades and in the upper horizons of the heap maybe some broken bottles.

And that will be it: decades of garbage in just one small pile. Now there were not trash collections in those days - people had to dispose of their own garbage so these dumps contained everything that was thrown away. All organic material, except leather, went to the pig, or if there was no pig, to the compost heap. Of real garbage, of the kind we produce today, there hardly was any!"

–John Seymour and Herbert Girardet, *Blueprint for a Green Planet.*

Leading Questions

How have our lifestyles changed in the past one hundred years? How have these changes affected our waste stream?

Procedure

1. Tell a story about a family who bought an old farm house and decided to dig up their back yard to plant a garden and found glass bottles, chunks of pottery and pieces of metal tools.
2. Ask the students to make a list of the items they use every day, such as kitchen appliances, bathroom conveniences, travel methods, types of clothing and food.
3. Have each student pick one item from the list and research its equivalent from a hundred or two hundred years ago. When information, pictures and artifacts are assembled, have students complete the worksheet.
4. As a class discuss differences of times in the two time groups. How do these differences affect our solid waste crisis?

Common Core Alignments

GRADE 4

CC.SL.4.1
Speaking & Listening:
Comprehension & Collaboration

CC.SL.4.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.4.4
Writing:
Production & Distribution of Writing

CC.W.4.7
Writing:
Research to Build & Present Knowledge

GRADE 5

CC.SL.5.2
Speaking & Listening:
Comprehension & Collaboration

CC.SL.5.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.5.4
Writing:
Production & Distribution of Writing

CC.W.5.8
Writing:
Research to Build & Present Knowledge

GRADE 6

CC.SL.6.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.6.4
Writing:
Production & Distribution of Writing

CC.W.6.8
Writing:
Research to Build & Present Knowledge

Classroom Activities

A. Take a class field trip to an old local farm dump and excavate, looking for artifacts. Piece together the evidence collected to determine when the dump was last used. Make a lifestyles display from the finds, comparing them with present day equivalents. An alternative would be to visit a farm museum or historical society.

B. Invent an alternative to a modern convenience which would not use any non-renewable resources to operate, would last a long time and would not adversely affect the environment when its useful life was over.

C. Interview older people in the community to see what they have to say about life before modern conveniences.

D. Write an essay describing how one or several events from the Trash Timeline (Information Section) have caused changes in our environment.

Name:______________________________ Date: ________________

Antique Predecessors:

1. Consider the following characteristics of each object:

a. Is it made from natural or synthetic components?
NOW:
THEN:

b. Is it made from renewable or non-renewable resources?
NOW:
THEN:

c. Is it labor saving or labor intensive?
NOW:
THEN:

d. Does it use energy from renewable or non-renewable resources to operate?
NOW:
THEN:

e. Does it last a long time or is it disposed of quickly?
NOW:
THEN:

f. Is it hand-crafted or mass-produced?
NOW:
THEN:

g. Is it something you wouldn't want to have to do without or something you wouldn't mind giving up?
NOW:
THEN:

h. Is it nonbiodegradable or biodegradable?
NOW:
THEN:

i. Is it non-toxic or does it contain hazardous substances?
NOW:
THEN:

j. Is it necessary for survival or a convenience?
NOW:
THEN:

2. List some luxuries from the past which are considered necessities today.

3. What changes in lifestyle would result from the following:

a. loss of a non-renewable resource

b. drastic increase in the price of non-renewable fuel

c. irreparable damage to a renewable resource (e.g. groundwater contamination, depletion of forest reserves, animal extinction)

How is Solid Waste Collected and Processed?

Concept
Collecting and transporting trash is expensive and we are running out of places to take it.

Objectives
Students will understand that their trash has to go somewhere, that there are limited disposal options and will understand some of the problems of managing so much waste.

Method
Students will interview school custodians, trash collectors, school business personnel, waste hauling businesses, recyclers and town officials.

Materials
Town, country, state maps

Subjects
Language Arts, Mathematics, Social Studies

Skills
Applying mathematical concepts, communicating information, interviewing, questioning

Time
Time prior to interview to develop questions

Vocabulary
Trash hauler, refuse, collection, disposal, tipping fee, curbside recycling

Resources
Sabbithry Persad, *Where do Recyclable Materials Go?*; local waste haulers, school custodians, school business office, town clerk, local recyclers

3R's of the Common Core
Parallel Activities
K-3, Taking Trash Away
7-8, Trash Haulers
Information
Transportation and Processing
Resources
General

Leading Question
How much does waste disposal cost?

Procedure
1. Invite the school custodian and administrator to the class. With the class develop a list of questions to ask, such as:
   - How often is trash picked up?
   - What is the cost of removal?
   - Has that cost changed recently? Why?
   - How much trash is produced each week? What is the composition of the trash?
2. Take a field trip to a transfer station, landfill or recycling center.
3. Find out about local waste hauling businesses. How many are there? How many residents and businesses do they serve? If possible, ask a local waste hauler to come talk to the class. Some possible questions to ask the waste hauler are:
   - How many trucks do you own/operate?
   - What kind of trucks are they?
   - How much does that kind of equipment cost?
   - Why is the equipment designed the way it is?
   - How many truckloads of trash are collected each day?
   - How is the refuse measured? In tons or cubic feet?
   - How many houses and or businesses do you collect from?
   - Where is the trash taken and what are the tipping fees there?
   - How many miles do you cover each day, each year?
   - Would you ever consider operating a recycling curbside service? Why or why not? What would it involve?
4. Interview someone from a voluntary recycling program or a recycling business. On the basis of the interviews, have the class determine the costs involved in collecting and disposing of waste. Include equipment, mileage, salaries, tipping fees, etc., incurred in a waste hauling business.
5. Discuss the reasons waste haulers may or may not be interested in curbside recycling. What added expenses would there be to their businesses? Who would pay these costs? What about recycling programs?

Common Core Alignments

GRADE 4

CC.SL.4.3
Speaking & Listening:
Comprehension & Collaboration

CC.SL.4.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.4.2
Writing:
Text Types & Purposes

CC.4.OA.3
Mathematics:
Operations & Algebraic Thinking

GRADE 5

CC.SL.5.3
Speaking & Listening:
Comprehension & Collaboration

CC.SL.5.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.5.2
Writing:
Text Types & Purposes

CC.5.NBT.5
Mathematics:
Numbers & Operations Base Ten

GRADE 6

CC.SL.6.3
Speaking & Listening:
Comprehension & Collaboration

CC.SL.6.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.6.2
Writing:
Text Types & Purposes

CC.6.NS.3
Mathematics:
The Number System

Evaluation

Students write small group summaries from their interview and report it to class. Include Classroom Activities D (below).

Classroom Activities

A. Determine costs for waste disposal for the school for a year. Determine how much paper and/or organic wastes the school produces and devise a recycling or composting program which will help the school save money by reducing disposal costs. Ask students to include multimedia components in their presentations, such as graphics, music, sound, or visual displays.

B. Draw a map of your community showing the route your solid waste travels. Estimate cost per mile.

C. Explore what other communities are doing with their solid waste. In what ways are our problems like or unlike those of other communities?

D. Use a comic book app to create a cartoon about hauling waste away. Students should show evidence of understanding that their trash has to go somewhere, that there are limited disposal options and some of the problems of managing waste.

E. Draw a picture of a truck designed to pick up recyclables along with the trash.

Why is Litter a Problem?

Concept
Plastic litter does not decompose and can be dangerous to aquatic wildlife in both marine and freshwater environments.

Objective
Students will recognize some of the environmental hazards of plastic litter.

Method
Students test the biodegradability of paper and plastic litter.

Materials
Two cardboard six pack containers, two plastic six-pack rings

Subjects
Science, Social Studies, Language Arts

Skills
Analyzing, carrying out investigations, explaining, observing

Time
One class period to start, ongoing results recording over several weeks or months, one class period to discuss results

Vocabulary
Litter, plastic, photodegradable, biodegradable, organic

Resources
Center for Environmental Education, *Plastics in the Ocean: More Than a Litter Problem;* Your state's fish and wildlife department

3R's of the Common Core
Parallel Activities
7-8, Waste Walk
Information
Plastic
Litter
Resources
Solid Waste and Recycling

Background

Since 1989, all six-pack plastic rings manufactured in the United States must be photodegradable, which means it's capable of being broken down into smaller pieces by sunlight. The photodegradability of plastic has been tested by exposing it to direct sunlight for long periods of time. Natural conditions, however, rarely imitate those necessary for the photodegradation of plastics, meaning that many of these rings do not break down.

Leading Question

Is plastic litter a problem?

Procedure

1. If your state has a bottle bill, review its history. Discuss the meaning of photodegradable and biodegradable.
2. Conduct this experiment to determine the biodegradability of different packaging materials: Tack one cardboard six-pack container to a fence post or other fully sunlit spot and secure the other to a shady spot, leave in water, or cover partially with wet leaves. Repeat with two plastic ''biodegradable six-pack rings.
3. Check periodically for decomposition. Discuss results. How long did the paper take to decompose? Did any animals or insects help in the process? Did the plastic rings decompose? Was there a difference in the rates of decomposition between sun and shade?
4. Share the attached illustrations and information with students. Discuss the effect of plastics on the environment and their harm especially toward aquatic wildlife, including fish, mammals, birds and reptiles. How might we begin to solve these problems?

Evaluation

What are two characteristics of plastic that make it harmful to the environment? What are two things you can do to prevent harm to wildlife from plastic litter?

Common Core Alignments

GRADE 4

CC.L.4.6
Language:
Vocabulary Acquisition & Use

CC.RI.4.2
Reading Informational Text:
Key Ideas & Details

CC.SL.4.2
Speaking & Listening:
Comprehension & Collaboration

CC.W.4.3
Writing:
Text Types & Purposes

GRADE 5

CC.L.5.6
Language:
Vocabulary Acquisition & Use

CC.RI.5.8
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.5.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.5.3
Writing:
Text Types & Purposes

GRADE 6

CC.L.6.6
Language:
Vocabulary Acquisition & Use

CC.RST.6-8.3
Reading in Science & Technical Subjects:
Key Ideas & Details

CC.RST.6-8.9
Reading in Science & Technical Subjects:
Integration of Knowledge & Ideas

CC.W.6.3
Writing:
Text Types & Purposes

Classroom Activities

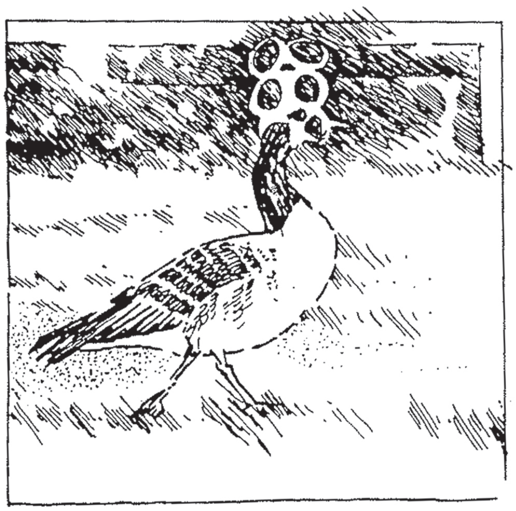
A. After reviewing the different problems caused by litter, play a game of charades. Break the class into groups of two or three. Give each group one of the attached charade cards. Students act out the litter action and then its effect on humans, wildlife and the environment.

B. After each charade has been guessed, the class as a whole discusses possible ways to prevent or solve the problem.

C. Show the class some pictures of animals that have been affected by plastic litter (available online). Write a story about a wild creature encountering plastic litter.

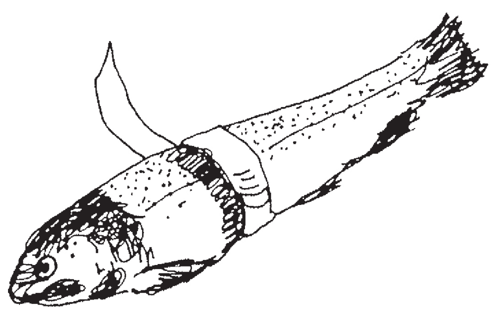
D. Collect as many different kinds of plastic as you can find. Then answer this question; Why is plastic difficult to recycle?

Why is Litter a Problem?



Every year countless numbers of marine animals are found entangled by fishing line. Sea turtles become entangled in snagged line, are then unable to break free and then drown. Birds even use discarded line for nesting materials that can create death traps for their young. It's not just fishing line that causes problem. Fish, birds and other animals have been found entangled in plastic rope, nets and even plastic connector rings used for beverage and motor oil cans. But entanglement is only part of the problem. Some animals, including sea turtles, whales and dolphins, even mistake plastic trash for food - a fatal mistake. One sea turtle was found with 590 feet of heavy duty line in its stomach and several have been found to eat plastic bags and sheeting. The animals then do not eat because their stomachs are full of plastic and they starve to death.

-Kathyrn O'Hara



Center for Environmental Education
The Institute for Sustainable Communication estimates 14 billion pounds of trash are dumped into the ocean each year. Commercial fishing fleets dump 150,000 tons of trash (including nets) into the ocean each year. This plastic netting entangles and kills fish and marine mammals. Scientists estimate that plastics are killing up to a million sea creatures each year. Recently plastics have been found in the stomachs of whales, dolphins, fish, birds and manatees. Leatherback turtles often mistake plastic bags floating in the sea for jellyfish, one of their favorite foods. As plastics accumulate in the intestines of such animals, starvation occurs slowly. Plastic holders for beverage cans, plastic bags and lost, or discarded, fishing line can all be damaging to wildlife.

-Institute for Sustainable Communication

Pollution Charade Cards

ACTION: **EFFECT:** **SOLUTION**:	**ACTION**: A person litters a plastic ring from a soda six-pack. **EFFECT:** The plastic ring strangles a duck or a fish. **SOLUTION:**
ACTION: A person is given a plastic gift card, uses it up and throws it on the ground. **EFFECT:** The plastic card is carried to rivers from the streets during heavy rain via storm drains and sewer overflows. **SOLUTION:**	**ACTION:** A person on a cruise ship notices plastic debris floating in the ocean. **EFFECT:** The ocean has become garbage soup. **SOLUTION:**
ACTION: **EFFECT:** **SOLUTION:**	**ACTION:** Those little plastic scrubbers found in so many beauty products (facial scrubs, toothpaste, body washes) slip through water-treatment plants. **EFFECT:** They look just like food to some marine animals. **SOLUTION:**
ACTION: A logging company clearcuts a forest. **EFFECT:** There are no more trees left and forest creatures are left homeless. **SOLUTION:**	**ACTION:** Someone changes his or her automobile oil and dumps it on the ground. **EFFECT:** A person or animal drinks contaminated water and becomes sick. **SOLUTION:**
ACTION: **EFFECT:** **SOLUTION:**	**ACTION:** A person throws a hot match on a path or roadside. **EFFECT:** A forest fire starts. **SOLUTION:**
ACTION: A farmer sprays pesticides on his potatoes. **EFFECT:** Rain washes the pesticides off into a stream and fish die. **SOLUTION:**	**ACTION:** A person throws a plastic sandwich bag out in the lake. **EFFECT:** A fish thinks the plastic is food, eats it and starves because its digestive tract gets blocked. **SOLUTION:**

How Do Landfills Work?

Concepts
Most solid waste is disposed of in landfills, but landfills are filling up and polluting our environment.

Objective
Students will learn how a sanitary landfill is made and operates and will understand some of the associated pollution problems.

Method
Students will review how a landfill works and will visit a sanitary landfill.

Materials
YouTube: "How Does a Modern Landfill Work?"; landfill illustration in Resource Section

Subjects
Science, Social Studies, Language Arts

Skills
Designing, gathering information, observing, questioning

Time
One class period

Vocabulary
Leachate, sanitary landfill, refuse, open dump

Resources
Sabbithry Persad, *Where do Recyclable Materials Go?* your state's waste management agency, local landfills; EPA, The Quest for Less

3R's of the Common Core
Parallel Activities
K-3, Litter Garden
7-8, Mini Landfills
9-12, New Landfills
9-12, Methane
Information
Landfills
Resources
Solid Waste and Recycling
Waste Management Agencies by State

Background

As the hazards of open dumping have become better known, landfill designs and rules have changed to better protect public health and our environment. The last major federal landfill regulations were passed in the mid to late 1990s, however, the EPA is always lobbying for amendments to existing legislation. Currently (2016), the EPA has proposed amendments to the Resource Conservation and Recovery Act that are still pending. There are several operating rules which characterize a sanitary landfill. Open burning is not allowed. Wastes are spread out, compacted and covered frequently with several Inches of soil to reduce odor, control litter, insects and rodents and protect public health. Liners and leachate collection systems are installed to protect ground and surface water from contamination. Fencing helps to control litter and prevent illegal dumping. When the site is finally full, it must be covered with a thicker layer of soil, landscaped and provisions made for the safe escape of methane gas and continued collection of leachate and monitoring of groundwater.

Leading Question

Do we take our trash to a sanitary landfill or an incinerator?

Procedure

1. Explain the differences between a landfill and an incinerator. Watch a video on how a sanitary landfill works. Provide the article "The Old Town Dump" from Information Section: Landfills to the students for them to read. Discuss.
2. Is there a landfill in your community? If not, where is the closest one? Is there a transfer station? Take a field trip to a local landfill. Call ahead and set up a time for your visit. Have students develop a list of questions to ask landfill personnel. (Use the attached list as a guide.) Students will be responsible for recording answers to the questions while at the landfill. Once back in the classroom, student groups will create posters with visuals and bullet point statements explaining the steps the landfill personnel take to build and operate a landfill.

Evaluation

Why are sanitary landfills now required in place of open dumps? How might we reduce our need for landfill space?

Common Core Alignments

GRADE 4

CC.RI.4.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.4.1c
Speaking & Listening:
Comprehension & Collaboration

CC.W.4.4
Writing:
Production & Distribution of Writing

GRADE 5

CC.RI.5.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.5.1c
Speaking & Listening:
Comprehension & Collaboration

CC.W.5.4
Writing:
Production & Distribution of Writing

GRADE 6

CC.RI.6.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.6.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.6.4
Writing:
Production & Distribution of Writing

Classroom Activities

A. Design a use for your local landfill when it closes.

B. Make a mini-landfill. See 7-8, II.B.I, Mini Landfills.

C. Access the EPA's Quest for Less curriculum and complete lessons about landfills. The entire cirriculum is available for free here: https://www.epa.gov/sites/production/files/2015-09/documents/qfl_complete.pdf. If the website is unavailable please contact the EPA to order or gain access to a copy. United States Environmental Protection Agency. Quest for Less: Activities and Resources for Teaching K-8 EPA530-R-05-005 (Washington, D.C., Government Printing Office, 200

Name:______________________________ **Date:** ______________________

VISIT TO A LANDFILL

1. Can you tell it is a landfill from the road?

2. Can you see what is happening from the road?

3. Does the site stand out from the rest of the landscape?

4. Are there many houses nearby?

5. What noises do you hear?

6. What kinds of trash do you see?

7. What is being done to the refuse?

8. How many vehicles do you see – working there? coming and going?

9. What kinds of vehicles?

10. What are they used for? How many workers?

11. Where does the leachate go?

12. Is it collected?

13. Can you see or smell methane gas coming from the landfill?

How Do We Burn Solid Waste?

Concept
Incineration as a waste management technique has both benefits and drawbacks.

Objective
Students will consider advantages and disadvantages of waste incineration.

Method
Students will research waste incineration plants and present the advantages and disadvantages of burning waste.

Materials
Wall chart

Subjects
Science, Social Studies, Language Arts

Skills
Analyzing, defining problems, evaluating, questioning

Time
Three class periods, field trip

Vocabulary
Incineration, dioxin, ash, heavy metal, emissions

Resources
EPA, local environmental groups, your state's air quality department

3R's of the Common Core
Parallel Activities
7-8, Burning Cans
9-12, Waste Management Choices
Information
Incineration
Resources
Air and Climate
Environmental Justice, Advocacy and Policy

Background

Every day approximately 2.9 pounds of trash per person in the United States are disposed in landfills. More space is needed for waste disposal as landfills fill up. Incineration is one answer to the lack of space. Incineration reduces the volume of waste requiring disposal by 80-90%. In a waste-to-energy plant, burning waste can also generate electricity for community needs. However, toxic substances such as dioxin may be released into the air, creating air pollution and possible health hazards. Dust and noise pollution are other possible problems associated with incineration.

Incineration is most efficient when certain materials are separated out of the waste stream. Newspapers may raise the burning temperature too high for efficient burning and they pollute the ash with heavy metals. Metals and glass do not burn. Because newspaper, steel, aluminum and glass are all recyclable, separation of these materials from the waste stream prior to incineration contribute to resource conservation and efficient plant operation. However, separating and recycling materials may be costly. The pros and cons of incineration need to be weighed by people looking for solutions for solid waste disposal and pollution. There are no right or wrong answers, only informed opinions.

Leading Question

Is burning a good way to get rid of trash?

Procedure

1. Divide the class into four groups. Ask them to read the article assigned to their group (one per group). Have students discuss key ideas and details from the article. Each group should work together to determine the problem/solution or cause/effect. Display a summary of the article and the problem/solution or cause/effect on chart paper. Then have each group present to the class.

Article choices:

Julia Pyper. "Does Burning Garbage to Produce Electricity Make Sense?" ClimateWire, Scientific American, August 26, 2011,

http://www.scientificamerican.com/article/does-burning-garbage-to-produce-energy-make-sense/

Timothy Williams. "Garbage Incinerators Make Comeback, Kindling Both Garbage and Debate," New York Times, January 10, 2015, http://www.nytimes.com/2015/01/11/us/garbage-incinerators-make-comeback-kindling-both-garbage-and-debate.html?_r=0

Common Core Alignments

GRADE 4

CC.RI.4.5
Reading Informational Text:
Craft & Structure

CC.SL.4.1c
Speaking & Listening:
Comprehension & Collaboration

CC.SL.4.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.4.4
Writing:
Production & Distribution of Writing

GRADE 5

CC.RI.5.5
Reading Informational Text:
Craft & Structure

CC.SL.5.1c
Speaking & Listening:
Comprehension & Collaboration

CC.SL.5.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.5.4
Writing:
Production & Distribution of Writing

GRADE 6

CC.RI.6.6
Reading Informational Text:
Craft and Structure

CC.SL.6.1d
Speaking & Listening:
Comprehension & Collaboration

CC.SL.6.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.6.4
Writing:
Production & Distribution of Writing

Dan Haugen. "Is Burning Garbage Green? In Sweden There's Little Debate," Midwest Energy News, October 17, 2013, http://midwestenergynews.com/2013/10/17/is-burning-garbage-green-in-sweden-theres-little-debate/

Nate Seltenrich. "Incineration Versus Recycling: In Europe, A Debate Over Trash," Environment360, August 28, 2013,

http://e360.yale.edu/feature/incineration_versus_recycling__in_europe_a_debate_over_trash/2686/

2. Discuss in class the pros and cons of incineration. Invite guest speakers who can present both points of view or conduct a debate either for or against incineration.
3. Construct a wall chart comparing the advantages and disadvantages of waste incineration.
4. View this YouTube video of an incineration plant.
5. Visit or contact a waste incineration plant. Have students develop a list of questions to ask incineration personnel.

Evaluation

Have students list the pros and cons of waste incineration.

Classroom Activities

A. Take a sampling of trash. Sort it for items that could be reused or recycled, removing them from the waste stream. Compare the amount left to be burned to the original sampling. Discuss the implications of burning our natural resources versus recycling them.

B. Wastus Solidus activity (at the end of this lesson)

C. Access Quest for Less cirriculum here: https://www.epa.gov/sites/production/files/2015-09/documents/qfl_complete.pdf and complete lessons for combustion (otherwise known as incineration). If the website is unavailable please contact the EPA to order or gain access to a copy. United States Environmental Protection Agency. Quest for Less: Activities and Resources for Teaching K-8 EPA530-R-05-005 (Washington, D.C., Government Printing Office, 2005).

D. Have students go to the Energy Justice Network's locator map on their website available here: http://www.energyjustice.net/map/localmap to locate local trash incinerators in the surrounding community. Arrange for a visit. Have students develop a list of questions to ask incineration personnel.

Name: ____________________ **Date:** ____________

THE LIFECYCLE OF THE SPECIES WASTUS SOLIDUS

Have students draw the lifecycle of the imaginary creature Wastus Solidus that is incinerated. Start with its birth in a garbage can or dumpster and follow it through incineration. After incineration, the Wastus Solidus divides and follows several different paths - captured electrical energy used in our community, ash buried in a landfill and air emissions from smoke stacks. Make sure students include these in their drawing.

As an extension, have students draw the lifecycle of Wastus Solidus that is buried in a landfill or that is recycled. Make sure to note that the lifecycle of Wastus Solidus does not end with death, since the waste we make stays as part of our environment forever.

How Do We Decide What to Do with Waste?

Concept
What we choose to do with our trash (reuse, recycle, recover or revise) will have an impact on our lives and our environment.

Objective
Students will evaluate solid waste items and decide which of the above four categories to place them in.

Method
Students will bring solid waste items from home or find them in the classroom and categorize them.

Materials
Bulletin board, thumbtacks, solid waste items from home

Subjects
Science, Social Studies, Language Arts

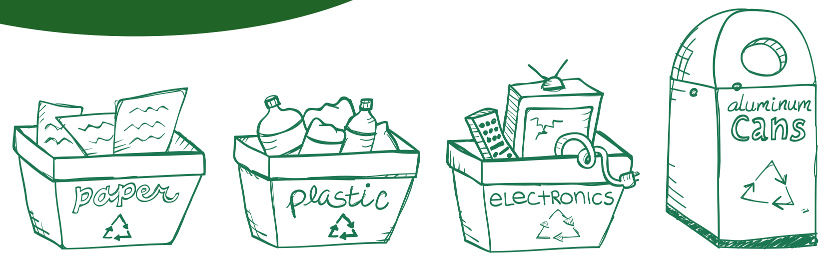
Skills
Applying ideas to solve problems, designing, developing models, evaluating

Time
Can be run throughout unit on recycling

Vocabulary
Revise, reuse, recycle, recover

Resources
Nuria Roca, *The Three R's: Reuse, Reduce, Recycle; The Trash Monster*

3R's of the Common Core
Parallel Activities
9-12, Waste Management Choices
Information
Public Planning and Policy



Background

Solid waste can be classified as reusable, recyclable, recoverable, or as a product that needs to be revised.

- Revise means to change, such as habits and attitudes in buying and using products as well as redesigning products.
- Reuse means to use again.
- Recycle means to collect used products and make them into new products.
- Recover means to produce energy by burning trash.

Leading Question

What can I do with this piece of solid waste?

Procedure

1. Introduce the concepts of Revise, Reuse, Recycle and Recover. Use the attached student page to stimulate thinking when introducing the concept of Revise.
2. Set up a bulletin board divided into sections with those four categories as headings. Have students begin tacking up items appropriate to each heading and have them explain why it belongs in that category. Some items may be appropriate to more than one heading. Have students select one item from the bulletin board display and write bullet point reasons and opinions for why it belongs in the category. Each student will present his/her ideas orally in the large or small group.

Evaluation

Can the student reasonably explain their choice of category for the item they are displaying?

Classroom Activities

A. For the items in the Revise category, how could it be changed? Have the students redesign the product to be less wasteful.

B. Do Solidus Wastus activity under 4-6, II.B.2, Investigating Incineration.

Common Core Alignments

GRADE 4

CC.L.4.6
Language:
Vocabulary Acquisition & Use

CC.SL.4.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.4.4
Writing:
Production & Distribution of Writing

GRADE 5

CC.L.5.6
Language:
Vocabulary Acquisition & Use

CC.SL.5.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.5.4
Writing:
Production & Distribution of Writing

GRADE 6

CC.L.6.6
Language:
Vocabulary Acquisition & Use

CC.SL.6.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.6.4
Writing:
Production & Distribution of Writing

Name:_______________________________ **Date:** ____________________

I can't	I don't want to	I might	I'll do it sometimes	Easy, I'll do it	
					Walk instead of asking for a ride.
					Ride a bike instead of asking for a ride.
					Throw papers in trash cans.
					Use dishes instead of paper plates and paper cups.
					Use the back of writing and drawing paper.
					Save envelopes and wrapping paper to use again.
					Save cans and bottles for recycling.
					Use plastic bags over and over.
					Avoid buying things in plastic containers or wrappers.
					Turn off all water faucets tightly.
					Fix drips and leaks.
					Don't let water keep running when you brush your teeth.
					Run dishwashers and washing machines only when full.
					Don't use the toilet as a wastebasket.
					Turn off lights when you're not using them.
					Plant trees.
					Fix things instead of throwing them out.
					Give outgrown clothes to someone smaller.
					Share books and games with your friends.
					Talk to people about ecology. *[Now add to this list and make copies for students.]*

How Can We Redesign Things to Waste Less?

Concept
Over packaging contributes to waste and is often unnecessary.

Objective
Students will examine examples of over or composite packaging, will assess its negative impact and will brainstorm alternatives.

Method
Students will compare different packaging.

Materials
Five different examples of wasteful packaging (e.g. brick packs, disposable razor in plastic bag, individually wrapped hardware items, individually wrapped cheese slices, fruits and vegetables individually wrapped in Styrofoam and plastic film.)

Subjects
Social Studies, Science, Language Arts

Skills
Designing, developing models, interpreting, problem solving

Time
One class period.

Vocabulary
Packaging, over-packaging, reusable, recyclable, conglomerate packaging

Resources
Student Environmental Action Coalition, Environmental Action Foundation

3R's of the Common Core
Parallel Activities
K-3, Egg Cartons
7-8, Packaging Design
Information
Components of the Waste Stream
Packaging
Redesign and Reuse
Resources
Green Consumption, Consumerism and Sustainable Development
Solid Waste and Recycling

Background

In 2012 approximately 30% of solid waste in the United States was packaging - more than 75 million tons! Packaging is designed to protect its contents from physical damage and spoilage thus allowing for transportation of goods from far away, without adding broken or rotten objects to the waste stream. For example, in the United States it is estimated that only 12% of fruits and vegetables and only 6.25% of seafood and meat spoil during transportation. Packaging not directly related to these two functions is what is often considered excessive packaging.

Packaging is made from a variety of materials, some recyclable or compostable and others not. Increasingly metal, glass and paper/cardboard materials, all recyclable or compostable, are being replaced by plastic or multi-type, multi-layered materials which are almost impossible to recycle or compost.

Leading Question

What problems does packaging pose?

Procedure

1. Examine the handout The Garbage-Rich Home. Brainstorm types of packaging with class. Have students bring in samples.
2. Break the class into five groups and give one example to each group. Have each group unwrap each package and record the different kinds of packaging material. Why was a particular type of packaging used? Was it necessary? Was it recyclable or reusable?
3. Have each group design an alternative packaging for their example. See 7-8, III.A, Packaging Design.
4. Using the subjects of discussion, each group will make a display to show excess or bad packaging, possible alternatives and a list of ways in which the new packaging reduces waste.

Evaluation

Students should be able to identify several examples of overpackaging, accompanying problems and reasonable alternatives.

Common Core Alignments

GRADE 4

CC.L.4.6
Language:
Vocabulary Acquisition & Use

CC.RI.4.8
Reading Informational Text:
Integration of Knowledge and Ideas

CC.SL.4.1c
Speaking & Listening:
Comprehension & Collaboration

CC.W.4.4
Writing:
Production & Distribution of Writing

GRADE 5

CC.L.5.6
Language:
Vocabulary Acquisition & Use

CC.RI.5.8
Reading Informational Text:
Integration of Knowledge and Ideas

CC.SL.5.1c
Speaking & Listening:
Comprehension & Collaboration

CC.W.5.4
Writing:
Production & Distribution of Writing

GRADE 6

CC.L.6.6
Language:
Vocabulary Acquisition & Use

CC.RI.6.8
Reading Informational Text:
Integration of Knowledge and Ideas

CC.SL.6.1c
Speaking & Listening:
Comprehension & Collaboration

CC.SL.6.6
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.6.4
Writing:
Production & Distribution of Writing

Classroom Activities

A. Identify examples of well-designed packaging (from an environmental perspective.)

B. Read the article Zoe Mcknight. "Plastic-wrapped, Precut Avocado Prompts Outcry Over Overpackaging," The Star, March 16, 2016, https://www.thestar.com/life/2016/03/15/plastic-wrapped-boxed-avocado-the-latest-in-overpackaging-outcry.html.

C. Debate the use of one kind of packaging compared to another.

D. Invite a packaging industry representative and an environmentalist to class to discuss opposing views of packaging.

E. Reuse packaging materials in a collage or sculpture.

F. Make a bulletin board display comparing natural and human-made packaging.

The Garbage-Rich Home

Household garbage comes in two main types: the leftovers from day-to-day living (i.e. packaging, bottles, cans, and newspapers); and then, once-in-a-while waste (i.e. broken appliances, old furniture, worn-out carpets, etc.). The latter is an inescapable result of modern life, but the former, which makes up the bulk of household garbage, can be greatly reduced without too much difficulty.

Unsorted Waste

Putting all household waste into one can makes recycling almost impossible. The mix of organic matter and household chemicals in the unsorted waste also presents disposal hazards.

Composite Materials

Many household products are packaged in composite materials - mixtures of plastics, paper, and metal that cannot be separated. (And so cannot be recycled.)

Plastic Packaging

Plastic makes up about 13% of household garbage; most of it is used as packaging. Plastics cause immense problems in waste incineration because many of them give off poisoned gases when burned.

Aluminum Cans

The most valuable material in the recycling bin is aluminum and it is still being lost to landfills. Americans throw away nearly $1 billion worth of aluminum cans every year. Aluminum is the most recyclable of all materials. Discarded aluminum is more valuable than any other item in the recycling bin.

Fast Food

Layers of paper, cardboard and plastic, surround fast food. Large quantities of materials go into making packaging that is then used for a ridiculously short time.

Newspaper and Magazines

Throwing a year's newspaper into the garbage can wastes at least 220 pounds of paper, a valuable commodity that coud easily be recycled.

Positive Action

Five steps for reducing your household garbage

1 Don't mix up your garbage

Ideally, every house should have a separate can for trash, recyclables, and compost. Understandably, recycling kitchen waste may be difficult if you don't have a garden, but recycling paper and glass is certainly possible.

2 Apply the overpackaging test

Excessive packaging is the most avoidable source of household waste. Choose products that are contained in the least amount of packaging and never buy those that fail the overpackaging test: How many times does it take to get to the center of your purchase?

3 Buy in bulk

Regular household products packaged in small quantities produce more waste than those packaged in large quantities. Six separate cans of drink, for example, will produce far more waste than a single bottle containing the same amount. So when possible, buy the biggest size (that won't go to waste) or in loose bulk.

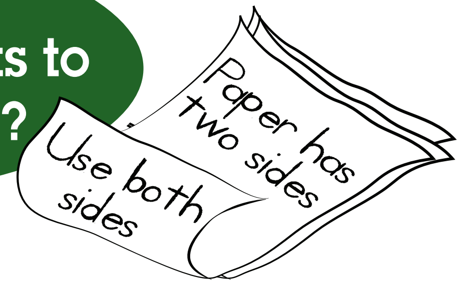
4 Choose returnable containers

Returnable bottles and cans are good for the economy. Choose returnable containers whenever you can.

5 Choose natural packaging

Packaging made of paper or cardboard is preferable to plastic because it can be recycled everywhere. For the same reason, glass bottles and aluminum cans are better than plastic ones, especially if they are returnable.

How Can We Revise Our Habits to Reduce Waste?



Concept
Many of our daily habits are wasteful regarding the use of paper.

Objective
Students will learn how much paper is wasted and will learn ways to conserve it.

Method
Students will collect and measure the amount of waste paper they consume in the classroom in a week.

Materials
Waste paper, two boxes, scale, paper for a graph.

Subjects
Mathematics, Social Studies, Language Arts

Skills
Collaborating, collecting data, investigating, researching

Time
Two weeks minimum

Vocabulary
Recycle, reuse

Resources
American Forest and Paper Association; Your state's Department of Natural Resources, Conservation, or Environmental Management; Project Learning Tree; Earth Care Paper Company; Vicki Cobb, T*he Secret Life of School Supplies*; Student Environmental Action Coalition, Environmental Action Foundation, I*t's Your Environment: Things To Think About,Things To Do*; Brad Herzog, *S is for Save the Planet: A How-to-be-Green Alphabet*

3R's of the Common Core
Parallel Activities
K-3, Yesterday's Paper
K-3, Trash or Treasure?
Information
Redesign and Reuse
Recycling
Resources
Reuse Activities

Background

The largest single component of solid waste is paper (about 30% by weight and 50% by volume). Americans consume more paper per capita than any other country in the world. In 2012 each person in the United States contributed approximately 437 pounds of paper to the solid waste stream. Individuals are the first links in the paper recycling process. By reusing and recycling paper we can help conserve resources, protect the environment and reduce energy use. Each ton of paper that is recycled replaces and preserves 13-20 500-pound, harvestable trees. Making paper from recycled fibers uses 30 to 55% less energy than making paper directly from trees and reduces the air pollution from the manufacturing process by 95%.

Leading Question

How much paper do you think you use? Do you need to use all of it?

Procedure

Day one:

1. Have the students collect the classroom paper they would normally recycle.
2. Divide the paper from step one into two boxes: paper we can still use (Reuse Box), paper we have used completely (Recycle Box - paper has been used on both sides).
3. Weigh the paper in each box, using pound (1 lb), half pound (½ lb) and quarter pound (¼ lb) increments.
4. Construct a list with two columns. One column showing the weight of the Recycle Box. Another column showing the weight of the Reuse Box.
5. Repeat steps 1-4 for one week.
6. Add the weight fractions from each column to create a total for the week.
7. At the end of the week compare the two results. Could we have used less paper? How can we reduce the amount of paper we use?
8. Repeat process for a second week. Start a line plot graph, showing weight on the Y axis and the week number on the X axis. Compare data from week to week. Have attitudes and habits changed? Is the amount of paper waste decreasing? Repeat again in a month or do once a month and graph.
9. After doing steps one through eight above, take the weekly totals and find the average daily weights. (e.g. Total week one weight = 20 lbs. Avg. daily weight = 20lbs / 5days = 4 lbs per day.)
10. Complete steps one through eight using decimals instead of fractions.

Common Core Alignments

GRADE 4

CC.SL.4.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.4.4
Writing:
Production & Distribution of Writing

CC.4.MD.4
Mathematics:
Measurement & Data

GRADE 5

CC.SL.5.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.5.7
Writing:
Research to Build & Present Knowledge

CC.5.MD.2
Mathematics:
Measurement & Data

GRADE 6

CC.SL.6.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.6.7
Writing:
Research to Build & Present Knowledge

CC.6.SP.2
Mathematics:
Statistics & Probability

Evaluation

Have habits and attitudes changed? How do you know? How can we conserve paper?

Classroom Activities

A. Working with a partner, make two lists: first, list all the paper products you use at home and second list substitute products to use in place of paper products.

Paper Items	Other Choices
Paper napkins	Cloth napkins
Paper dishes	Washable dishes and glasses
Tissues	Handkerchief
Paper towels	Dishcloths or sponge for spills

B. Visit a paper mill or paper recycling industry.

C. Make recycled paper. See Activity 4-6, III.B.2 Papermaking.

D. Use your results to predict the amount of paper the school uses in a year.

  a. Research marketing possibilities for the school's waste paper. Contact or write to local recyclers asking for their assistance in helping your school recycle waste paper.

  b. Compare school results to a local business' use of paper. Contact local businesses by writing letters and arranging for a visit to weigh waste paper. Report findings back to the business with suggestions for ways to recycle, using knowledge from local recyclers and other resources.

Name:______________________________ Date: ______________

National Center for Appropriate Technology. Sophie Diven. Illustrator

How Can We Revise Our Habits to Reduce Waste?

Concepts
Reusing waste will conserve natural resources and save landfill space.

Objective
Students will learn that they can reuse material to make useful objects.

Method
Students will look at examples of old quilts and will make their own object from scrap fabric.

Materials
Fabric scraps, scissors, thread, needles, old t-shirt brought from home, example of recycled textile such as rug padding, etc.

Subjects
Art, Social Studies, Language Arts

Skills
Collaborating, designing, interviewing, sharing research and writing

Vocabulary
Reusing, textiles, conserving, resources, patchwork quilt

Resources
Local historical societies and museums: books by Eric Sloane: quilt books; local state art councils; Sewing and reuse books for kids; Carolyn Jabs, *RE/USES*

3R's of the Common Core
Parallel Activities
K-3, Yesterday's Paper
K-3, Trash or Treasure?
7-8, Art Reflecting the Environment
Information
Waste and Society
Redesign and Reuse.
Resources
Environmental Education and Educational Resources

Background

"Use it up, wear it out, make it do, or do without."

One hundred years ago, Americans threw out very little. They made use of everything they could because purchasing new materials was expensive and difficult. Following the old "waste not, want not" ethic saved money and made solid waste problems almost non-existent. Our ancestors braided rugs, made patchwork quilts and found many other uses for the scraps of material that they carefully saved from worn-out clothes. Quilt-making has become a popular craft again, in most cases not as a way to conserve resources, but for the decorative and artistic value in the quilts. Many people today buy new fabric for their quilts or rugs and throw out the excess.

Leading Question

Why did our ancestors make patchwork quilts?

Procedure

1. Bring in a real patchwork quilt to touch and see, if possible. Discuss the materials of which patchwork quilts are made. Why? Why didn't people just go to the store and buy a new blanket or comforter?
2. Ask students to collect scraps of fabric (nothing new!). Have them ask family members for materials and if they have ever made a patchwork quilt or similar item before. Did they use new fabric or old?
3. Make a theme quilt as a class. or have students make their own small useful objects such as book bags, pillow covers, satchels, potholders, sports bags, bike bags, computer keyboard covers. This project may be done at school or at home. Students will present their product to the class and explain how the materials were obtained. For a shorter lesson, have material scraps available in a bag for the class. Then, rather than sewing a quilt, have students lay scraps together In a pattern for a pretend quilt or other useful object.

Common Core Alignments

GRADE 4

CC.SL.4.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.4.4
Writing:
Production & Distribution of Writing

CC.4.MD.4
Mathematics:
Measurement & Data

GRADE 5

CC.SL.5.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.5.7
Writing:
Research to Build & Present Knowledge

CC.5.MD.2
Mathematics:
Measurement & Data

GRADE 6

CC.SL.6.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.6.7
Writing:
Research to Build & Present Knowledge

CC.6.SP.2
Mathematics:
Statistics & Probability

4. Provide time for students to read about quilting. See book list. Students may:
    a. Conduct a short research project and write about the history of quilting.
    b. Read books with a partner to determine theme and message.
    c. Share knowledge and understanding from the above exercises by presenting to the class, using multimedia components.

Evaluation

Why is it important to reuse things instead of tossing them out?

Classroom Activities

A. Invite a quilt, rug, paper maker or other artisan to visit and demonstrate his or her craft. See if your state has a registry of craftspeople.

B. Visit a museum to explore other reuses in history.

C. Have students list some items that we produce today which great grandmother did not have. Are they improvements? Bring an elderly person into the class to talk about how things used to be and discuss what modern developments they think have been improvements.

D. Visit a nursing home and interview the residents about how life used to be and how products have changed.

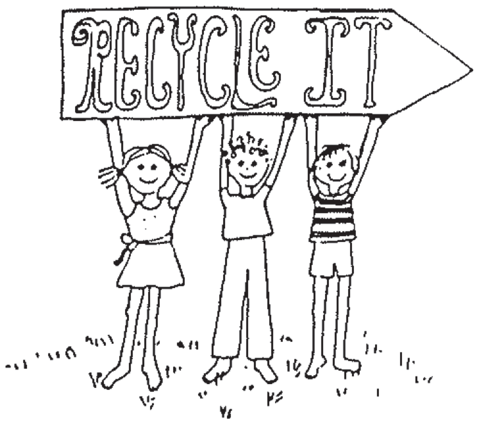
E. Have students make a patchwork poster from discarded packaging materials.

F. Have students bring in an old t-shirt to create a reusable bag. Cut off the sleeves. Make slit cuts in the bottom of the shirt to form rectangular tabs. Have students tie the front tab to the back tab so that the bottom of the shirt becomes closed up like a bag. Encourage the students to bring their new bag to the grocery store in place of disposable plastic bags.

G. Discuss textile recycling. What can you do if you have leftover scraps of fabric, towels with holes in them, one lonely sock, or a shirt with lots of stains on it? Can you give it to GoodWill or the Salvation Army? Why or why not? (Yes you can! Textile recyclers will pick up clothing that can not be sold or given to people in need.) Show examples of rug padding (available at the local hardware store) or the stuffing inside a stuffed toy. These products are typically made from recycled textiles. Share the statistics about textiles thrown in the trash.

H. Complete activities from handout (at end of the lesson).

Name:______________________________ **Date:** ____________________

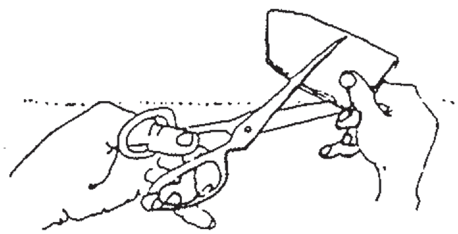


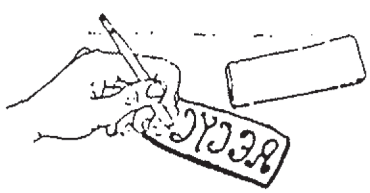
Materials

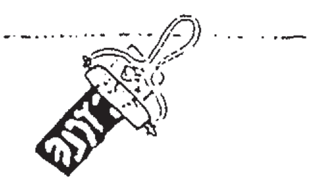
- Used Styrofoam packaging trays for printing block (only yellow holds paint on surface)
- Flat surfaced tray for the paint rolling surface
- Newspaper
- Poster paint
- Scrap construction paper

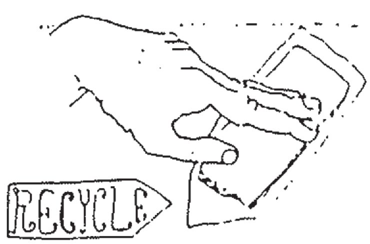
Tools

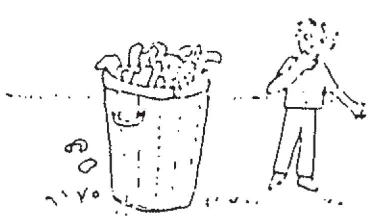
- Scissors
- Pencil for carving
- Used plastic spoon
- Brayer (roller) or sponge











1. Spread out newspaper to work on.
2. Cut the bookmarker printing block out of yellow tray. Make it any shape.
3. With a pencil, write the word RECYCLE backwards in the Styrofoam. Press the pencil point 1/8″ in when carving. Practice on a piece of paper. Hold the piece of paper up to a mirror and look at the image. What happens? Try different ways to make the work look exciting or fancy.
4. Place a spoonful of poster paint in a tray, rolling it out with a brayer or sponge in a solid even layer.
5. Roll a solid even layer of paint onto your brayer or dab a sponge onto the paint. Roll or dab this over your carved piece of Styrofoam. Keep the paint out of the wording you've carved.
6. Place the printed surface of your printing block onto a piece of scrap construction paper. Press the entire area of the block with your fingers to make sure the paint transfers. The paint will print better if there is a layer of newspaper underneath.
7. Wash your paint rolling trays and keep for another time.
8. Cut out your bookmarkers and use, share with friends, or leave a stack of them at a library for the public to use.
9. How much waste did you create by using Styrofoam? How much did you throw away?

QUILTING BOOKS

FICTION AND INFORMATIONAL BOOKS

Bolton, Jane. MY GRANDMOTHER'S PATCHWORK QUILT (Doubleday, 1994). A story of life on a farm is told in words and pictures as a quilt is made.

Brumbeau, Jeff. THE QUILTMAKER'S GIFT (Scholastic Press, 2001). A greedy king has a change of heart when a quiltmaker agrees to make him a quilt.

Brumbeau, Jeff. THE QUILTMAKER'S JOURNEY (Orchard Books, 2005). A wealthy but unhappy child finds happiness through giving. Gr. 2-5

Cobb, Mary. THE QUILT-BLOCK HISTORY OF PIONEER DAYS WITH PROJECTS KIDS CAN MAKE (Demco Media, 1995). A history of American pioneers is told through the quilts they made. Designs can be made of paper. Gr. 2-6

Coerr, Eleanor. THE JOSEPHINA STORY QUILT (HarperCollins, 2003). A family journey to California in 1850 brings unexpected events leading to the making of a quilt. Gr. 1-3

Dock, Julie B. QUILTING NOW AND THEN (Now & Then Pubns, 1994). Mother explains how quilts are made today and in the time of pioneers.

Flournoy, Valerie. THE PATCHWORK QUILT (Dial, 1997). An intergenerational and multicultural family story tells how girls and boys pitch in to finish a quilt.

Gibbons, Gail. THE QUILTING BEE (HarperCollins, 2004) A quilting bee sets the stage for history and fun facts about quilts as well as "how-to." Gr. 1-4

Hopkinson, Deborah. SWEET CLARA AND THE FREEDOM QUILT (Reading Rainbow Books, 1997). An African American slave girl overhearing talk of escape to Canada creates a quilt with a map to freedom.

Jonas, Ann. THE QUILT (Greenwillow Books, 1984) A quilt is created from scraps of a child's clothing through the years. Gr. K-3.

Johnston, Tony. THE QUILT STORY (FBAPowerSetup, 1996). A loving mother creates a quilt that comforts her daughter and another child generations later.

Kaldenberg, Phyllis E. QUILT FOR MR. MAC: A QUILT OF VALOR STORY (CreateSpace Independent Publishing Platform, 2015). A quilt is made to honor a man for his service during WW II.

Lyons, Mary E. STITCHING STARS: THE STORY QUILTS OF HARRIET POWERS (Atheneum, 1993). The life and art of an American slave is captured in her quilts. Gr. 4

Paul, Ann Whitford. EIGHT HANDS ROUND: A PATCHWORK ALPHABET (HarperCollins, 1996). Information about pioneer life through the letters of the alphabet. Gr. 1-4

Polacco, Patricia. THE KEEPING QUILT (Simon & Schuster, 2001). An immigrant Jewish family's clothing from Russia is made into a quilt and handed down through the generations.

Stroud, Bettye. THE PATCHWORK PATH: A QUILT MAP TO FREEDOM (Candlewick, 2007). A girl and her father escape slavery using symbols on a quilt. Gr. 1-4

Vaughan, Marcia. THE SECRET TO FREEDOM (Lee & Low Books, 2002). Set before the Civil War, a found sack of quilts helps slaves escape on the Underground Railroad. Gr. 2-4

Wallace, Nancy Elizabeth. THE KINDNESS QUILT (Two Lions, 2006). Teacher and students work on a kindness project and create a quilt. Gr. K-2

Woodson, Jacqueline. SHOW WAY (Putnam, 2005) The knowledge of quilting show ways, or maps for slaves to follow to freedom, are passed down from one generation to the next as a remembrance of the past and a celebration of future possibilities.

INSTRUCTIONAL BOOK

Addison, Kristen Kolstad. PLAY QUILT: CREATIVE ACTIVITY QUILTS FOR KIDS (Martingale and Company, 2001).

Ball, Maggie. CREATIVE QUILTING WITH KIDS (Krause Publications, 2001)

Gaddy, Kim. STORY TIME: PICTURE QUILTS TO STIR A CHILD'S IMAGINATION (C&T Publishing, 2012).

Hale, Christy. QUILTING ACTIVITIES FOR YOUNG LEARNERS: 15 EASY AND DELIGHTFUL"NO SEW"PROJECTS (Scholastic Press, 2005).

Hendler, Muncie. TWELVE QUILT BOOKMARKS (Dover Publications, 1992).

Levin, Susan. SHOW ME HOW: QUILTING STORYBOOK AND HOW-TO-QUILT INSTRUCTIONS (Sixth&Spring Books, 2007).

Smith, Sieglinde Schoen. MOTHER EARTH'S QUILT SAMPLER (Breckling Press, 2009).

Tracy, Kathleen. PRAIRIE CHILDREN AND THEIR QUILTS: 14 LITTLE PROJECTS THAT HONOR THE PIONEER SPIRIT (That Patchwork Place, 2006).

How Does Recycling Work?

Concept
Everything we make, use and throw away comes from and returns the earth.

Objective
Students will trace objects from their source, to the consumer and back again.

Method
Students will examine and trace the life cycles of common household objects.

Materials
One object made of one material per student.

Subjects
Language Arts, Social Studies, Science

Skills
Analyzing, applying ideas to solve problems, communicating information, researching

Time
One class period.

Vocabulary
Cycle, resource, reuse, recycle, transportation, energy

Resources
Vicki Cobb, *The Secret Life of School Supplies*

3R's of the Common Core
Parallel Activities
K-3, Cycles
7-8, Destination Recycle
Information
Components of the Waste Stream
Recycling
Resources
Solid Waste and Recycling

Background

Natural resources are something useful we get from the environment, such as air, water, plants, animals, rocks and minerals. Humans' need for natural resources and our actions impact the environment. Students should be encouraged to be ecologically sensitive and practice habits that help conserve natural resources. In order for children to develop a sense of urgency, it is necessary that children learn how much in their daily lives comes from the Earth and its environment.

Leading Question

Where do things we use come from and where do they go to?

Procedure

1. Have students examine the "Life Cycle of Stuff" article on the EPA website https://www3.epa.gov/climatechange/climate-change-waste/life-cycle-diagram.html Ask students to take notes about the steps in the process of creating products. How does reducing the use of materials lessen the environmental impact? (Optional Resource): Teachers can also have students watch the Natural Resources video on BrainPop.com (must become a member first). https://educators.brainpop.com/lesson-plan/natural-resources-background-information-for-teachers-and-parents/
2. Ask each student to bring to class a common household object made from only one material (e.g. rubber eraser, glass jar, piece of paper, plastic bag). Each student will identify the natural resources used and the steps taken to make the object and deliver it to the consumer. Then trace all the steps needed to recycle the product back into another object.
3. Illustrate the life cycle on poster board and write a detailed caption for each step taken to recycle the product. In small groups have students present their life cycles, explaining the steps from creation to recycle. Students should add enhancements to their presentations, either through audio recordings, music or other computer graphics/visual displays to clarify information.
4. Discuss the different steps required to produce the things we use each day. How many times is the object transported in its lifetime? By what? Using what as fuel? Is the object easily reusable? Is it easily recyclable? What are the environmental effects of producing and transporting the object?

Common Core Alignments

GRADE 4

CC.SL.4.1c
Speaking & Listening:
Comprehension & Collaboration

CC.SL.4.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.4.4
Writing:
Production & Distribution of Writing

GRADE 5

CC.RI.5.1
Reading Informational Text:
Key Ideas & Details

CC.SL.5.1c
Speaking & Listening:
Comprehension & Collaboration

CC.SL.5.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.5.4
Writing:
Production & Distribution of Writing

GRADE 6

CC.RI.6.1
Reading Informational Text:
Key Ideas & Details

CC.SL.6.1d
Speaking & Listening:
Comprehension & Collaboration

CC.SL.6.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.6.4
Writing:
Production & Distribution of Writing

Evaluation

Students should be able to trace the life cycle of any object made from one material. How many steps or phases are there in the life cycle of your object?

Classroom Activities

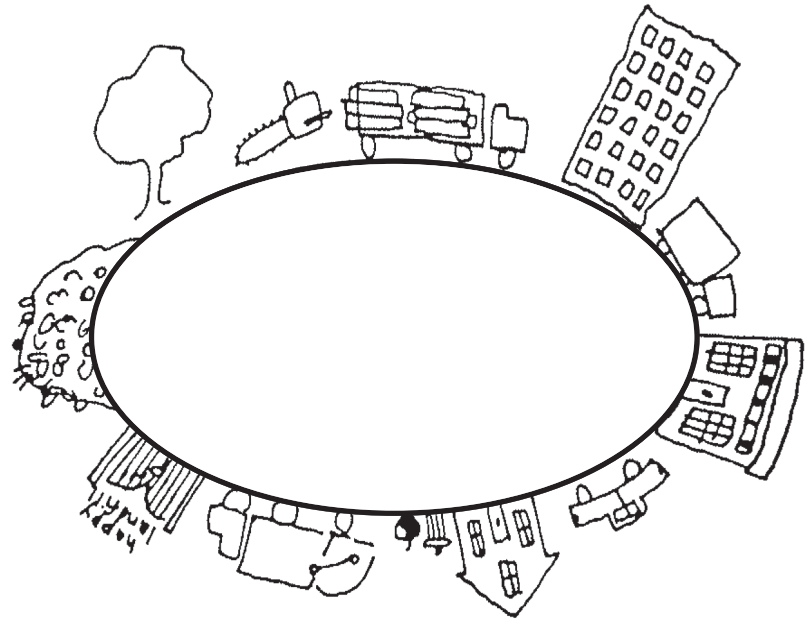
A. Trace the life cycle of a pencil or other commonly used, inexpensive object made from several different resources. Is a pencil easily recyclable?

B. Have your students discover their own global network by completing the "Global Closet Calculator"—a two-part interactive game that introduces the concepts of interdependence and globalization. http://nationalgeographic.org/media/globalcloset/

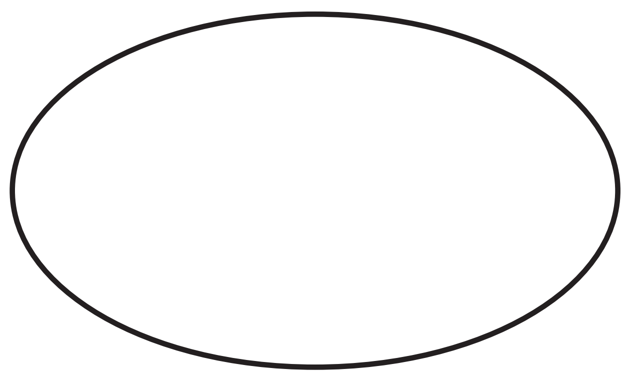
C. Roleplay the life cycles of different objects (e.g. one not widely recycled vs. recycled; Styrofoam vs. paper.)

Name:_______________________________ **Date:** _______________

tree
logger cuts
trucker hauls
processed in mill
furniture factory buys wood
trucker hauls
factory processes into candlesticks
trucker hauls
wholesale store buys
trucker hauls
retail store buys
transports
customer buys and uses
transports
thrift store
transports
discarded in landfill
decays into contaminated soil



Lifecycle of:



How Does Recycling Work?

Concept
Our natural resources can be reused and recycled into new and useful products.

Objective
Students will learn how paper is recycled.

Method
Students will make their own recycled paper.

Materials
Scrap paper (preferably white ledger paper, construction paper for coloring), decorative filler scraps (flowers, seeds, pine needles, small pieces of colorful paper, yarn, thread, feathers, etc.), two wooden frames the same size, nylon fly screening or substitute, many absorbent rags at least as large as the frames, one wash basin, blender, sponge

Subjects
Art, Science, Language Arts

Skills
Applying mathematical concepts, collecting data, designing, researching

Time
Two hours

Vocabulary
Papermaking, mould, deckle, pulp, screen

Resources
American Forest and Paper Association; Local state departments of conservation, wildlife or natural resources; Vicki Cobb, *The Secret Life of School Supplies*; Leonard Fisher, *The Paper Makers;* Gail Gibbons, *Paper, Paper, Everywhere*; Arnold E. Grummer, *Paper By Kids*

3R's of the Common Core
Parallel Activities
9-12, Recycling Paper Pollution
Information
Paper
Recycling
Resources
Pulp and Paper
Recycling

Background

The trickiest part of making paper is finding enough absorbent material to sop up all the water. Make sure to have plenty of sponges, sheets and towels handy. You might want to have each student bring in his or her own towels. Avoid using newspaper if possible.

Newsprint will turn everything dark grey and if you dry something on a sheet of newspaper you will not be able to recycle it. If you would like everyone in the class to get a chance in one class period, you might want to set up stations around the class so that there is one basin with mould and deckle for each four to five students.

Leading Question

Why should we recycle paper?

Procedure

1. Explain the process of making paper.
2. Follow the attached directions to make a sheet of paper. Emphasize the reasons for recycling:
    - resource conservation
    - less energy used
    - less waste needing landfilling

Also discuss the related problems of water pollution, contaminants, paper grades, costs of collection and transport. Ask students to explain the relationship between the process of making new paper and the related problems listed above. Students should locate specific information from a scientific resource (book, website, etc.) and cite it as evidence.

Evaluation

What are the steps required to turn waste paper into new paper? What are some of the problems in recycling paper?

Common Core Alignments

GRADE 4

CC.L.4.6
Language:
Vocabulary Acquisition & Use

CC.RI.4.3
Reading Informational Text:
Key Ideas & Details

CC.SL.4.2
Speaking & Listening:
Comprehension & Collaboration

CC.W.4.4
Writing:
Production & Distribution of Writing

CC.4.MD.4
Mathematics:
Measurement & Data

GRADE 5

CC.L.5.6
Language:
Vocabulary Acquisition & Use

CC.RI.5.3
Reading Informational Text:
Key Ideas & Details

CC.SL.5.2
Speaking & Listening:
Comprehension & Collaboration

CC.5.MD.2
Mathematics:
Measurement & Data

CC.5.NBT.7
Mathematics:

GRADE 6

CC.RI.6.4
Reading Informational Text:
Craft & Structure

CC.RST.6-8.3
Reading in Science & Technical Subjects:
Key Ideas & Details

CC.SL.6.2
Speaking & Listening:
Comprehension & Collaboration

CC.6.RP.3c
Mathematics:
Ratios & Proportional Relationships

CC.6.SP.2
Mathematics:
Statistics & Probability
Number & Operations in Base Ten

Classroom Activities

A. Students can write poems (e.g. Haiku) or try calligraphy on their paper (if you use pens or pencils that do not bleed).

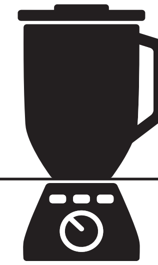
B. Go to http://search.earth911.com/ and learn what types of paper are commercially recycled, how to prepare the paper for recycling and where the closest paper recycler is located.

C. Weigh all the waste paper your class generates in a week. (See Wise Use of Paper 4-6, III.A.2) Separate the recyclable portion and weigh the remainder to see how much the class can save for recycling. Have a contest with another class to see who can save the most. Have each class weigh the amount of waste paper and the amount of paper that can be recycled per week, month and school year. Keep track of the percentage of waste recycled in each classroom.

D. Collect all the waste paper that can be reused from around the whole school. With adult supervision, use a paper trimmer to have students cut the paper into four rectangles. Punch two holes in the top of each rectangle. Create paper pads by stacking the paper and tying string through the holes to create a binding. Give the notepads to the teachers and ask them to allow students to use them for class notes or scrap paper for calculations.

EQUIPMENT

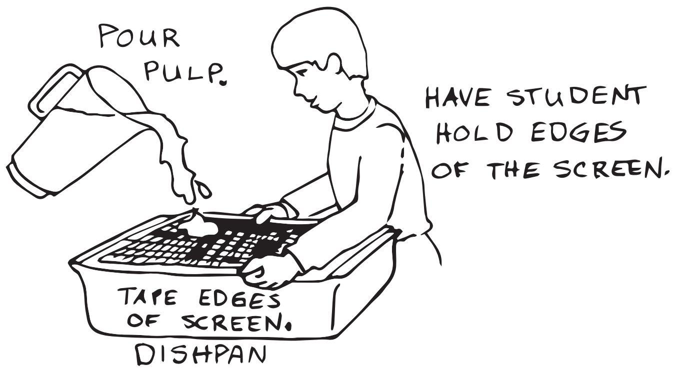
- Scrap paper
- Plant and vegetable scraps
- Staples, tack, or waterproof glue
- 2 wooden frames (suggested dimension 20cm x 15cm)
- Nylon fly screening
- Kitchen cloths (at least 2)
- A wash basin
- Blender
- Sponge
- Iron



1. To make paper you must first make a 'paper mould' - a wooden frame with nylon fly screen stapled tightly to it. You can use a second wooden frame (deckle) without the fly screen to help make your paper more even.
2. Take some scrap paper, remove any plastic or staples, tear it into small pieces (about 2 cm square) and soak it in hot water for half an hour.
3. Take a handful of the soaked paper and put into a blender about half-full of warm water. Blend at a moderate speed until you no longer see pieces of paper. (If you have problems, take out some of the paper.) To this mixture (pulp) you can add small amounts of vegetable material like orange peels, carrot tops or flowers, and blend again.

Coloring the Pulp: If you want colored paper, you can add fabric dye to the pulp. Make sure the dye is non-toxic.

4. Pour the mixture into a large plastic basin, half-full of warm water. Increasing or decreasing the amount of the pulp will affect the thickness of the paper.



5. Place the deckle on top of your screen. With both hands, dip the mould into the basin and scoop up some of the pulp. Gently shake the mould back and forth to get an even layer of fibers on the screen. When the water has drained through, place the mould to one side and carefully lift off the deckle, leaving the just-formed sheet on the screen.
6. Toe remove the pare from the screen, lay a clean kitchen cloth on the flat table, then take the screen and lay it face down on the cloth. Soak up extra water from the back of the screen with a sponge. Very gently lift the screen. The paper should remain on the cloth.
7. To dry the paper quickly, cover it with another cloth and iron at a medium dry setting. Once dry, pull gently on either side of the cloth to stretch it - this helps loosen the paper from the cloth. Gently peel the paper off.
8. A CLEANUP NOTE: When you've finished, collect the left over pulp in a strainer. Be careful NOT to pour pulp down the drain - it might block it. The strained pulp can be thrown out or kept in a plastic bag in the freezer for the next time.

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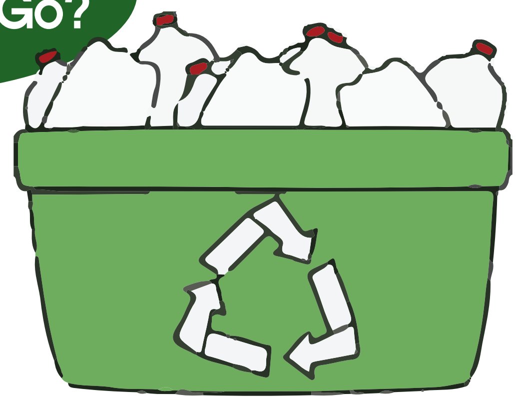
Hunter David. Papermaking: The History and Technique of an Ancient Craft, 2nd ed. New York: A. Knopf, 1947. Reprinted: New York, Dover Publications, 1978.

Studley, Vance. The Art and Craft of Handmade Paper. New York: Van Nostrand Reinhold, 1977.

If you have any suggestions require more information, write to:

The Printed Word,
Printing and Papermaking,
Ontario Science Center,
770 Don Mills Road,
Toronto, ON M3C 1T3
www.ontariosciencecentre.ca

Where Do Recyclables Go?



Concepts
Recyclables should be source separated; publicity for recycling centers is necessary for their success.

Objective
Students will gather information about where materials can be recycled.

Method
Teachers will invite guest speakers to present information on recycling centers.

Materials
Maps, recycling locations, mapmaking materials

Subjects
Science, Social Studies, Language Arts

Skills
Collaborating, communicating information, gathering information, sharing research and writing

Time
Several class periods.

Vocabulary
Solid waste district, collection points, recycling center, source separation

Resources
State agencies; town clerk; solid waste management and planning commissions

3R's of the Common Core
Parallel Activities
K-3, What's Recyclable
7-8, Destination Recycle
9-12,Collecting and Sorting
Information
Recycling.
Resources
Solid Waste and Recycling
Waste Management Agencies by State

Background

Successful recycling depends in part on public education, publicity and convenience. Most people agree that recycling benefits the environment and helps reduce disposal problems. They would like to recycle, but don't because they either do not know how to recycle, where to recycle, or available recycling centers are too far away or collection days too infrequent. Therefore, public education and convenience are vital parts of any successful recycling program.

Leading Question

What is recyclable and where can we take our recyclables?

Procedure

1. List recyclables on the board. Include the following; three colors glass, plastic beverage bottles (PET), plastic detergent and milk jugs (HDPE), newspaper, ledger paper, mixed paper, mixed plastic, corrugated cardboard, aluminum (cans, pie plates, foil), steel cans, other metals, batteries and oil. Discuss methods of preparation for various materials. Review what happens to the items when they are recycled. Show YouTube videos of recycling facilities going through the recycling process. Do you and the students know where these items can be recycled locally? If not locally, where in your state? Go to http://search.earth911.com/ to find out.
2. Have the town recycling committee or a regional solid waste commission member visit your classroom to talk about local recycling efforts.

Evaluation

Students should know where to recycle various materials and will begin to understand the complexities of setting up and maintaining successful recycling programs.

Common Core Alignments

GRADE 4

CC.SL.4.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.4.1b
Writing:
Text Types & Purposes

CC.W.4.6
Writing:
Production & Distribution of Writing

GRADE 5

CC.SL.5.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.5.1b
Writing:
Text Types & Purposes

CC.W.5.6
Writing:
Production & Distribution of Writing

GRADE 6

CC.SL.6.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.6.1b
Writing:
Text Types & Purposes

CC.W.6.6
Writing:
Production & Distribution of Writing

Classroom Activities

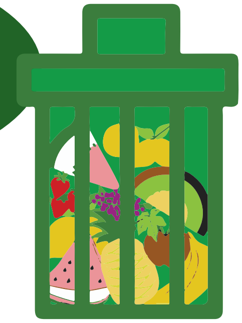
A. Make maps of recycling centers in your area. Display maps at home or distribute maps to local bulletin boards, businesses, etc. to stimulate recycling activity in the community.

B. Make a map of the towns in your solid waste district, showing collection points for solid waste and recyclables.

C. Use technology to create an informational flyer for giving away at area businesses, such as banks and supermarkets.

D. Write letters to the editor of your local newspaper about what students have learned and why recycling is so important in the world today.

How Can We Recycle Organic Matter?



Concept
Organic waste can be recycled to enrich soil for growing more organic matter.

Objective
Students will learn about recycling organic matter.

Method
Students will build a model compost pile in a classroom terrarium.

Materials
Aquarium, organic wastes, soil (not potting soil), thermometer, trowel or large spoon, 1-2 dozen red earthworms

Subject
Science, Language Arts, Mathematics

Skills
Graphing data, investigating, observing, predicting

Vocabulary
Decomposition, humus, microorganisms, aerate

Time
One class period to a full year

Resources
"The Wild World of Compost", *National Geographic*; Mary Appelhof, *Worms Eat My Garbage*; Pat Hughey, *Scavengers and Decomposers*

3R's of the Common Core
Parallel Activities
K-3, Take Me Out to the Compost
7-8, Making Good Compost
9-12, Microorganisms
9-12, Effective Fertilizers
Information:
Composting
Resources:
Environmental Education and Educational Resources, Green Consumption, Consumerism and Sustainable Development

Background

When we mention 'recycling,' we often think of recycling glass bottles, aluminum cans and newspapers. But another 30% of the household garbage we throw out can also be recycled. These recyclables are food scraps, leaves, grass clippings and other biodegradable organic wastes. Organic wastes can be recycled by composting. Simply stated, composting creates optimal conditions for decomposition to occur. Decomposition is the biochemical process by which bacteria, fungi and other microscopic organisms break organic "wastes" into nutrients that can be used by plants and animals. Decomposition occurs in nature whenever a leaf falls to the ground or an animal dies. It is essential for the continuation of life on earth. The result of decomposition in a compost pile is a nutrient-rich humus that is excellent for improving soil quality and plant growth.

Leading Question

What do you do with your food scraps?

Procedure

1. Assemble a variety of organic wastes including with following: manure and green grass clippings, sawdust, hair, wood ash, leaves, kitchen food scraps, etc. Avoid meat scraps, dairy products, fats and oils which inhibit decomposition, cause odors and can attract pests. Chop the organic wastes into small pieces. You can leave some large pieces of the same materials to compare rates of decomposition between large and small items. Why might there be a difference?
2. Read Necessary Components of a Compost Pile. Turn and Talk: Ask students to provide a summary of the text to a classmate. Students should highlight or underline key information in the text that show evidence of one or two main ideas. Create a compost by alternating layers of the materials as follows (amounts are approximate): one inch of soil, two inches of organic waste, sprinkle of manure or green grass clippings, sprinkle of water. Repeat.
3. Cover with an inch of soil. Water the pile enough to make it moist but not soggy. It should feel like a damp sponge (It feels moist, but you can't squeeze water out of it).
4. Add the earthworms and observe their behavior. In notebooks ask students:
   a. to make predictions about what each believes will happen in one day, one week, one month, etc.
   b. to date and post their observations, inferences and conclusions.

Common Core Alignments

GRADE 4

CC.RI.4.1
Reading Informational Text:
Key Ideas & Details

CC.W.4.4
Writing:
Production & Distribution of Writing

CC.4.NBT.3
Mathematics:
Number & Operations in Base Ten

GRADE 5

CC.RI.5.2
Reading Informational Text:
Key Ideas & Details

CC.W.5.4
Writing:
Production & Distribution of Writing

CC.5.OA.1
Mathematics:
Operations & Algebraic Thinking

GRADE 6

CC.RI.6.2
Reading Informational Text:
Key Ideas & Details

CC.W.6.4
Writing:
Production & Distribution of Writing

CC.6.SP.2
Mathematics:
Statistics & Probability

Classroom Activities

5. Place the compost pile where it will be at room temperature (not in direct sun). Gently mix the compost once a week to aerate It. Use a thermometer to test the temperature of the pile. (For consistency do it at the same location and depth at the same time each day.) Students will date and post their conclusions in their notebooks. Students should have two columns: the first column is the actual temperature measurement to the nearest degree and the second column is the temperature rounded to the nearest five or ten degrees.
6. After the first week of measurements, calculate the following: a. sum, b. average (center), c. range (spread)
7. Make a graph of results, analyze the data and draw conclusions. Determine the overall shape of the graph. Is it symmetrical or is it skewed left or right?
8. Convert fahrenheit temperatures to celsius, using the following formula:

   Tc=celsius

   Tf=fahrenheit

   Tc=(Tf-32)x5/9
9. Discuss composting. How does it reduce the amount of waste you would have thrown out? What do you think happens to organic wastes that end up in the landfill? Is the landfill a gigantic natural compost pile, or are there problems with placing large amounts of organic material in landfills?

Evaluation

Students will identify the ingredients of a compost pile.

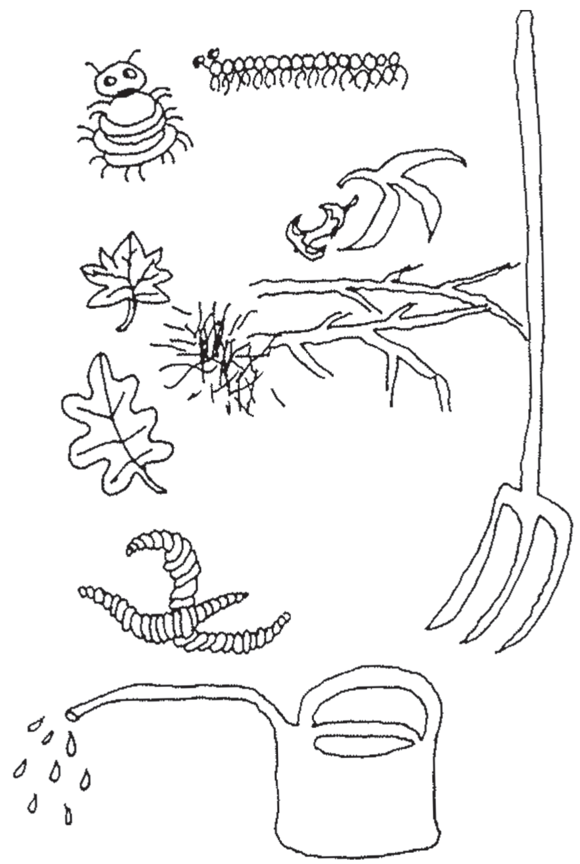
Classroom Activities

A. Construct a compost pile at home to use for the family garden or a vermi-compost bin in the classroom for disposing of daily snacks.

B. Begin a school garden. Use the soil you've made to plant some flowers or vegetables.

Necessary Components of a Compost Pile

SOIL: Contains microorganisms that help decomposition.

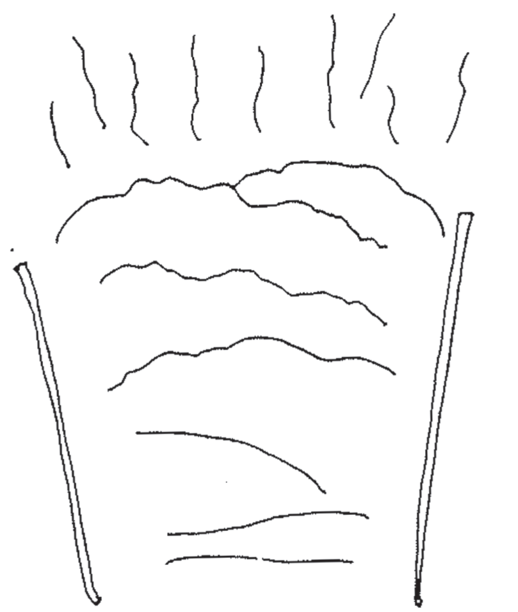


ORGANIC WASTES: such as leaves, food scraps and grass clippings. Wastes should be varied, including materials with both carbon and nitrogen. By alternating layers of high-carbon and high-nitrogen materials, you can create good environmental conditions for decomposition to occur.

NITROGEN: many of the organisms responsible for decomposition need nitrogen, thus nitrogen is necessary for rapid and thorough decomposition. Nitrogen is found naturally in many organic wastes, such as manure and green grass clippings, as well as in many commercial fertilizers.

WORMS: they eat the waste, helping to break it down; make droppings, which enrich the soil; tunnel through and aerate the waste, facilitating decomposition and eventually die and become part of the compost.

WATER: necessary for normal functioning of life. Too much water in a compost pile may make it soggy and slow decomposition by reducing needed oxygen.



AIR: the biological activity of fungi, bacteria, small insects and other organisms results in decomposition. Most biological processes require adequate amounts of oxygen.

TIME: decomposition takes time. To speed up decomposition, aerate your pile every few days; otherwise, just leave it and wait.

HEAT: heat is produced by chemical reactions resulting from increased biological activity that occurs during decomposition. Heat helps sanitize compost by killing certain organisms, such as weed seeds, pathogens and harmful insect larvae.

MASS: In order to generate enough heat for optimal decomposition the pile must contain at least one cubic meter of organic material. Thus, the temperatures generated in an aquarium compost pile may be different from those generated in one that is larger.

3R's of the Common Core

7-8 Activities

Brought to you by

Northeast Resource Recovery Association
2101 Dover Rd | Epsom, NH 03234
www.nrra.net | info@nrra.net
800-223-0150

NRRA School CLUB
www.schoolrecycling.net
theclub@nrra.net

USDA Rural Development
Committed to the future of rural communities.

Lesson Matrix Grades 7-8

3R's of the Common Core

Lesson	Leading Question	Objective	Common Core Alignments		Skills
7-8 Throwing It All Away I.A.1	What do you know about the solid waste we produce?	• Understand the sources, content and magnitude of the solid waste problem	**Grade 7** CCRI.7.1 CC.W.7.7 CC.SL.7.1 CC.7.RP.3	**Grade 8** CC.RI.8.1 CC.W.8.7 CC.SL.8.1	• Communicating • Comparing multiple solutions • Sharing research and writing • Applying mathematical concepts
7-8 School Trash Analysis I.A.2	What are all the things we throw away?	• Analyze waste producing habits in order to begin changing them	**Grade 7** CC.SL.7.4 CC.W.7.4 CC.7.SP.1	**Grade 8** CC.SL.8.4 CC.W.8.4 CC.8.SP.1	• Analyzing • Applying mathematical concepts • Investigating
7-8 Potato Cakes I.A.3	Could we save energy and other natural resources by choosing one product or packaging over another?	• Examine the complexities of food processing and packaging	**Grade 7** CC.RI.7.4 CC.SL.7.4 CC.W.7.4 CC.7.EE.3 CC.7.RP.1	**Grade 8** CC.RI.8.4 CC.SL.8.4 CC.W.8.4	• Applying ideas to solve problems • Collaborating • Researching • Using mathematical and computational thinking
7-8 Resource Protection Game I.B.1	How do our activities impact on our environment?	• Identify the ecological impacts of some of the solid waste management practices on natural resources	**Grade 7** CC.RI.7.4 CC.SL.7.1 CC.W.7.7	**Grade 8** CC.RI.8.4 CC.SL.8.1 CC.W.8.7	• Collaborating • Gathering information • Problem solving
7-8 Trash Timeline I.C.1	What can the waste we produce tell us about ourselves?	• Examine and classify various forms of evidence in the study of current trash and that of a past culture	**Grade 7** CC.RI.7.8 CC.SL.7.4 CC.W.7.6	**Grade 8** CC.RI.8.8 CC.SL.8.4 CC.W.8.6	• Analyzing • Collaborating • Sharing research and writing
7-8 Art Reflecting the Environment I.C.2	Why do people create art? What is the difference between "art" and "waste"?	• Understand the visual artist as a recorder of history and ideas • Identify society's impact on artistic expression • Identify potential ways artistic expression can impact society	**Grade 7** CC.RI.7.1 CC.SL.7.5 CC.W.7.6	**Grade 8** CC.RI.8.1 CC.SL.8.5 CC.W.8.6	• Analyzing • Applying ideas to solve problems • Questioning • Sharing research and writing
7-8 Waste Walk II.A.1	What is litter?	• Document and categorize litter in their neighborhood • Explore ways to get people to stop littering	**Grade 7** CC.RI.7.4 CC.W.7.2 CC.7.SP.1	**Grade 8** CC.RI.8.4 CC.W.8.2 CC.8.SP.1	• Applying mathematical concepts • Collecting data • Interviewing • Problem solving

Lesson Matrix Grade 7-8

3R's of the Common Core

Lesson	Leading Question	Objective	Common Core Alignments		Skills
7-8 **Recovering Recyclables** **II.A.2**	How can mixed trash be separated for recycling?	• Devise materials recovery systems for recovering recyclables from the waste stream	**Grade 7** CC.RI.7.1 CC.SL.7.4 CC.W.7.4	**Grade 8** CC.RI.8.1 CC.SL.8.4 CC.W.8.4	• Applying ideas to solve problems • Comparing multiple solutions • Developing models
7-8 **Trash Haulers** **II.A.3**	How much does waste disposal cost?	• Investigate the efficiency and costs of solid waste collection • Assess advantages/disadvantages of operating a recycling business and/or a curbside recycling program	**Grade 7** CC.SL.7.1 CC.W.7.4 CC.7.NS.3	**Grade 8** CC.SL.8.1 CC.W.8.4 CC.8.SP.1	• Gathering information • Interviewing • Sharing research and writing • Using mathematical and computational thinking
7-8 **Mini-Landfills** **II.B.1**	What are some of the possible hazards that might result from an improperly designed landfill?	• Learn how a sanitary landfill is made and operates • Understand some of the associated pollution problems	**Grade 7** CC.RST.6-8.3 CC.SL.7.4 CC.WHST.6-8.7 CC.7.G.6	**Grade 8** CC.RST.6-8.3 CC.SL.8.4 CC.WHST.6-8.7 CC.8.G.9	• Applying mathematical concepts • Developing models • Observing • Providing evidence
7-8 **Landfill Soil** **II.B.2**	Why is it important to test the soils of a potential landfill site?	• Determine the importance of soil studies prior to the siting of landfills	**Grade 7** CC.SL.7.1 CC.W.7.4 CC.W.7.7 CC.7.RP.3	**Grade 8** CC.SL.8.1 CC.W.8.4 CC.W.8.7 CC.8.F.5	• Carrying out investigations • Developing models • Observing • Sharing research and writing • Using mathematical and computational thinking
7-8 **Burning Waste: Then and Now** **II.B.3**	Why do we burn trash?	• Research the historical perspective of burning solid waste • Examine the reasons for these changes over the decades	**Grade 7** CC.RI.7.1 CC.SL.7.4 CC.W.7.4	**Grade 8** CC.RI.8.7 CC.SL.8.1 CC.W.8.6	• Sharing research and writing • Analyzing • Comparing multiple solutions • Collaborating
7-8 **Packaging Design** **III.A.1**	How could packaging be designed to waste less?	• Explore parameters of packaging design • Use guidelines in their own design project	**Grade 7** CC.RST.6-8.8 CC.SL.7.4 CC.WHST.6-8.7 CC.7.G.6	**Grade 8** CC.RST.6-8.8 CC.SL.8.5 CC.WHST.6-8.6 CC.8.G.9	• Applying ideas to solve problems • Designing • Researching • Using mathematics

Lesson Matrix Grades 7-8
3R's of the Common Core

Lesson	Leading Question	Objective	Common Core Alignments		Skills
7-8 **Source Separating** **III.B.1**	What is the best way to sort and store our recyclables?	• Investigate current containers and make proposals • Design containers for the easy and efficient source separation of recyclables, as needed	**Grade 7** CC.RST.6-8.2 CC.SL.7.4 CC.WHST.6-8.4 CC.7.G.6	**Grade 8** CC.RST.6-8.2 CC.SL.8.4 CC.WHST.6-8.4 CC.8.G.9	• Applying mathematical concepts • Collaborating • Developing models • Problem solving
7-8 **Graphing Recyclables** **III.B.2**	Do recycling businesses pay us for the materials we collect?	• Examine how fluctuating markets and different offered prices affect the fate of recycling	**Grade 7** CC.SL.7.1 CC.WHST.6-8.4 CC.WHST.6-8.7 CC.7.SP.7	**Grade 8** CC.SL.8.1 CC.WHST.6-8.6 CC.WHST.6-8.7 CC.8.SP.4	• Communicating • Evaluating • Graphing data • Investigating
7-8 **Destination Recycle** **III.B.3**	When you recycle where does it all go? What does it become?	• Identify the destination and fate of their states recyclables	**Grade 7** CC.RST.6-8.2 CC.SL.7.1 CC.WHST.6-8.4	**Grade 8** CC.RST.6-8.2 CC.SL.8.4 CC.WHST.6-8.7	• Gathering information • Interviewing • Problem solving • Sharing research and writing
7-8 **Making Good Compost** **III.C.1**	What are the essential ingredients for a successful compost?	• Conduct experiments testing the effects of too little water, nutrients, air, and imbalance of material on producing successful compost • Learn the basic principles necessary to construct a good compost pile	**Grade 7** CC.RST.6-8.3 CC.SL.7.4 CC.WHST.6-8.4	**Grade 8** CC.RST.6-8.3 CC.SL.8.5 CC.WHST.6-8.6	• Collaborating • Collecting data • Communicating information • Synthesizing

How Much Solid Waste Do We Produce?

Concept
Our present consumer society produces a great amount of waste.

Objective
Students will begin to understand the sources, content and magnitude of the solid waste problem.

Method
Students (and their families) will answer a questionnaire and class will discuss results.

Materials
Attached worksheet

Subjects
Social Studies, Language Arts, Mathematics

Skills
Communicating,comparing multiple solutions,sharing research and writing, applying mathematical concepts

Time
One class period

Vocabulary
Solid waste, garbage, trash, obsolescence

Resources
Solid waste management plans, solid waste management rules, state agencies

3R's of the Common Core
Parallel Activities
4-6, Lunch Bags
Information
The Solid Waste Stream
Resources
General

Leading Question
What do you know about the solid waste we produce?

Procedure
1. As an introduction to the problems of solid waste, distribute questionnaire to students and allow time for completion. After students read them, they will write their answers and any thoughts/opinions they have about any of them.

OPTION: The students could complete the survey at home with their families, then bring it back for discussion the next day.

2. Discuss each of the questions in terms of possible solutions that people can offer as citizens, community members, members of government, business and industry. Pick one area (local business,industry, etc.) to research what has been or is being done in the area of solid waste management.

Evaluation
Do students have a better idea of how much waste is generated in our society? Do they have an idea of how much they and their families contribute to waste generation?

Classroom Activities
A. Conduct a week-long home waste study where students sort and weigh their own family's trash. Have students calculate percentages of types of trash, make future predictions, etc., by weighing the contents before sorting and then weigh each category found. Studying their calculations, find which items can be recycled. What is the total percent of their current waste that can be recycled?

B. Create a bulletin board or display using facts from the background and resource sections: make mini-garbage cans from construction paper or have kids make a piece of trash and write a fact on it. Students will compile facts based on the current year and their state information database.

Common Core Alignments

GRADE 7

CC.RI.7.1
Reading Informational Text:
Key Ideas & Details

CC.SL.7.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.7.7
Writing:
Research to Build & Present Knowledge

CC.7.RP.3
Mathematics:
Ratios and Proportional Relationships

GRADE 8

CC.RI.8.1
Reading Informational Text:
Key Ideas & Details

CC.SL.8.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.8.7
Writing
Research to Build & Present Knowledge

How Much Solid Waste Do We Produce?

1. In 2012, the average American generated about 4.39 pounds of trash every day! Multiplied by 365 this equals 1600 pounds each year per person. This means the average American family of four generates about 123 pounds of garbage every week. In 2012, Americans generated a total of 251 million tons of waste!

2. In the past 50 years, the amount of waste discarded per person in the United States has almost doubled. Increased packaging, increase in number of disposable items, development of industry and production technology, increase in personal wealth and purchasing power and the switch to planned obsolescence as a design strategy are all contributing factors to the increase in personal consumption and disposal.

3. In the United States 40% of all food is wasted or thrown away, in 2010 that equalled about 133 billion pounds, that's over 364 million pounds each day! According to archaeologist William Rathje of the University of Arizona, this waste consists in large part of spoiled foods never even used. In addition, what surpluses do farmers in the United States create that are never used and eventually require disposal? In stark contrast to the food waste produced in the United States are the numbers of people who are underfed and undernourished throughout the world. The United Nations estimates that 795 million people do not receive an adequate amount of the right kinds of food. The diet of these people is frequently lacking in:

   * Calories: fewer than 2200 calories per person each day is the norm throughout China, India and much of Africa. Self-reported data in the United States suggests that the average calorie consumption per person is 2,640 calories, however it was also found that many people in the United States under report their intake by up to 25%, meaning the true intake of calories per person each day in the United States could be as high as 3,300.

   * Protein: less than 60 grams per day in the above named places compared to more than 100 grams each day in the United States.

   * Needed micronutrients: malnutrition exists not because we don't produce enough food, but rather because of unequal distribution of what is grown. The most affluent third of the world's population eats well over half the food produced.

4. We send between 12 and 15 million cars to junkyards (and 290 million tires) each year.

5. In 2010, 28.5 million televisions were thrown out. Television sets last on average ten to fifteen years. The number of appliances and audio visual equipment thrown out within only a few years of purchase reflects a fast turnover in technology, the consumer desire for state-of-the-art equipment and new fashion, a planned obsolescence design strategy by producers and the fact that it is often less expensive to buy something new than to repair something old.

6. Packaging represents 30% of the solid waste stream and an increasing percentage of these materials are made of plastic, a substance noted for non-biodegradability and long life.

7. Americans used 66.62 million tons of paper in 2012. It takes 17 trees to produce one ton of paper. Newspaper is usually discarded within 24 hours of being purchased. In 2012, 64.6% of paper was recycled.

8. Americans recycled 87 million tons of waste in 2012, about 34.5% of the total waste produced.

How Much Solid Waste Do We Produce?

1. The average American family of four creates about ____ pounds of trash each week.

_____20 _____120 _____500 _____1000

2. In the past 50 years, the amount of waste discarded per person in the United States has

_____stayed the same _____doubled _____decreased _____increased 10 times

3. Each day, Americans throw away _____ million pounds of edible food.

_____30 _____300 _____364 _____643

4. We send _____ cars to the junkyard each year.

_____12,000 _____1,000,000 _____12,000,000 _____20,000,000

5. How many televisions are thrown out each year?

_____285,000 _____5.2 million _____1 million _____28.5 million

6. What percentage of what we throw away is packaging?

_____30% _____75% _____50% _____10%

7. How much paper do Americans use each year?

_____6 million tons _____6 million tons _____66 million pounds _____66 million tons

8. How many tons of solid waste did Americans produce in 2012?

_____25 _____25 million _____251 _____251 million

Where Does All Our Trash Come From?

Concept
Analyzing the source and content of a waste streams is the first step in learning how to reduce, reuse and recycle.

Objective
Students will analyze their waste producing habits in order to begin changing them.

Method
Students will survey the waste produced in their school.

Materials
School map, triple beam balance, containers to hold trash on scale, lab tongs, standard trash container (such as a brown paper bag)

Subjects
Mathematics, Social Studies, Science

Skills
Analyzing, applying mathematical concepts, investigating

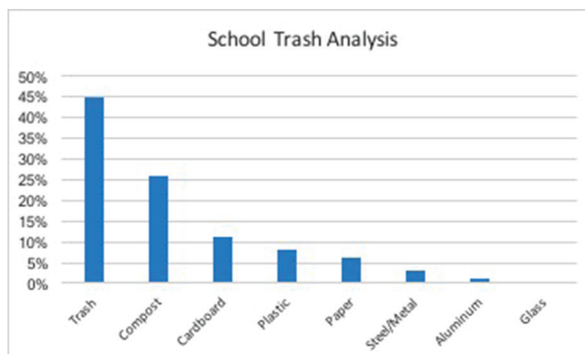
Time
Day One: 80 minutes
Day Two: 80 minutes
Day Three: 80 minutes
Vocabulary
See handout

Source
NRRA's School Trash Analysis (TOLD: Trash on the Lawn Day)

3R's of the Common Core
Parallel Activities
K-3, Garbage Bag Recipe
4-6, Litter Search
Information
The Solid Waste Stream
Resources
General
Environmental Education and Educational Resources

Background
This chart illustrates the results of an NRRA School Trash Analysis completed in October 2015 at a NH middle school. The analysis shows that 55% of the school trash could have been diverted from the waste stream if materials had been recycled or composted.

Using this study as an example, you can create a current one with your class.



Leading Question
What are all the things we throw away?

Procedure
<u>Day One</u>

1. Give the class about ten minutes to brainstorm a list of things we throw away. As they are listing things, have them think about whether the items are recyclable and/or pollute (air, land or water). Discuss the results as a whole class.
2. Distribute Overview of the Waste Problem. Read the overview and discuss the meaning of the vocabulary words.
3. Tell the students that they are members of a research team that is going to take a look at waste habits of the school and offer recommendations on the findings. Hand out School Building Trash Analysis to help explain the project.

Common Core Alignments

GRADE 7

CC.SL.7.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.7.4
Writing:
Production & Distribution of Writing

CC.7.SP.1
Mathematics:
Statistics & Probability

GRADE 8

CC.SL.8.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.8.4
Writing:
Production & Distribution of Writing

CC.8.SP.1
Mathematics:
Statistics & Probability

Day Two

1. Following the directions on the School Building Trash Analysis, have students collect and sort trash from different places in the school. All data should be recorded on a class chart and/or computer spreadsheet.

Day Three

Students write their answers to the questions on Analysis of the School's Trash as individuals, in groups or as a whole class.

Evaluation

Worksheets.

Classroom Activities

A. Act upon the recommendations for solving school waste problems made by the class.

B. Find out what the school is paying for waste disposal. How much money could be saved by recycling and composting instead?

C. Have class investigate amounts of household wastes from other sources (e.g.: own homes, surveys, regional solid waste districts). How can wastes be treated in the various situations?

Overview of the Waste Problem

United States and most of the world are now facing a waste problem of huge proportions. It is estimated that every person in the United States produces 1,600 pounds of household waste per person each year. (As large as this number is, it does not include all the other wastes we dispose of, such as factory and transportation wastes.) This is by far the most waste per person from any country in the world and so we are truly the most wasteful group of people in the world. Not only does this lifestyle use up valuable resources that future generations might need, but it also threatens to pollute our land, water and air which can only result in less healthy human beings.

However, when one looks at how we live and what waste we produce there is hope that we can change some of the ways we live and leave a healthier environment. For instance, it is estimated that we could recycle 40-50%, compost 25-30% and reduce waste 5-10%. **An effort such as this could reduce the wastes we send to the landfill by 70-90%!** There are also many chemicals and other products we use that are simply not necessary. If we decide not to use many of these substances we will each be reducing the amount of waste and pollution that is entering the earth's ecosystem.

Waste Terms To Understand:

Pollution (Air, Water and Land)
Recyclable
Compostable
Renewable Resource
Plastics
Paper
Glass
Metals
Sewage
Oil
Food
Pesticides
Groundwater
Biodegradable
Conservation
Toxic Wastes
Marine Pollution
Incineration
Love Canal
Ozone Layer Depletion
Radioactive Wastes
Fertilizers
Acid Rain

Name:____ Date: ______________________

School Building Trash Analysis

You are a member of a research team that is responsible for sampling the school environment in order to understand its waste habits. You will be assigned one area in which to collect waste samples. These waste samples will be brought back to the lab for analysis. Follow the following procedure step by step very carefully:

1. Obtain the proper size trash container.
2. Go to your area of the school.
3. Be very quiet and polite as you collect a trash container full of trash.
4. Go back to the lab.
5. Sort your trash according to the data charts.
6. Weigh out each kind of trash and record this on your data chart.
7. Record your data on the class chart.
8. Make a list of items found in each category of trash.
9. Using the class chart, copy the data from other teams on your data tables.
10. After filling out Analysis of School Trash, write out and answer the following questions:

A. Considering the data you have collected, explain what you think our school should do about its wastes. Why do you feel this way?

B. Using a map of the school, show where we could set up recycling stations. Also explain how you believe recycling could be achieved. Tell what jobs each member of our school community (e.g.: students, teachers, principals, custodians, cafeteria workers) could do to make recycling a reality (also include school groups such as student council, honor society, etc.).

C. Since not all of our school's trash ends up in trash cans, explain an idea that you have for keeping the floors of our school clean.

Trash Analysis l Waste Basket Sample l Date:

All weight in grams

Area	Total Weight	Plastics	White Paper	Color Paper	Glass	Food	Aluminum	Steel	*Deposit	Cardboard
TOTALS										

*Deposits from redeemable beverage containers and any fundraising item.

Name:______________________________ Date: ____________________

Analysis of The School's Trash

You have now had a chance to examine the data you have collected. This data is useless unless we are able to understand what it means and how we can use it to improve our school. Answer the following questions to help focus your concentration:

1. What area of the school produces the most trash?
2. How much trash does the school produce each day?
3. What area of the school produces the least amount each day?
4. What is the most common kind of trash?
5. What is the least common kind of trash?
6. What percentage of trash is recyclable?

A. Add up those materials that are recyclable:

_________ Material = _________ Grams

_________ Material = _________ Grams

_________ Material = _________ Grams

_________ Material = _________ Grams

_________ Material = _________ Grams

_________ Material = _________ Grams

_________ Material = _________ Grams

____

B. Divide the number you just got by the total weight of the materials.

Recyclable weight in grams _________

Total weight in grams _________

C. Multiple this answer by 100.

_____

x _____

= _____% Recyclable

How Much Does Packaging Contribute to Our Waste?

Concept
Extensive packaging and processing uses up limited natural resources and increase the amount of solid waste requiring disposal.

Objective
Students will examine the complexities of food processing and packaging.

Method
Students will survey different food products.

Materials
Attached handouts

Subjects
Language Arts, Social Studies, Environmental Education, Mathematics

Skills
Applying ideas to solve problems, collaborating, researching, using mathematical and computational thinking

Time
Two classes, outside assignment

Vocabulary
Packaging, food processing, natural resources, energy

3R's of the Common Core
Parallel Activities
K-3, Too Much Packaging
4-6, The Story of…
9-12, Packaging Preferences
Information
Packaging
Resources
Green Consumption, Consumerism and Sustainable Development

Background
In 1974, the Environmental Action Foundation published research showing that the energy used to produce the packaging used annually by McDonald's fast food restaurants was equal to the amount of energy required to supply Boston, Washington, San Francisco and Pittsburgh residents for one year. Since the 1970s and 1980s, McDonald's and packaging manufacturers in general, have tried to make plastic packaging more lightweight and use more recycled and recyclable materials. According to Plasticpackagingfacts.org "Since 1977, the two-liter plastic soft drink bottle has gone from 68 grams to 47 grams, representing a 31 percent reduction per bottle. This saved more than 180 million pounds of packaging in 2006—just for two-liter soft drink bottles alone. The one-gallon plastic milk jug has gone on a similar diet, weighing 30 percent less today than 20 years ago." According to McDonald's website, by 2020, 100% of McDonald's packaging will be from recycled sources. McDonald's website keeps their sustainability reports archived.

Follow the link below to learn more about McDonald's changing business practices and sustainability goals: http://www.aboutmcdonalds.com/mcd/sustainability/sustainability_CR_reports.html.

Leading Question
Could we save energy and other natural resources by choosing one product or packaging over another?

Procedure
1. Examine the list of 17 different potato products. Discuss the questions on the handout or have students fill them out.
2. Working in pairs and using a chart similar to the potato chart, have students choose a form of fresh food to investigate at a local grocery store. Students will write and gather information to present to their classmates.
3. After the investigation, have students meet in small groups to discuss their results. Then each group shares their research reports with the teacher and class for discussion.

Evaluation
What percentage of the cost of packaged foods do you think is due to the packaging? Which of your favorite foods could you buy without packaging? How could food packaging be reduced?

Common Core Alignments

GRADE 7

CC.RI.7.4
Reading Informational Text:
Craft & Structure

CC.SL.7.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.7.4
Writing:
Production & Distribution of Writing

CC.7.EE.3
Mathematics
Expressions and Equations

CC.7.RP.1
Mathematics
Ratios and proportional Relationship

GRADE 8

CC.RI.8.4
Reading Informational Text:
Craft & Structure

CC.SL.8.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.8.4
Writing:
Production & Distribution of Writing

Classroom Activities

A. Take a field trip to a co-op. Compare the different product choices, packaging, sales methods and philosophies between conventional and cooperative shopping.

B. Research differences in nutritional value between the different foods discussed.

C. Discuss the influence of advertising and packaging design on purchasing decisions.

D. Develop a list of commonly used plastic packaging types. Have the students figure out what was used for the same purpose before plastic was readily available. What are some of the pros and cons of the two types?

How Much Does Packaging Contribute to Our Waste?

Name:____ **Date:** _______________________

1. Which forms of the product are most highly processed and packaged?

2. Which are most expensive per pound?

3. Which form of product would you purchase if you were interested in reducing solid waste?

4. Which form of the product would you purchase if you were interested in saving money?

5. Which form of packaging do you think:

   a. Uses the most energy?

   b. Saves the most energy?

6. What are the relationships between cost and the amount of packaging and processing in a product?

7. What conclusions can you make about these relationships?

8. Looking at the product form with the most packaging, is all this packaging necessary?

9. Which packaging:

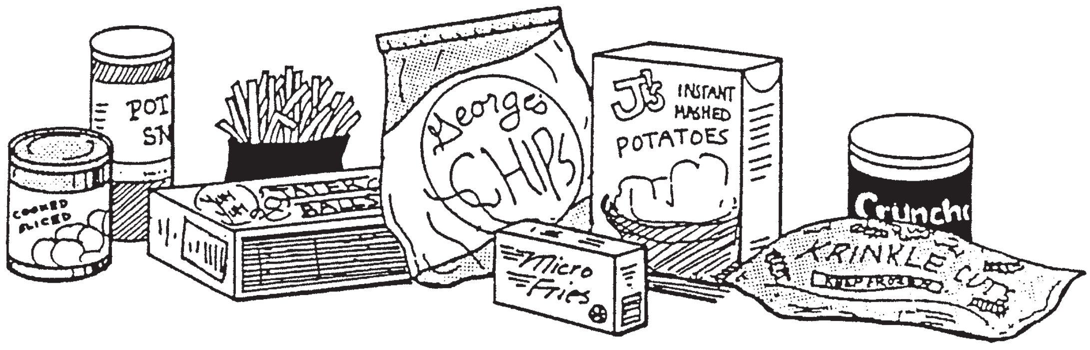
   a. Weighs the least per pound of product?

   b. Takes up the least space in the landfill?

   c. Decomposes most or least quickly?

   d. Doesn't produce toxic materials when it breaks down?

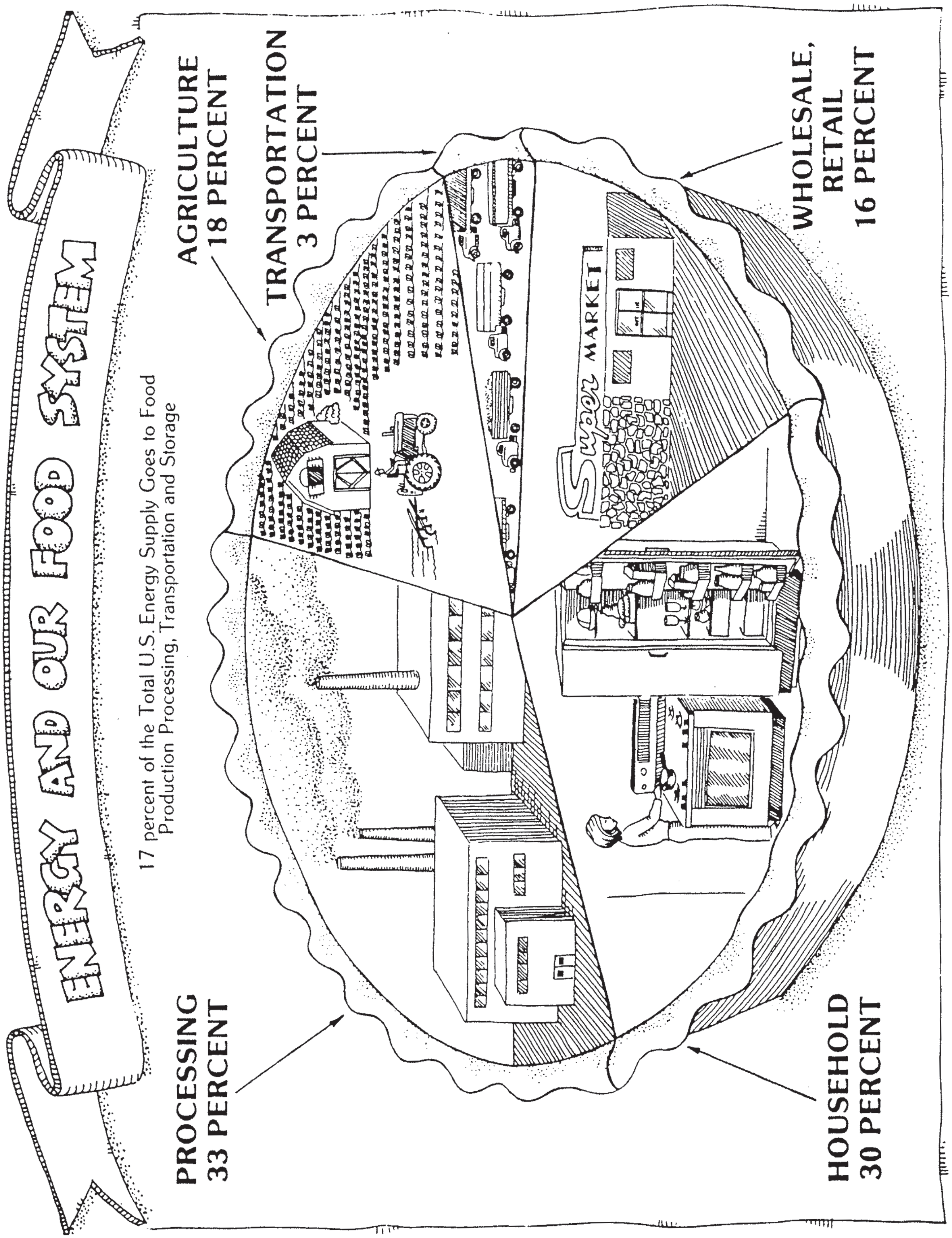
10. Which of these products will you buy in the future? What criteria will you use for making your decisions about what to buy and what not to buy?



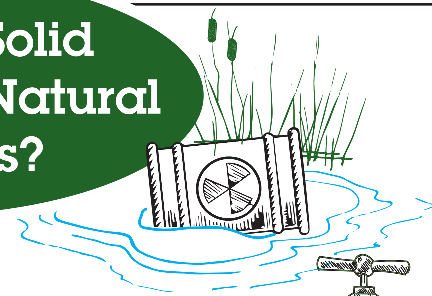
This Spud's For You

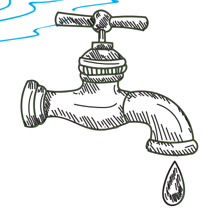
PRODUCT*	PACKAGE SIZE	PRICE	PRICE PER POUND
Fresh Russet Potatoes	10 lb	$4.99	$ .50
Fresh Russet Potatoes	5 lb	2.99	.60
Fresh Russet Potatoes	Loose	.99	.99
Hannaford's Canned Sliced Potatoes	15 oz	.79	.84
Ore Ida Tater Tots	2 lb	2.89	1.45
Ore Ida Mini Tater Tots	1.75 lb	2.89	1.65
Hannaford's Crinkle Cut French Fries	5 lb	3.99	.80
Hannaford's Crinkle Cut French Fries	2 lb	1.69	.85
Small Order McDonald's French Fries	2.6 oz	1.68	10.33
Medium Order McDonald's French Fries	3.9 oz	2.17	8.90
Large Order McDonald's French Fries	5.9 oz	2.29	6.21
Betty Crocker Mashed Potato Products	4.7 oz	1.09	3.71
Hannaford Potato Sticks	6 oz	1.99	5.30
Pringle's Potato Chips	5.68 oz	1.79	5.04
Pringle's Potato Chips 18 pack	12.69 oz	7.59	9.56
Lay's Potato Chips	8 oz	2.50	5.00
Lay's Potato Chips 6 pack	6 oz	2.49	6.64

*All items priced on April 18, 2016, at Hannaford's website for online shopping in Manchester NH, McDonald's prices for NH calculated on fastfoodmenuprices.com


ENERGY AND OUR FOOD SYSTEM
17 percent of the Total U.S. Energy Supply Goes to Food Production Processing, Transportation and Storage
AGRICULTURE 18 PERCENT
TRANSPORTATION 3 PERCENT
WHOLESALE, RETAIL 16 PERCENT
HOUSEHOLD 30 PERCENT
PROCESSING 33 PERCENT
Super MARKET

How Does Solid Waste Affect Natural Resources?





Concept
Human intervention impacts areas of our environment in a variety of ways.

Objective
Students will identify the ecological impacts of some solid waste management practices on natural resources.

Method
Students will play a game.
Students will write/research resource information.

Materials
Natural resource cards (one per group)

Subjects
Science, Social Studies, Language Arts

Skills
Collaborating, gathering information, Problem solving

Time
Two classes, Classroom Activities: 2- 4 classes

Vocabulary
Natural resources, interdependence

Resources
Dr. Seuss, *The Lorax*; Lawrence Pringle, *Ecology*; National Geographic DVD, *The Human Footprint*, any literature discussing ecosystems, cycles, interdependence

3R's of the Common Core
Parallel Activities
4-6, *The Lorax*
9-12, Nonrenewable Resources
9-12, GNP(P)
Information
Waste and Natural Resources
Resources
General
Biodiversity and Wildlife
Environmental Education and Educational Resources

Background

Leading Question
How do our activities impact our environment?

Procedure
1. As an introduction, review the earth's natural cycles, human interruptions and alternatives. Using one of the given situations or a specific local example, demonstrate how each of the natural resources are affected and discuss alternatives to the situations.
2. Divide the class into six groups. Distribute natural resource cards and have a spokesperson from each group read about the resource to the rest of the class. Each group is to be responsible for protecting that resource.
3. Individual students can research and write a paper on their natural resource. It should list the department to contact for protection in their state. Students can present their findings to the class.
4. Read individual situations to the class and list them on the board. Ask each group to answer the following questions in terms of their resource and each situation. Each group will collaborate and write their answers to the questions and present them.
   a. How does this situation help your natural resource?
   b. How does it harm your natural resource?
   c. Is this a good situation or a bad situation? How might it be improved? What possible alternatives would be better?
5. Create a bulletin board with proposed Solutions To Pollutions of their resources.

Evaluation
Successful involvement of students and resolution of issues.

Common Core Alignments

GRADE 7

CC.RI.7.4
Reading Informational Text:
Craft & Structure

CC.SL.7.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.7.7
Writing:
Research to Build & Present Knowledge

GRADE 8

CC.RI.8.4
Reading Informational Text:
Craft & Structure

CC.SL.8.1
Speaking & Listening:
Comprehension & Collaboration

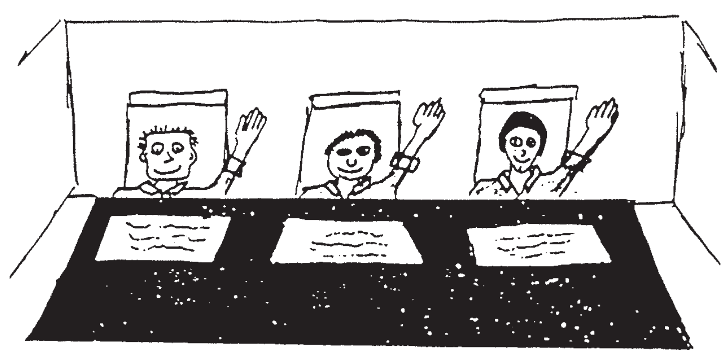
CC.W.8.7
Writing:
Research to Build & Present Knowledge

Classroom Activities

A. Distribute copies of all natural resources and situation cards to each student. Have each student write an essay addressing the effects of one situation on all natural resources or one natural resource by each situation.

B. Conduct a debate or panel discussion or simulate a zoning board meeting. Students brainstorm a variety of individual positions, choose a position to role play, research and gather information on the position and defend the position in debate. Using the ski development expansion, possible positions and concerns are as follows:

- **Neighboring Farmer and/or Homeowner**
  (lost privacy and pollution)
- **School Board Member**
  (impact on school population)
- **Town Selectmen/Chamber of Commerce**
  (impact on employment, tax $, traffic)
- **8th Grade Ski Club**
  (entertainment physical education)
- **Ski Developer**
  (money)
- **Environmentalist, Your state's Dept. of Water Resources, or similar department**
  (impact on environment)
- **Audubon Club**
  (destruction of wildlife habitat)
- **Legislator/Zoning**
  (Based on your state and area the development may vary. Example: a water park or amusement park on the coast of your state)



Newark Street School, West Burke

Situations

1. A MANDATORY CURBSIDE RECYCLING PROGRAM has just begun in your town. Residents must separate their newspaper, aluminum, steel cans and glass for recycling and set them out with their other trash. It is now illegal to send bags of leaves and yard waste to the landfill.

2. The local **SKI DEVELOPMENT** has decided to expand by constructing three more lifts, adding snow-making equipment and building 360 new condominium units.

3. HAZARDOUS WASTE A print shop generates 40 lbs. of chemical waste each month which does not have to be reported to the state or disposed of with other regulated hazardous wastes. The print shop operator waits until he can couple 55-gallon drums of the stuff and then dumps them at the local landfill.

4. A NEW LANDFILL The municipal landfill for your town is scheduled to close in six months. The town has decided to build a new landfill on the other side of town.

5. A local **CHEESE FACTORY** produces several hundred pounds of whey waste each week. The milk haulers dump the whey illegally in local swamps, streams and on unused fields when they think no one is looking.

6. WATER POLLUTION After heavy rains, untreated sewage and rainwater contaminated with automobile oil flow directly into lakes, rivers and other water bodies used by people for recreation and drinking water.

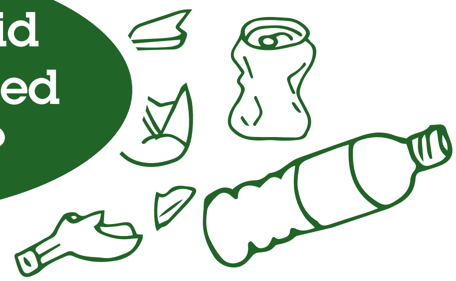
7. LITTERING A fishing party was out on a local lake. By the end of the day their inexpensive Styrofoam cooler had disintegrated into several pieces. It, along with beer bottles, plastic sandwich bags and orange peels were conveniently discarded overboard before the end of the trip. One of the fishing lines also got caught on the motor; both tangled line and lures were lost in the lake.

8. INCINERATION A trash to energy incinerator plant is being built in a nearby town. This plant will supply your town with some of its electricity and be the disposal facility for your waste. Some of the ash produced may be toxic and will be deposited in your town's landfill.

Natural Resource Cards

AIR Clean air is needed by all forms of life. Any smoke or chemicals which enter the air cause air pollution. Protect the air from any and all forms of pollution.	**WATER** Fresh water has two important jobs. It is home to many life forms and living creatures must drink it to survive. Salt water also supports many forms of life. Protect both kinds of water.
SOIL AND MINERALS Soil nurtures all forms of plant life. It contains the minerals and nutrients needed by all living things. There is a limited supply of minerals on the earth. Protect the soil and its minerals.	**FORESTS AND PLANTS** Plants are an important natural resource. They are beautiful. They help purify our air through the oxygen they give off in photosynthesis. We need plants for food and medicine. Plants are also a source of food and shelter for animals. Protect the plants and the forests.
WILDLIFE, FISH, BIRDS AND INSECTS Fish and wildlife give us many foods and other products. They provide recreation such as nature study and fishing. Many birds and insects pollinate our fruits and vegetables. We must protect them.	**PEOPLE** Are human beings a natural resource? We are part of many food chains. We affect the ecological balance of the earth. We consume natural resources. Think about what is best for the people today. Plan for the future generations who will inherit the earth from us.

How Has Solid Waste Changed Over Time?



Concept
What we throw away reflects our own personalities as well as that of the society in which we live.

Objective
Students will consider and classify various forms of evidence in the study of their own and a past culture.

Method
Students will keep records of the solid waste they produce in a day and compose hypothetical lists for other characters in history. The class will play a game of charades to determine the identity of an historical character by what he/she has thrown out.

Materials
The attached handout cut up into separate cards.

Subjects
Social Studies, Language Arts

Skills
Analyzing, collaborating, sharing research
and writing

Time
Two class periods

Vocabulary
Archaeology, trash composition

Resources
Peter T. White, *"The Fascinating World of Trash,"* National Geographic, April 1983; Lawrence Pringle, *Throwing Things Away*; University of Arizona, "The Garbage Project"

3R's of the Common Core
Parallel Activities
K-3, Grandparents' Toys
9-12, Then and Now
9-12, The Dump Ground
Information
Waste and Society
Resources
General

Background

"Archaeologists have long used refuse from ancient cultures to reconstruct behavior; modern household garbage is no less a reflection of the behavior of those who have generated it."

- Archaeologist William Rathje, University of Arizona

Leading Question
What can the waste we produce tell us about ourselves?

Procedure
1. Ask the students to keep a journal of everything they throw out over a 24-hour period. Explain that we don't usually notice all the stuff we throw out. (This is part of the solid waste problem because we aren't conscious of how much and what we throw away.) Solid waste experts study what we throw out to try to start solving our problems. Each student will write a reflection paper on their 24-hour rubbish journal. The reflection will include: What did you learn about yourself and your culture? What is working and what needs improvement? How can you improve your trash disposal habits?
2. Archaeologists also study what societies all through history have discarded in order to learn about the people who created the waste. Announce that the class is going to become an archaeological team.
3. Break the class up into four groups and pass out three character cards to each. Have each group research and read about their characters to support their knowledge and awareness of the trash they may have produced. Brainstorm a garbage composition list of six items for each one. The group and/or individual students will write a short research paper on their characters. It should include what the characters waste tells you about their culture and their values.

OPTION: Teachers can choose characters from other topic areas studied that year. When the lists are complete, have the first group read their list for one character. List one garbage item at a time until one of the other groups has been able to guess the identity of the character. Move on to the next group until all the character cards and garbage lists have been identified.

Common Core Alignments

GRADE 7

CC.RI.7.8
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.7.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.7.6
Writing:
Production & Distribution of Writing

GRADE 8

CC.RI.8.8
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.8.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.8.6
Writing:
Production & Distribution of Writing

4. Discuss what kinds of things you can tell about a culture and about a person from studying its waste. How has the waste we have produced changed over time?

Evaluation

What does your own list tell you about yourself and about our society? How do archaeologists use their findings to determine characteristics of a culture?

Classroom Activities

A. Compose a landfill garbage composition list for an imaginary civilization which reflects some of the civilization's characteristics.

B. Have students list Items they would bring on a picnic lunch. If Columbus (or another character in history) had the same meal, what would still be around today?

C. Keep a garbage journal for a character in history or in your imaginary civilization describing what he/she does and throws out in a day.

Trash Timeline

NEANDERTHAL	ROMAN SOLDIER	AZTEC PRIEST
NATIVE AMERICAN, 1700	BENJAMIN FRANKLIN	FARMER, 1890
NEW YORK CITY RESIDENT, 1860	13 YEAR OLD GIRL, 1956	5 YEAR OLD BOY, 1988
CORPORATE EXECUTIVE, 1988	STUDENT'S CHOICE	STUDENT'S CHOICE

How Do Attitudes Affect Waste?

Concept
Each of us is responsible for the waste stream. The waste, like the art, a society produces, tells us a lot about its values.

Objectives
Students will understand the visual artist as a recorder of history and ideas, identify society's impact on artistic expression and the potential ways in which artistic expression can impact society and use the visual medium to express their own values.

Method
Students will compare existing art and will create art expressing their own environmental ethic.

Materials
Fine art picture books, current magazines, web sites

Subjects
Art, Language Arts, Social Studies

Skills
Analyzing, applying ideas to solve problems, questioning, sharing research and writing

Time
Two class periods; artwork can be extended

Vocabulary
Environmental art

Resources
Carolyn Jabs, *RE/USES;* Peter T. White, *"The Fascinating World of Trash,"* National Geographic, April 1983; Barbara Kataoka Slavin, *Pictures and Pollution;* Local Arts councils/groups; local artists.

3R's of the Common Core
Parallel Activities
K-3, Impressions with E. B. White
9-12, Shopper Survey
Information
Redesign and Reuse
Resources
Green Consumption, Consumerism and Sustainable Development

Background
"In May 1983 the artist Christo, with 430 helpers, created Surrounded Islands - surrounding eleven small islands in Miami's Biscayne Bay with floating skirts of bright-pink plastic fabric. After two weeks the artwork was dismantled and 6.5 million square feet of polypropylene went to the landfill."

– Lawrence Pringle, *Throwing Things Away*

Leading Question
Why do people create art? What is the difference between art and waste?

Procedure
1. Display at least 20 different examples of artwork which illustrate the following: environmental art, love of natural environment, consumer society and American values, current American life, typical American life 100-200 years ago, political propaganda, etc. Ask students to write key words expressing their immediate responses to the pictures. Have each student select a picture. They will write their opinion of the importance of it in regards to the environment.
2. As a class, discuss the impressions. What is the purpose of art? What can art tell us about the person who created it and the society/environment in which it was created? Can art influence society? Why do we create art? What is the difference between art and waste?
3. View art made from "waste." See links below: "Recycled Art: 66 Masterpieces Made From Junk," Hongkiat, www.hongkiat.com/blog/recycled-art-masterpiece-made-from-junks/ . "Green Art:10 Artists Working with Recycled Materials," Beautiful Decay, http://beautifuldecay.com/2010/07/21/green-art-10-artists-working-with-recycled-materials/. "6 Textile Artists Using Recycled Materials," TexitleArtist.org, http://www.textileartist.org/textile-artists-using-recycled-materials/. After reading the biographies listed on the site(s), discuss what the artists' purpose of art and environment are. Read about Environmental Art on Wikipedia and discuss the information. Students can write an informative text about what Environmental Art is and its purpose(s).
4. Ask the students to isolate one issue or observation about contemporary society about which they feel strongly and using the visual medium, express their viewpoint/ emotion/observation.

Common Core Alignments

GRADE 7

CC.RI.7.1
Reading Informational Text:
Key Ideas & Details

CC.SL.7.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.7.6
Writing:
Production & Distribution of Writing

GRADE 8

CC.RI.8.1
Reading Informational Text:
Key Ideas & Details

CC.SL.8.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.8.6
Writing:
Production & Distribution of Writing

Evaluation

Repeat the activity with student art. Discuss possible connections between what the students believe and what emotions their artwork evokes.

Classroom Activities

A. Students could select one artist to explore in depth, reporting on the artist's style and philosophy, impact on society, cultural and historical background.

B. Students could write poems using descriptive words to match a piece of artwork.

C. Create trash sculptures.

Why is Litter a Problem?

Concept
Littering is improper waste disposal. Education and publicity can help prevent it.

Objective
Students will document and categorize litter in their neighborhood and will brainstorm ways to get people to stop littering.

Method
Students will photograph and collect local litter.

Materials
Bags for collecting litter, litter survey charts, camera, poster board, glue, non-latex gloves

Subjects
Art, Language Arts, Science, Mathematics, Social Studies, Photography

Skills
Applying mathematical concepts, collecting data, interviewing, problem solving

Time
Three full classes: one outside, one in small groups processing, one class discussion.

Vocabulary
Littering, biodegradable, organic, disposable, human-made, resource base, recyclable

Resources
Lawrence Pringle, *Throwing Things Away*

3R's of the Common Core
Parallel Activities
K-3, Litter Garden
4-6, Plastic Litter
Information
Litter
Resources
General
Solid Waste and Recycling

Background
Sometimes we may not be aware of how much litter there is until we consciously look for it. However, its ugliness may motivate us and others to dispose of it properly.

Leading Question
What is litter?

Procedure
1. Read article(s) about littering from the web: "Various Facts About Littering," *Conserve Energy Future*, http://www.conserve-energy-future.com/various-littering-facts.php. *"10 Interesting Littering Facts,"* Daily World Facts, http://www.dailyworldfacts.com/littering-facts/. "9 Interesting Facts and Statistics About Littering," *Litter. It Costs You.*, http://www.litteritcostsyou.org/9-interesting-facts-and-statistics-about-littering/.
2. Students can interview a person familiar with litter collection before modern recycling laws were enacted and/or before recycling became part of the garbage pick up routine.
3. Break the class up into small groups or pairs and assign a local strip of road for each to survey.
4. Have each student take pictures of litter they find. Each strip should be documented for types and number of pieces of litter found. Then have the students collect all the litter in their strip.
5. Weigh total litter collected and compare results of collection from other strips in different parts of town and on different types of roads. Make projections to determine amount of litter generated and requiring clean-up each year. What is the per-mile average of litter objects collected in the area?
6. Brainstorm a variety of ways to categorize the litter. Define terms such as resource base, biodegradable, disposable, recyclable, nonrenewable, organic, human-made, deposit containers, etc. Create litter composition charts documenting the different categories or graph the results (e.g.: Glass, Aluminum, Plastic, Paper). Compare the amount of deposit to non-deposit containers found.
7. Brainstorm ways to help people stop littering and start an anti-littering campaign. Illustrate the problem by creating a photographic display of the litter survey along with litter statistics to post in the

Common Core Alignments

GRADE 7

CC.RI.7.4
Reading Informational Text:
Craft & Structure

CC.W.7.2
Writing:
Text Types & Purposes

CC.7.SP.1
Mathematics:
Statistics & Probability

GRADE 8

CC.RI.8.4
Reading Informational Text:
Craft & Structure

CC.W.8.2
Writing:
Text Types & Purposes

CC.8.SP.1
Mathematics:
Statistics & Probability

school or community. Write poems to accompany the photographic displays. Make a slideshow of garbage pictures to match the Pete Seeger song "Garbage," or other similar song.

8. After completing various steps in the procedure, students can write an informative text on why its is important to not litter and/or write an editorial on the subject to submit to the school or local newspaper.

Evaluation

Define and categorize litter. Define vocabulary words. How does litter vary from place to place? How can we reduce litter?

Classroom Activities

A. Investigate bottle bill legislation across the United States (as of 2016, 10 states have 'bottle bills') its effect on roadside litter and the impact of local 'clean up days' on littering.

B. Utilize trash collected to make mobiles, three-dimensional collages, sculpture or other creative displays of types of trash found at certain locations.

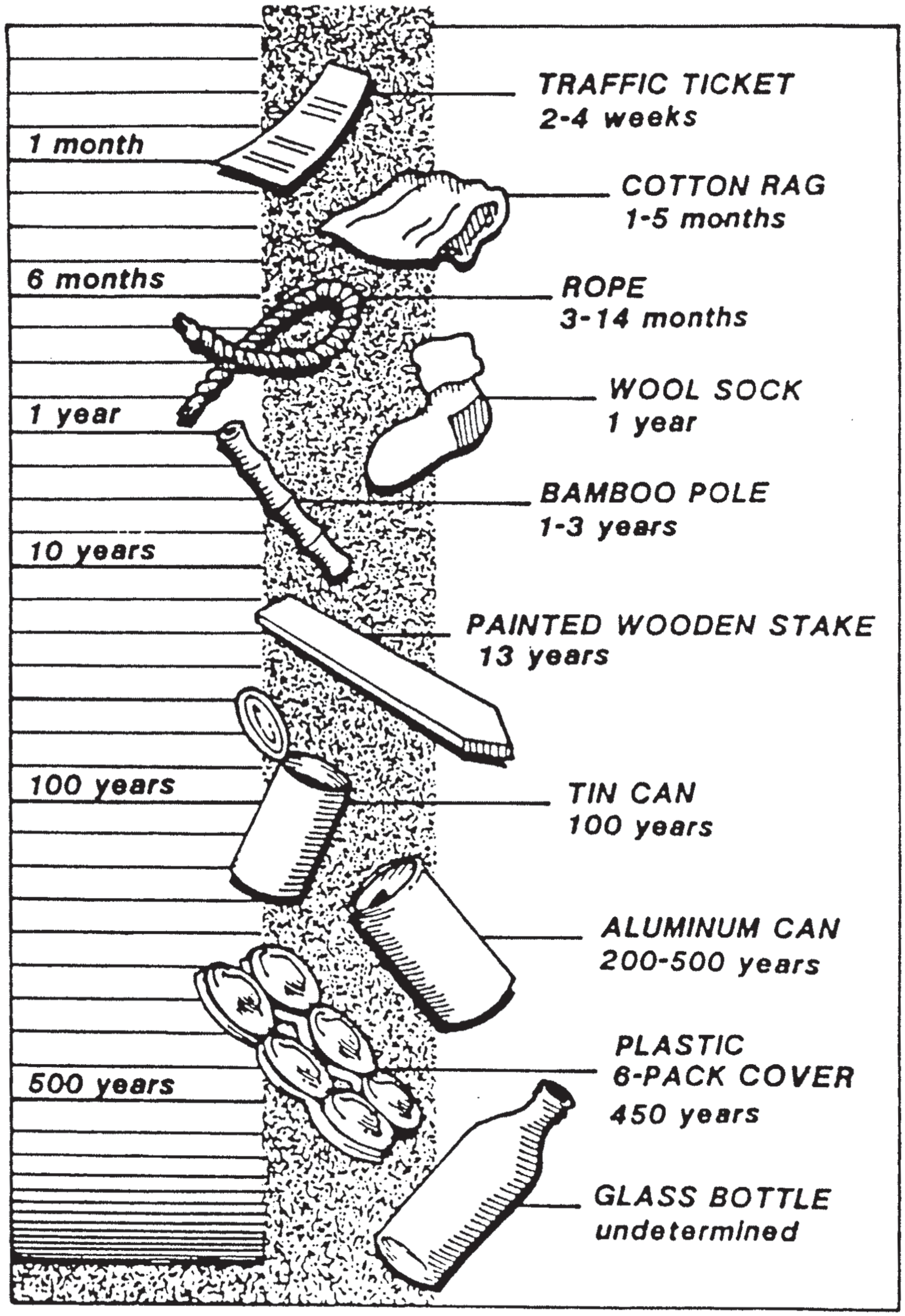
C. Make mobiles or posters to illustrate trash categories or vocabulary.

D. Illustrate trash idioms/expressions: Dump on someone, wasting time, etc. and proverbs: Waste not/want not, etc.

E. Illustrate on an adding machine tape the proportions of disintegration times for litter.

Enduring Litter

Litter at the roadside is ugly. How long will it take before decaying may be a surprise.



Source: *Book of Litter*

How Can We Recover Recyclables from Waste?

Concept
It is far more complicated and expensive to remove recyclables from the waste stream than to separate them at their source.

Objective
Students will devise materials recovery systems for recovering recyclables from the waste stream.

Method
Students will design a model of a materials recovery facility.

Materials
Magnets, water-holding containers, screens of different sizes, strainers, mixed garbage with floatables, magnetic and different sized particles

Subject
Science

Skills
Applying ideas to solve problems , comparing multiple solutions, developing models

Time
One or two class periods

Vocabulary
Materials recovery facility (MRF)

Sources
NRRA's School Trash Analysis (TOLD: Trash On the Lawn Day)

Resources
Recycling: Wealth Out of Waste (film) (C.3); *PRF: Strategic Vision* (video)

3R's of the Common Core
Parallel Activities
7-8, Source Separating
9-12, Collecting and Sorting
Information
Transportation and Processing
Recycling
Resources
Solid Waste and Recycling

Background
"Proponents of Materials Recovery Facilities (MRF) point to three principal reasons for their attractiveness. Because the feedstock of MRFs is co-mingled recyclables it makes it easier for citizens to participate. That translates into higher volumes of materials taken from the solid waste stream. Again, because of the commingled nature of the recyclables, collection equipment needs can be simplified. There is no need for vehicles with four, five or six compartments; at most, two are required. Collection times and costs can be held to a minimum because less time is spent at the curb sorting materials or emptying several containers. Finally, most advocates believe that materials processed through MRFs are more marketable. They feel that they can better meet industry standards and that the high volume of material that they can generate help to assure a market."

–Jim Glenn, BioCycle

Leading Question
How can mixed trash be separated for recycling?

Procdure
1. Take mixed trash and discuss. Mention that this trash contains valuable resources. It would have been easier to separate them out at the source, but it can still be done.
2. Explain the following:

a. Magnets could be built on large scale for taking out iron-containing substances

b. Light objects could be floated or blown away from other materials

c. Screens can separate the remaining material using different size sieves.

d. Read various articles on www.recyclenow.com. You can also watch a video (Collection Services) or check out both 'curbside and MRF procedures' for recycling on this site or visit www.teacherstryscience.org - Understanding Recycling and a MRF.

Common Core Alignments

GRADE 7

CC.RI.7.1
Reading Informational Text:
Key Ideas & Details

CC.SL.7.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.7.4
Writing:
Production & Distribution of Writing

GRADE 8

CC.RI.8.1
Reading Informational Text:
Key Ideas & Details

CC.SL.8.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.8.4
Writing:
Production & Distribution of Writing

3. Students review and research some current systems used. They will write an informative text on their findings. Then have students design and construct a mini-materials recovery system.

Evaluation

Students display and explain their mini-materials recovery systems.

Classroom Activities

A. Compare MRF designs with those for source separation. See 7-8, III.B.1, Source Separating

B. Investigate a commercial materials recovery systems company and their projects. Write a report about their projects and procedures.

How Do We Collect and Transport Our Wastes?

Concept
Waste haulers rates depend on their costs and the variety of services they provide.

Objective
Students will investigate the efficiency and costs of solid waste collection and will determine the advantages and disadvantages of operating a recycling business and/or curbside recycling program.

Method
Students will interview waste haulers and recycling businesses.

Materials
Tape recorder, graphing paper, sketch pad

Subjects
Mathematics, Social Studies, Economics

Skills
Gathering information, interviewing, sharing research and writing, using mathematical and computational thinking

Time
Variable

Vocabulary
Trash hauler, collection, disposal

Resources
Local waste haulers, local recyclers, town and city officials

3R's of the Common Core
Parallel Activities
K-3, Taking Trash Away
4-6, Hauling it Away
Information
Transportation and Processing
Recycling
Resources
Solid Waste and Recycling
Waste Management Agencies by State

Background
Waste hauling is a business which may serve residential, commercial and industrial customers. This business involves administrative, equipment, labor, transportation and landfill fee costs. Individuals or businesses use a waste hauler or pay these costs themselves to transport their waste (e.g. a business may own and operate its own dump truck for earth moving which it uses to transport its waste: an individual drives his/her waste to a transfer station on the way to work).

The collection of waste in a systematic manner and its transportation and compacting or sorting in specially designed vehicles can realize economies of scale using fewer nonrenewable resources and having less environmental impact than transportation by individuals. Besides general inflation, rising costs for waste haulers have lately been influenced by a dramatic increase in landfill fees. State regulation for planning and environmental safety reasons, has affected hauler costs. For example, some states require that haulers license each of their trucks and designate which waste facilities they have access to. Some haulers have recently increased the amount they charge customers.

Leading Question
How much does waste disposal cost?

Procedure
1. Discuss the costs of collecting and transporting trash in your community. How might these costs vary throughout the state? Has that cost changed recently? Why? How much trash is produced each week? How many local waste hauling businesses are there? How many residents and businesses are served? Compile and write interview questions for your speakers and others you may interview.

Common Core Alignments

GRADE 7

CC.RI.7.1
Reading Informational Text:
Key Ideas & Details

CC.SL.7.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.7.4
Writing:
Production & Distribution of Writing

GRADE 8

CC.RI.8.1
Reading Informational Text:
Key Ideas & Details

CC.SL.8.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.8.4
Writing:
Production & Distribution of Writing

2. Ask a local waste hauler to come talk to the class.
   - How many trucks do you own/operate?
   - What kind of trucks are they?
   - How much does that kind of equipment cost?
   - Why is the equipment designed the way it is?
   - How many truckloads of trash do you collect each day?
   - How is the refuse measured?
   - How many houses and or businesses do you collect from?
   - Where is trash taken and what are the tipping fees there?
   - How many miles do you cover each day? each year?
   - Would you ever consider operating a recycling curbside service? Why or why not? What would it involve?
   - What effect have new recycling and landfill rules had on residents/your business/town?
3. Interview someone from a voluntary recycling program or a recycling business:
   - What are their costs?
   - How much voluntary labor does the program depend upon?
4. On the basis of the interviews, have the class determine all the costs involved in collection and transport of waste. Include equipment, mileage, salaries, tipping fees, etc., incurred in a waste hauling business. Discuss the reasons waste haulers may or may not be interested in curbside recycling. What added expenses would there be to their businesses? Who would pay these costs? What about recycling programs?
5. The students can create reports based on their interview findings.

Evaluation

Display information. Write an article for the school paper.

Classroom Activities

A. Take a field trip to a transfer station, landfill and/or recycling center.

B. Determine costs for waste collection and transport for the school for a year. Determine how much paper and/or organic wastes the school produces and devise a recycling or composting program which will help the school save money by reducing disposal costs. See 7-8, I.A.2, School Trash Analysis.

C. Design a vehicle which can pick up trash and sorted recyclables.

How Do Landfills Work?

Concept
90% of solid waste is currently disposed of in landfills.

Objective
Students will learn how a sanitary landfill is made and operates and will understand some of the associated pollution problems.

Method
Students will construct a small scale replica of a sanitary landfill.

Materials
One five gallon ice cream container and two lids, one used; clear plastic bag large enough to fit in the ice cream container; three bricks, safety goggles

Subjects
Science, Language Arts, Mathematics

Skills
Applying mathematical concepts, developing models,observing, providing evidence

Time
One hour the first day, 10-15 minutes each day initially until the landfill settles, 1-2 hours for report writing /sharing.

Vocabulary
Leachate, sanitary landfill

Resources
Local landfills; your state's department for waste management.

3R's of the Common Core
Parallel Activities
4-6, Landfills
7-8, Landfill Soil
9-12, New Landfills
9-12, Methane
Information
Landfills
Public Planning and Policy.
Resources
Waste Management Agencies by State

Leading Questions

What are some of the possible hazards that might result from an improperly designed landfill?

Procedure

1. Cut four or five large circles, squares and triangles out of the sides of the container.
2. Make one straight cut in the lid from the rim to the center.
3. Cut a half-inch hole in the center of the lid and another in the center of the bottom of the ice cream container.
4. Fold the ice cream container top together so the ends overlap and put it down into the bottom of the carton.
5. Pull a corner of the plastic bag out through the two holes (one in the top and one in the bottom of the container) eight to ten inches. This will act as a reservoir for the leachate.
6. Fill the container daily with layers of small pieces of the following: scraps from your lunches, leaves from the school yard, paper, glass, aluminum, steel, bi-metal, plastic and maybe some vegetable oil. The material should be put in at a ratio of four parts waste to one part dirt. A good rule to follow would be one inch of waste covered by ¼ inch dirt. Remember to always cover the waste with dirt and pack it down lightly. (To really simulate a landfill, use clay or glacial till as cover because it is less permeable.) Sprinkle a small amount of water on the landfill after each layer of waste and dirt is added. Keep a journal. Record what is added daily to the landfill (scraps, metal, grass, etc.). Record when you add water and any observations of the landfill.
7. Fill the mini landfill one-half to three-quarters full. Place it on three bricks so there will be space under the container for the comer of the plastic bag to fill with leachate.

Common Core Alignments

GRADE 7

CC.RST.6-8.3
Reading in Science & Technical Subjects:
Key Ideas & Details

CC.SL.7.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.WHST.6-8.7
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.7.G.6
Mathematics:
Geometry

GRADE 8

CC.RST.6-8.3
Reading in Science & Technical Subjects:
Key Ideas & Details

CC.SL.8.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.WHST.6-8.7
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.8.G.9
Mathematics:
Geometry

8. Water occasionally to simulate rain, but don't over water. Try to reproduce the conditions that exist for a real landfill. Remember to record and to write any observations.
9. When the mini landfill is complete, use the second top to cover the container and let it sit for at least two months.
10. After two months have passed, collect the leachate that ended up in the comer of the plastic bag. Empty the contents of the mini landfill to see which items decomposed and which did not. At the end of two months or upon completion of the determined decomposition' time, write a report on your findings and observation of the decomposition in the landfill. Write a conclusion of what might be necessary for a properly designed landfill based on your leachate findings.
11. Students can present and share their reports and findings on the landfill experiment with the class.

Classroom Activities

A. Test a sample of leachate for acidity. See handout.

B. Research why leachate needs to be controlled at landfills. What materials leach from landfills?

C. Find the volume of the mini landfill before and after the two month sitting time. What is the difference? Does the volume of the leachate account for the difference?

Testing Leachate

To determine how leachate, once it has reached the aquifer, contaminates groundwater, conduct the following experiment:

Materials Needed:
- 4 petri dishes
- 4 steel nails
- Soap
- Rubbing alcohol
- Paper towels
- Universal indicator paper
- A sample of leachate*
- Household ammonia
- Household vinegar
- Tap water
- Safety goggles

1. Measure the acidity of the leachate with universal indicator paper. Compare it with indicator dipped in tap water, in household ammonia and in household vinegar.
2. Clean the nails with soap and water, rinse with alcohol and dry with paper towels. Be careful not to touch the nails with bare hands after rinsing.
3. Fill each of four petri dishes about half-full; place tap water in one, leachate in another, household ammonia in the third and vinegar in a fourth. Place one nail in each dish.
4. After a few days, when the liquid has evaporated, observe the nails. Record the observations. Have the nails changed in appearance?
5. Discuss results in relationship to landfill management. Why do we need to try to control the amount of liquid in a landfill? Under what conditions do metals leach? What other materials leach under the conditions found in a landfill?

* An easy way to produce leachate is to take mixed trash, drain water through it and collect resulting liquid.

Landfill Soil

7-8, II.B.2

What are Some Problems with Landfills?

Concept
By carefully analyzing different economic, environmental and social factors, communities may select the most appropriate and least harmful method for disposing of solid waste.

Objective
Students will determine the importance of soil studies prior to the siting of landfills.

Method
Students will compare the water holding capacity of various soils.

Materials
Empty milk or juice plastic containers, cups of pebbles, gravel, coarse sand, fine sand, topsoil, clay (any soil samples available), watch or clock with second hand, jars of water, bowls, measuring cup, powdered paint, student worksheets (one per student or group)

Subjects
Science, Geology

Skills
Carrying out investigations, developing models, observing, sharing research and writing, using mathematics, computational thinking

Time
40 minutes

Vocabulary
Groundwater, hazardous waste, leach, percolate, soil, zone of influence, attenuate

Resources
Your state's solid waste agency; state geologist; GIS data and maps

3R's of the Common Core
Parallel Activities
K-3, Litter Garden
4-6, Landfills
7-8, Mini Landfills
9-12, New Landfills; Methane
Information
Landfills
Resources
General
Waste Management Agencies by State

Background

"The nature and composition of subsurface material should be known for a distance of at least 20 feet below the lowest part of the landfill, to bedrock, or to the water table, whichever is shallower … Landfill base soil should be relatively impermeable and have some capability to attenuate or remove contaminants expected in leachate… The development of a landfill in areas underlain by bedrock is not recommended because of the possibility of groundwater contamination through fractures in the bedrock… All other factors contained in these guidelines notwithstanding, it is expected that some unquantifiable amounts of leachate will enter the groundwater within the zone of influence. In particular, the organic fraction of the leachate receives little or no attenuation while passing through even the best base soils. Therefore, the determination of the potential zone of influence and the landfill's possible effect on this area is the most critical portion of the hydrogeologic evaluation of a proposed site."

– Excerpts from State of Vermont's Guidelines for the Landfill Disposal of Solid Waste

Vermont consistently ranks as the greenest state in the United States. Strict laws that are consistently and centrally enforced are key in maintaining a clean environment. Other states are not so fortunate. Wyoming, which currently ranks last in environmental quality, is facing a massive water contamination crisis partly due to the false assumption that arid states would not have a problem with leachate. Wyoming's landfills were not lined. Wyoming is now working to address the costs and practicalities of cleaning up and improving its landfills and environmental quality. To learn more go to the Wyoming Department of Environmental Quality website. http://deq.wyoming.gov/shwd/landfill-remediation-program/

Leading Question
Why is it important to test the soils of a potential landfill site?

Procedure
1. To prepare containers, perforate the cap of each plastic jug and cut off the bottom end. Replace the cap, then fill the container about two-thirds full with one kind of soil. Repeat with as many types of soil as desired. In addition, prepare a separate container of soil in which you place several tablespoons of powdered paint into a well in the soil and cover completely so that students will not know the paint is there.

Common Core Alignments

GRADE 7

CC.SL.7.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.7.4
Writing:
Production & Distribution of Writing

CC.W.7.7
Writing:
Research to Build & Present Knowledge

CC.7.RP.3
Mathematics:
Ratios & Proportional Relationships

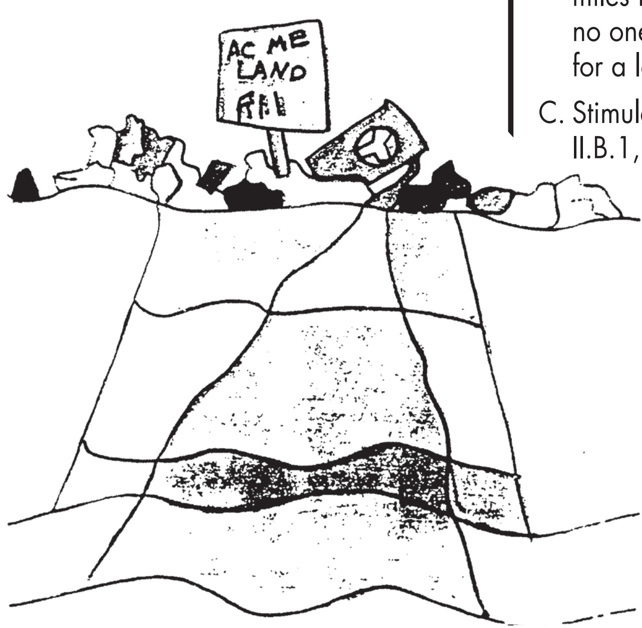
GRADE 8

CC.SL.8.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.8.4
Writing:
Production & Distribution of Writing

CC.W.8.7
Writing:
Research to Build & Present Knowledge

CC.8.F.5
Mathematics:
Functions



Newark Street School, West Burke

2. Select one of the soil containers. Place a bowl underneath the container cap to catch the water. Pour in one pint of water, noting the time you begin to pour. Record how much time passes before the water starts dripping into the bowl and the duration of the dripping water. Measure the amount of water that came through and compare with the amount with which you started. Discuss what happened to the remaining water. What conclusions can be drawn? Students will write up the experiment procedure and record results. (They will be informed at conclusion of it about the paint additive.)
3. Repeat the experiment with each type of soil. When the experiment is performed with the soil containing the paint, the students should be surprised to see colored water. Discuss with students the fact that, like the paint, there are many hazardous wastes buried in the ground which are not detectable to the eye. Although the land beneath a landfill may look all right, continuous testing must be done to detect hazards before they leach into groundwater supplies.

Evaluation

What types of soil would students recommend be the base for landfills? Why? Students will write a conclusion paper based on the Leading Question and Evaluation question.

Classroom Activities

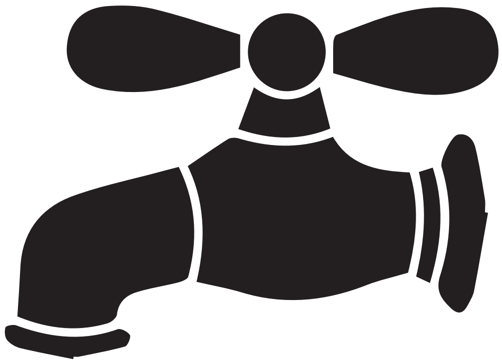
A. Fill several large cans with soil, each with a different type, such as gravel, sand or clay. Press a sharpened pencil into each can to see how far it can be inserted. Compare and record results. Next, wet the soils and try again. Let the soils dry and record results a third time. Students can make comparisons among the soils and among the three tests and make judgements on which types of soil were the most or least compact. Compare results with the above experiment.

B. Consider the following problem: There is a swamp about fifteen miles from your town. The land cannot be used for farmland and no one builds homes in a swamp. Would this be a good location for a landfill?

C. Stimulate the siting of a new landfill in your community. See 9-12, II.B.1, New Landfills.

Landfills

National water data statistics:



<u>2009 United States geological survey:</u>
2,100 private wells across the United States examined: **23% had contaminants that were high enough to merit a 'health concern'** - there are approximately 15 million private wells across the US

<u>California geological survey 2004 - 2012: 11,000 public wells survey:</u>
20% contaminated - there are between 1-2 million public wells across the state

It should also be acknowledged that water contamination has many sources (agriculture, drilling, toxic run off).

LAB REPORT WORKSHEET

Names of group members: ____

Leading Question:

Why is it important to test the soils of a potential landfill site?

Prediction

Which soil is best for a potential landfill site? ______________________________

Procedure

Soil Type	Time elapsed before water seeps	Time elapsed until water seeps completely	Amount of water collected
Soil 1			
Soil 2			
Soil 3			
Soil 4			

Conclusions: What did you notice about the different soils? What conclusions can you draw?

____
____
____
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____

Evaluation: What types of soil would you recommend be the base for landfills? Why?

____
____
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____

Concept
Burning can reduce the volume and weight of solid waste, but produces air emissions and ash still needing disposal.

Objective
Students will research the historical perspective of burning solid waste and how it has changed over the decades. They will examine the reasons for these changes.

Method
Students will compare information from two articles written by the same resource obtaining a historical perspective of burning waste controversies over the years.

Materials
Two articles from *The Museum of Solid Waste and Energy*, published by The NEED Project - 8408 Kao Circle, Manassas, Virginia 20110

Subjects
Science, Environmental History, Social Studies, Language Arts

Skills
Sharing research and writing, analyzing, comparing multiple solutions, collaborating

Time
Two - Three class periods

Vocabulary
Ash, pollution, incinerator, landfill, combustion, leachate, monofills, emissions, toxins

3R's of the Common Core
Parallel Activities
4-6, Investigating Incineration
9-12, Waste Manage ment Choices
Information
Incineration
Public Planning and Policy
Resources
Air and Climate
Environmental Justice, Advocacy and Policy

Background
The first municipal incinerator was designed and built in England more than a century ago. It seemed to be a simple, efficient and sanitary way to dispose of garbage. Burning garbage eliminated the need for transporting waste from cities, saved space in dumps and destroyed many disease-causing microorganisms and viruses. The technology was soon imported to this country and by the 1920s there were more than 300 incinerators in use.

The first incinerators burned trash without worrying about what was coming out of their smokestacks. As concern rose over the quality of our air and legislation was introduced to prevent further air pollution, their use declined, since the cost of pollution control equipment made it cheaper to landfill waste. The development of waste-to-energy technology in the 1970s revived incineration.

Today's waste-to-energy plants can reduce up to 90% of the volume of waste requiring disposal and can be designed to process from 100 to over 3,000 tons of refuse daily. At the same time, they produce steam or electricity that can satisfy a portion of local energy needs. However, the ash remaining from the burn and the exhaust gas can both contain toxic materials.

Leading Question
Why do we burn trash?

Procedure
1. Read the two articles about Waste-to-Energy written by the NEED (National Energy Education Development) Project in their curriculum, *The Museum of Solid Waste and Energy.*
2. Discuss the similarities and differences between the article published in 1992 (following pages) and the 2015 version located on the NEED website: www.need.org/files/curriculum/guides/Museum%20of%20Solid%20Waste%20&%20Energy.pdf.
3. Create the Museum Station Exhibit 7: Waste-to-Energy (pg.163), as directed in the NEED curriculum either as a class or in smaller groups. (The 1992 museum station version is included because it provides more direction than the 2015 online version.)
4. Plan different events where the students can show their exhibit beyond the classroom - a sports event, parents' night, Earth Day, etc.

Common Core Alignments

GRADE 7

CC.RI.7.1
Reading Informational Text: Key Ideas & Details

CC.SL.7.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.7.4
Writing:
Production & Distribution of Writing

GRADE 8

CC.RI.8.7
Reading Informational Text: Integration of Knowledge & Ideas

CC.SL.8.1
Speaking & Listening: Comprehension & Collaboration

CC.W.8.6
Writing:
Production & Distribution of Writing

Evaluation

How has burning garbage evolved? Why should we combine burning waste and recycling together?

Classroom Activities

A. Research the different toxins produced by burning various objects and their potential health effects.

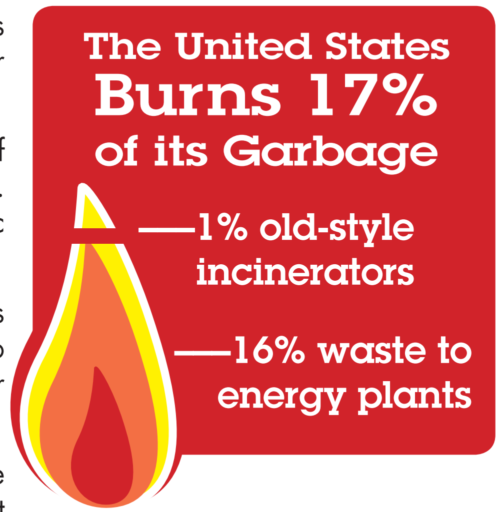
B. Research methods of pollution control in incinerators.

C. Visit a waste-to-energy plant.

Just Burn It!

Americans are producing more and more waste with each passing year. In 1960 the average American threw away 2.7 pounds of trash a day. Today the average American throws away four pounds of trash every day! What are we going to do with all that trash?

One solution is to burn it. (Burning is sometimes called "combustion.") All organic waste contains energy. Organic waste is waste that is made from plant or animal products.



People have burned one type of organic waste for millions of years. Can you guess what that organic waste is? It's wood.

Ancient peoples burned wood for its heat energy. They used the energy to keep them warm and to cook their food.

Today we can burn garbage and use its heat energy to make steam to heat buildings or to generate electricity. This may sound amazing, but it is really nothing new. Most electric power companies already burn another type of material to make electricity. That material is coal. Coal is a mineral that was formed from the remains of tiny plants and animals that died millions of years ago. Power companies use the heat energy in coal to make electricity

Garbage does not contain as much heat energy as coal though. It takes one ton (2,000 pounds) of garbage to equal the heat energy in just 500 pounds of coal.

Today there are 142 waste-to-energy plants in the United States. Plus there are another 34 old-style solid waste incinerators. These old-style incinerators simply burn trash to get rid of it. They do not use the heat energy to make steam or electricity. In total, the United States burned 17 percent of its garbage in 1990; 16 percent in waste-to-energy plants and one percent in old-style incinerators.

Why Burn Garbage?

Waste-to-energy plants generate enough electricity to supply 1.2 million households. But providing electricity is not the major advantage of waste-to-energy plants. Frankly, it costs more to generate electricity at a waste-to-energy plant than it does at a coal, nuclear, or hydro electricity plant. Instead, the major advantage of burning garbage is that it reduces the amount of garbage we bury in our landfills.

Burning waste substantially reduces the amount of trash going to a landfill. Let's look at an example. The average American produces 1,500 pounds of waste a year. If this waste were landfilled, it would take more than two cubic yards of landfill space. That's the same space as a box three feet long, three feet wide, and six feet high - about the size of a refrigerator box. If that waste were burned, on the other hand, the ash residue would fit into a box three feet long, three feet wide, but only nine inches high!

Why is reducing the amount of waste buried in landfills so important? This country is in what some people have called a landfill crisis. Our existing landfills are filling up quickly and, in many places, local governments are not building new ones. The cost of building a landfill today runs about $2 to $4 million.

Taking the country as a whole, the United States has plenty of open space, of course, but it is expensive to transport garbage a few hundred miles just to put it in a landfill.

Inside a Waste-to-Energy Plant

Waste-to-energy plants work very much like coal-fired power plants. The difference is the fuel. Waste-to-energy plants use garbage - not coal - to fire an industrial boiler.

But the same steps are used to make electricity at a waste-to-energy plant as a coal-fired power plant.

1. The fuel is burned, releasing hot energy.
2. The heat energy superheats water into steam.
3. The very high pressure of the steam turns the blades of a turbine generator to produce electricity.
4. The local utility company sends the electricity along power lines to homes, schools, and businesses.

You can think of garbage as a mixture of energy-rich "fuels." In every 100 pounds of garbage, more than 80 pounds can be burned as fuel to generate electricity at a power plant. The "fuels" include paper, plastics, and yard waste. A ton of garbage generates about 525 kilowatt-hours (kWh) of electricity, enough energy to heat a typical office building for one day.

The high-temperature incinerator in a waste-to-energy plant burns most of the waste. All that is left is a substance called ash.

Ash is the solid residue left over when something is burned. It's like the ash left over from a wood fire in the bottom of a fireplace.

In a waste-to-energy plant, 2,000 pounds (one ton) of garbage is reduced to 300 to 600 pounds of ash.

Burning Garbage and the Environment

Some people are concerned that burning garbage may harm the environment. Like coal plants, waste-to-energy plants produce air pollution when the "fuel" is burned to produce steam or electricity.

Burning garbage releases the chemicals and substances found in the waste. Some chemicals can be dangerous to people, the environment, or both if they are not properly controlled.

Air Emissions

The Environmental Protection Agency (EPA) - an agency of the federal government - applies strict environmental rules to waste-to-energy plants. The EPA wants to make sure that harmful chemical gases and particles are not just going out the smokestack.

The EPA requires waste-to-energy plants to use several anti-pollution devices, including scrubbers, fabric filters, and electrostatic precipitators.

Scrubbers clean chemical gas emissions by spraying a special liquid into the gas stream to neutralize acids.

Fabric filters and electrostatic precipitators remove particles from the emissions. The particles are then mixed with the ash that is removed from the bottom of the plant's furnace when it is cleaned.

Waste-to-energy plants also have a kind of built-in anti-pollution device. A waste-to-energy furnace burns at such high temperatures (1,800 to 2,000) degrees Fahrenheit) that many complex chemicals naturally break down into simpler, less harmful compounds.

Ash Disposal

Another challenge is the disposal of the ash after combustion. Ash can contain high concentrations of various metals that were present in the original waste. Textile dyes, printing inks, ceramics, and some electronic equipment, for example, contain the heavy metals lead and cadmium.

Separating waste before combustion can solve part of the problem. For instance, because batteries are the largest source of lead and cadmium in the solid waste stream, they should be taken out of the mix and not burned.

The ash must be disposed of carefully. Like regular garbage, it is not a good idea to place ash in an unprotected landfill because water trickling through the landfill , called "leacheate," will pick up the chemicals and metals in the ash and could contaminate the ground and surface waters nearby.

At some landfills, ash is put in a special cell that is separate from the regular mixed waste. Other landfills, called "monofills," are built solely to hold ash.

Do Other Countries Use Waste-to-Energy

Yes! Most countries do not have as many landfills as the United States. So many countries burn even more of their trash in waste-to-energy plants than we do.

Country	Percent of Waste Burned
Canada	4%
Great Britain	10%
United States	14%
The Netherlands	40%
Denmark	60%
Japan	72%
Switzerland	75%

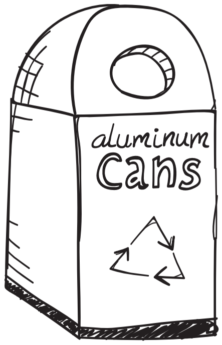
To Burn or Not to Burn?

Some critics of waste-to-energy are afraid that burning waste will hamper recycling programs.

If everyone sends trash to the waste-to-energy plant, they say, there will be little incentive to recycle.

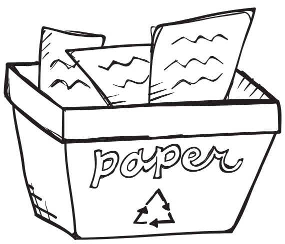
Several states have considered of are considering banning waste-to-energy plants unless recycling programs are in place. Massachusetts, New Jersey, and New York City have delayed new waste-to-energy plants, hoping to increase recycling first.

So, what's the story? Can recycling and burning waste co-exist?



At first glance, recycling and waste-to-energy seem to be at odds, but they really complement each other. That's because while it makes sense to recycle some materials, it makes better sense to burn others.

Let's look at **ALUMINUM**, for example. Aluminum ore is so expensive to mine that recycling aluminum more than pays for itself. Also, because aluminum melts at a low temperature, it can clog up the works in a waste-to-energy plant. So clearly, aluminum is valuable to recycle and not useful to burn.



PAPER, on the other hand, can either be burned or recycled - it all depends on the price the used paper will bring.

Today the East Coast has a glut of old newspapers. Some East Coast communities get paid next to nothing for the paper they have collected. And some communities cannot find anyone who wants to buy their old newspapers, so they end up paying a trucking company to haul the newspapers to a landfill!

In these cases, burning newspaper for its energy value is a good alternative. Other types of paper, such as those using colored inks and glossy finishes, are not so easily recycled and usually should be burned for their energy content.

PLASTICS are another matter. Because plastics are made from petroleum and natural gas, they provide an excellent source of energy for a waste-to-energy plant.

This is especially true since it is not as easy to recycle plastics (they almost always have to be hand-sorted) as it is steel, aluminum, or paper, and since making a product from recycled plastics may cost more than making it from new materials.

To burn or not to burn is not really the question. Ideally, we should use both recycling and waste-to-energy to manage our solid waste problem.

How to Make Your Museum Station

Congratulations! The Director of the Museum of Solid Waste and Energy has just hired your group to be museum curators. (A curator is someone who is in charge of caring for an exhibit at a museum or zoo.) Your group will create Station Seven. [Other museum curators will be creating stations on a different solid waste and energy topics. Together you will create an eight-station tour for the Museum of Solid Waste and Energy. Your class, school, or even your entire community will be invited to tour your station. NOTE: See NEED's curricula on line for other stations if interested.]

So, roll up your sleeves. Here is a quick look at what you will need to do:

- Read the museum backgrounder for your station.
- Find the main ideas and write a three-minute script for your station tour.
- Make posters and hands-on displays for your tour.

Step 1 - Learn by Example

Please take out your museum backgrounder (previous article). Your job is to tell the story of your backgrounder to others and to create posters or displays that highlight the most important facts or ideas. Your boss, the museum director, has done a sample for you since you are new on the job. You will follow his example as you create your station tour.

Let's see how the director created a tour script and exhibit for the opening of your station. Of course the first thing he did was read the entire backgrounder. Then he underlined the most important ideas or facts - things he thought others should know or things he thought were particularly interesting. You can see what the director wrote down in the box at the bottom of this page. The next thing the director did was brainstorm a few ideas for the exhibits.

You can see his ideas for exhibits in the box too.

Director's Sample

1. Main Ideas - The director wrote down the main ideas for the first section of your backgrounder. You will underline the main ideas on your backgrounder too.

1 – We can burn garbage and use its heat energy to make steam or electricity. That's just what we do with coal.

2 – One ton of garbage equals the heat energy in 500 pounds of coal

2. Exhibits - Next, the director jotted down some ideas for presenting the information to visitors touring your museum station. You will decide what types of exhibits your group will use.

1 – Get five lunch bags. Write 500 pounds on each bag. Label four of the bags as garbage and one bag as coal.

3. Tour Script:

Hello and welcome to the waste-to-energy station. One way we can help solve our country's waste problem is to burn our garbage.

Burning garbage is nothing new. It's probably as old as dumping garbage. But today we can burn garbage and use its heat energy to make steam for heating buildings or to generate electricity. That's what waste-to-energy is all about - turning waste into usable energy.

Today most electric utilities burn coal, using the heat energy in coal to make electricity. Garbage doesn't have as much heat energy as coal though.

Do you see the garbage bags on the table? It takes 2,000 pounds of garbage to equal the heat energy in just 500 pounds of coal. So waste-to-energy may not be the cheapest way to make electricity, but it is a good way to cut down on landfill disposals while at the same time doing something useful with our garbage

Step 2 - Learn by Doing
Now it's your turn. Your group can work together. Here's what you need to do:

1. Read your backgrounder (the previous article).
   Read silently, or have one person read aloud as the others follow along.
2. Underline the main ideas in each station.
   The backgrounder is divided into sections with headings or boxes. Working section by section, each person should underline the main ideas on his or her backgrounder.
3. Using your own sheet of paper, write down at least two ideas for exhibits for each section.
   Again working section by section, decide what displays would make your station interesting. Remember, the exhibits will need to tie into your tour script.
4. Write a tour script for your station.
   Work together as a group to write the script for your station tour. (Choose one person to write down your group's script.)

You may take sentences straight from the backgrounder if you want. Just keep in mind that you will be speaking to a group of people, so make your discussion conversational. You may want to ask your visitors questions, for example, or pass a display around for them to look at. You also will need to keep your script very short. You may need to combine sections of your backgrounder or eliminate a section if your script is running long. Remember, your tour should only take about three minutes!

Note: Your teacher will be checking your progress periodically to make sure you're on the right track. Try to stay on schedule. Don't get so bogged down with details that you fall behind.

Step 3 - Decide Who Does What
Next decide who will do what in your group. Who will be the tour guide(s)? Who will make which displays?

On a sheet of paper write down each person's name. Next to their name, jot down the person's tasks. This will ensure everything gets done on time.

Step 4 - Creation!
Are your creative juices brewing? You have the next few days to create the displays to go along with your station and to refine your script.

MORE HELP

Station 7 Main Ideas - You'll want to be sure to include the following information in your station tour:

- We can burn garbage to make steam and electricity
- One ton of garbage has the same heat energy as 500 pounds of coal
- It's not the cheapest way to make electricity, but it greatly reduces the amount of waste that is landfilled
- After garbage is burned, all that is left over is a substance called ash
- Strict rules require waste-to-energy plants to be clean-burning
- Recycling and burning waste should be used together

Hints for Making a Great Station Tour

- Try to involve your visitors in your station tour. Ask them questions or pose problems.
- Don't use too many posters for your exhibits. Try to use some props or 3-dimensional displays as much as possible. Example: use beverage cans to represent garbage cans, etc.
- Once you have made your station tour, time it to see how long it is. You may need to eliminate information or re-write sentences if your presentation is running long.
- The tour guide(s) should memorize the script for the museum tour. Nobody wants to listen to somebody reading from a piece of paper.
- The tour guide(s) should rehearse in front of your group. Together you may come up with ways to improve the script or displays.

After getting these ideas together, the director wrote a script to go along with the first part of your backgrounder. He wrote the script as if he was giving a tour to a group of people. You'll want to keep that in mind when you write your script too. You may read the director's tour script in the box at the bottom of previous page.

Name:____ Date: ______________________

How Can We Redesign Things to Waste Less?

Concept
Packaging is useful and necessary for many reasons, but also contributes significantly to our society's solid waste problems.

Objective
Students will explore parameters of packaging design and will use these guidelines in their own design project.

Method
Students will design environmentally sound packaging.

Materials
Magazines, drawing materials, computer access

Subjects
Art, Social Studies, Home, Economics, Industrial Arts

Skills
Applying ideas to solve problems, designing, researching, using mathematics

Time
Two or more class periods

Vocabulary
Design, parameters, packaging, prototypes

Resources
Packaging World; Packaging Digest

3R's of the Common Core
Parallel Activities
K-3, Too Much Packaging
K-3, Egg Cartons
4-6, The Story of …
4-6, Pondering Packaging
9-12, Packaging Preferences
9-12, Cart Before the Horse
Information
Packaging; Public Planning and Policy; Redesign and Reuse
Resources
Environmental Justice, Advocacy and Policy
Solid Waste and Recycling
Waste Management Agencies by State

Background

Functions and Benefits of Packaging:
- Preservation and protection of contents
- Sanitation and safety, protection of public health
- Identification of product
- Prevention of theft
- Providing instruction as to product use
- Compliance with regulatory standards
- Manufacturing of packaging provides employment
- Increase sales and profits by making the product attractive
- May decrease cost of product to consumer

Drawbacks of Packaging:
- Contributes significantly to solid waste
- Without reuse or recycling, wastes the energy and natural resources that go into packaging
- Contributes significantly to litter
- May create false impressions about the amount or quality of products
- May increase the cost of a product to the consumer

Leading Question
How could packaging be designed to waste less?

Procedure
1. Have students look through magazines for about ten minutes and cut out pictures of packaged products.
2. Have students choose one of the products for which they would like to design an alternative packaging. After selecting the item they want to design alternative packaging for; the student can go to the products site to obtain any information on the product and its packaging. Students should also research information on alternative packaging that may help them with their own designs.
3. Ask the students to look at their product and decide what the designer was trying to accomplish. Discuss the functions and drawbacks of packaging. Are any of the products designed to protect the environment? Using the notes they have taken on the product, packaging and alternatives and the discussion questions students will assess their product.

Common Core Alignments

GRADE 7

CC.RST.6-8.8
Reading in Science & Technical Subjects:
Integration of Knowledge & Ideas

CC.SL.7.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.WHST.6-8.7
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.7.G.6
Mathematics:
Geometry

GRADE 8

CC.RST.6-8.8
Reading in Science & Technical Subjects:
Integration of Knowledge & Ideas

CC.SL.8.5
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.WHST.6-8.6
Writing in History/Social Studies,
Science & Technical Subjects:
Production & Distribution of Writing

CC.8.G.9
Mathematics:
Geometry

4. Have the students design a new environmentally-sound alternative to their packaging. The designs should include considerations of waste reduction, reuse and recycling as well as public safety, product protection, shipping weight, cost of packaging material, advertising and public demand. New design parameters should include some or all of the following: minimum resource extraction, minimum use of energy in processing, minimum transportation, selection of reusable or recyclable resources, design for reusability and recyclability, use of non-hazardous materials, etc. How do these new parameters conflict with or limit old ones?
5. Students will share their written report on their design with the class. The report should explain how design decisions were made and show research to help support their new design. The report will include drawings of prototypes and/or a sample to view.

Classroom Activities

A. Make models of new package.

B. Have students write to and send their designs and/or prototypes to packaging manufacturers as suggestions for improvement in packaging design.

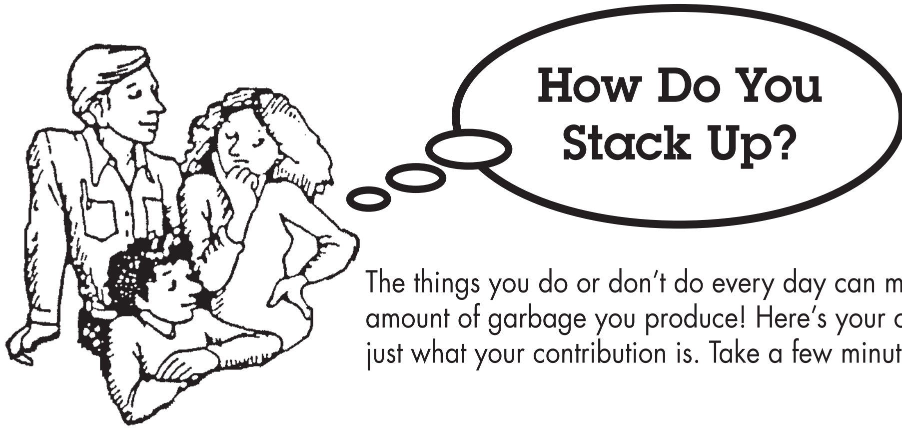
C. Analyze a variety of products, measuring the actual amount of the product compared to the size and shape of the product's package.

D. Invite representatives from the grocery business and the packaging industry to class to discuss packaging. Invite an industrial designer to class to discuss packaging design.

E. Research the regulatory standards packagers and retail outlets are required to meet. Who sets these standards? What is required? Why is safety a concern today?

F. Discuss the pros and cons of new types of packaging, such as brick packs and plastic cans. Divide students into small groups which will build cylinders and rectangular prisms containing exactly one pint. If filling a cardboard carton for shipping, which solid would fit more compactly?

G. Have students complete the attached How Do You Stack Up worksheet.



The things you do or don't do every day can make a difference in the amount of garbage you produce! Here's your chance to stop and consider just what your contribution is. Take a few minutes to complete this checklist.

Then find your total by adding the numbers you circled in each column.
The back of this sheet will tell you how you stack up.

Do You…	**Never**	**Sometimes**	**Often**
Take advantage of opportunity to recycle in your area?	3	2	1
Shop at garage sales and second-hand stores?	3	2	1
Try not to use disposable products when longer-lasting alternatives are available?	3	2	1
Use sponges and dishcloths rather than items that can be used only once?	3	2	1
Compost yard debris, kitchen waste and other organic matter?	3	2	1
Think about what happens to a product or package when you're finished with it?	3	2	1
Try to reuse things instead of disposing and buying new ones?	3	2	1
Consider whether you really need something before you buy It?	3	2	1
Consider whether pollution/wastes were caused by manufacturing the item you buy?	3	2	1
Avoid products with built-in obsolescence?	3	2	1
Express concern about the need to produce less wasteful products by writing product manufacturers or your legislator?	3	2	1
Ask that the least amount of paper and plastic wrapping be used for your order in fast-food restaurants?	3	2	1
Talk to store managers about stocking products in bulk or avoiding unnecessary packaging?	3	2	1
Make a habit of reading labels and consumer information articles to learn about the quality and durability of products you buy?	3	2	1
TOTALS			
GRAND TOTAL *(Add 3 Columns)*			

How Do You Stack Up?

SCORE SHEET

Your GRAND TOTAL

If Your Score Was ...

40 or more

You're contributing a great deal of trash to our rapidly filling landfills, including thousands of tons of reusable, recoverable materials which are thrown away each year!

What you can do!

- Become more aware of the amount of trash you throw out every day. What could be reused, recycled or avoided completely?
- Next time you go to the store, see if products you usually buy in non-recyclable containers are also available in returnable, refillable or recyclable containers.
- Call your local government, garbage collector or recycler for information on how, when and where to recycle.

Between 21 & 39

Pretty good! It's obvious you're doing some reusing, recycling and reducing of the amount of trash you throw out. These habits need to be practiced consistently by all if we're to reduce the increasing quantity of waste produced in the United States.

What you can do!

- Look at various types of packaging and the available alternatives. Does it cost you more or less to buy reusable or recyclable packages?
- Reuse plastic sacks; bring your own grocery bags to the supermarket.
- Look around your home for more items to recycle and phone your local government, garbage collector or recycler for information.

20 or less

Congratulations! It's clear you've done some serious thinking about the need for waste reduction and recycling. You're helping ensure that future generations enjoy natural resources, pristine beauty and better quality of life. You're also providing jobs for the many people working in industries that use recycled materials to make new products.

What you can do!

- Encourage one other person to recycle. You set a good example!
- Write letters, attend meetings. Get involved in solid waste management in your community.
- Give yourself a pat on the back and keep up the good work!

Less is better when it comes to garbage and energy consumption.

How Can We Recycle to Reduce Waste?

Concept
The most efficient method for sorting recyclables is to separate them at their source.

Objective
Students will investigate current containers and make proposals and design containers for the easy and efficient source separation of recyclables as needed.

Method
Students will investigate current recycling methods and containers. They will propose a design for containers for recycling where needed and build prototypes.

Materials
Attached handout(s), additional information and designs, shop equipment and materials, drawing and graphing materials, computer access

Subjects
Industrial Arts, Home Economics, Social Studies, Art, Language Arts, Science

Skills
Applying mathematical concepts, collaborating, developing models, problem solving

Time
Two - four class periods for discussion, design, drawing, group work and report writing and presenting.

Vocabulary
Source separation, container

Resources
Resource Recycling Magazine; Rodale's New Shelter Magazine

3R's of the Common Core
Parallel Activities
K-3, What's Recyclable?
4-6, Where to Recycle
9-12 Collecting and Sorting
Information
Transportation and Processing
Public Planning and Policy
Redesign and Reuse
Recycling
Resources
Solid Waste and Recycling
Waste Management Agencies by State

Background

"Paper rapidly loses its value when mixed with other refuse, particularly glass and organic waste. Glass and metals, while less vulnerable to degradation, compete with uncontaminated raw materials in the marketplace. Organic wastes destined for the compost pile are easiest to handle if they are free of inorganics and substances toxic to plants. As a rule, the nearer to the origin of the waste that recovery occurs, the less sorting and processing will be needed before the materials can be recycled. The cleanest secondary materials always command the highest prices."

- Cynthia Pollack.

Leading Question

What is the best way to sort and store our recyclables?

Procedure

1. Have students research the history of recycling. Discuss the benefits of source separation in recycling. Review the different types of sorting containers illustrated and the different purpose each serves.
2. Have students do an investigation on what types of containers the school uses and what might be needed. Consider where recycling centers might be needed in the home and community? Have students gather their information and display on a chart.
3. Students assess each area and the containers in it. Ask students what different design features need to be considered for each location? Have students consider the following for each location:
   - What type of space is the container to serve? (e.g.: school, classroom, park, kitchen, garage, office)
   - Are there any space limitations?
   - What is the projected volume, weight and type of recyclable the container will need to hold?
   - How often will it need to be emptied?
   - How will the contents (and/or the container itself) be transported and emptied?
   - Will the container need to be cleaned frequently?
4. Break into groups of students each taking a different location. Each group should design a container to meet the outlined needs of their location. Students make a drawing of the container and present it to the class, explaining why it meets the needs.

Common Core Alignments

GRADE 7

CC.RST.6-8.2
Reading in Science & Technical Subjects:
Key Ideas & Details

CC.SL.7.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.WHST.6-8.4
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.7.G.6
Mathematics:
Geometry

GRADE 8

CC.RST.6-8.2
Reading in Science & Technical Subjects:
Key Ideas & Details

CC.SL.8.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.WHST.6-8.4
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.8.G.9
Mathematics:
Geometry

5. After designing their containers, students will work in groups to study an actual location. They will assess the current containers used or the lack of them. They will consider questions used in designing a container(s) and whether the container(s) are designed for easy source separating. They will compile a group written report that reviews the current recycling containers and their effectiveness. They will propose new containers and recycling ideas, as needed. They will compare their proposed design container to what is currently used. They will consider which one would be more effective and provide a concluding statement about their location findings.

Evaluation

Students groups will share their reports and proposed designs with the class. Are the containers currently used convenient, clean and functional? Are the proposed designs a better option? Why or why not?

Classroom Activities

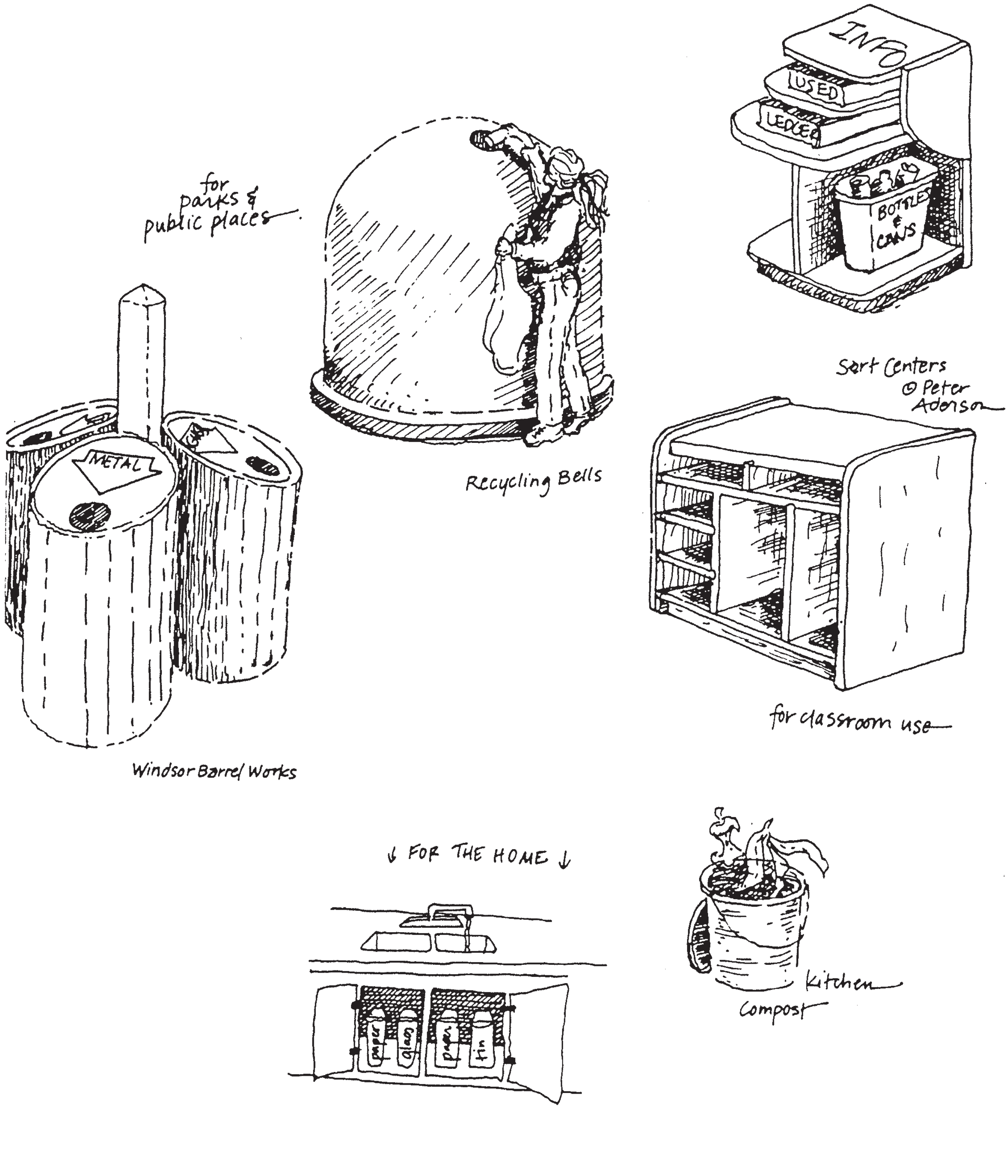
A. Develop a project requirement list including materials to be used, equipment needed, skills necessary, specifications for container and build a prototype. If possible use salvaged materials. Test its usefulness by sorting and storing recyclables and modify the design if needed.

B. Design a recycling center for the community or school. See 9-12, III.B.2, Collecting and Sorting.

C. Visit and compare existing source separation sites.

D. Design a truck for the collection of recyclables.

SOURCE SEPARATION CONTAINERS



How Can We Recycle Resources to Reduce Waste?

Concept
Continuing and comparative studies may be done to find the most profitable place to take recyclables.

Objective
Students will see how fluctuating markets and different commodity prices affect the fate of recycling.

Method
Students will graph prices offered for recyclables.

Materials
Graph paper, transparencies, list of recycling businesses, computer and internet access,

Subjects
Mathematics, Business, Language Arts,

Skills
Communicating, evaluating, graphing data, investigating

Time
Several months

Vocabulary
Subsidize, recyclable

Resources
Local Recycling Businesses, Resource Recycling Magazine (Market Update Section); William D. Robinson, *The Solid Waste Handbook*; your state's natural resources department or other environmental agencies

3R's of the Common Core
Parallel Activities
4-6, Where to Recycle
9-12, Cart Before the Horse
Information
Redesign and Reuse
Recycling
Resources
Solid Waste and Recycling
Waste Management Agencies by State

Background
Each community faces different challenges with recycling and waste management. Geography, populations and local legislation will affect a community's ability (or inability) to effectively manage its waste. Below is information regarding a rural area (Vermont) and an urban area (Chicago).

"While progress has been made in reducing and diverting solid waste since the passage of Vermont's first robust solid waste management law (Act 78 in 1987), the amount of waste that Vermonters generate is significant at 5.18 pounds per person per day which leaves much room to improve upon waste reduction efforts. At the same time the diversion rate, amount of material kept out of landfills or incinerators, has stagnated in the mid 30% range for the last ten years....This sustainable materials management strategy focuses on using materials throughout the entire lifecycle of a product or material with the intent of preventing overall waste, increasing reusability, and increasing recycling and organics diversion.... managing materials sustainably transforms the waste management industry into an industry that has even greater influence on local economic development, ability for communities to build a working landscape, and decrease Vermont's greenhouse gas (GHG) emissions that contribute to climate change"

– State of Vermont, Materials Management Plan (2014)

"The Illinois per capita waste generation rate was significantly higher than the national average in 2007...Illinois is relatively urban with 87.3% of its residents living in cities, urban areas ...and produce on average 25% more trash than rural areas.....Although the state imposes some mandates concerning recycling, the actual business of managing the solid waste stream falls on the shoulders of local and municipal government... Many municipalities do not provide waste removal directly but allow several companies to compete in garbage removal service market....Volatile commodity prices make it difficult for recycling companies to plan ahead and unexpected downturns in commodity prices may leave companies without the liquidity they need to finance day to day operations. Recycling companies may be unwilling or unable to take on the risk that volatile commodity prices pose."

– Institute of Government and Public Affairs,
Waste and Recycling in Illinois (2010)

Common Core Alignments

GRADE 7

CC.SL.7.1
Speaking & Listening:
Comprehension & Collaboration

CC.WHST.6-8.4
Writing in History/Social Studies,
Science & Technical Subjects:
Production & Distribution of Writing

CC.WHST.6-8.7
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.7.SP.7
Mathematics:
Statistics & Probability

GRADE 8

CC.SL.8.1
Speaking & Listening:
Comprehension & Collaboration

CC.WHST.6-8.6
Writing in History/Social Studies,
Science & Technical Subjects:
Production & Distribution of Writing

CC.WHST.6-8.7
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.8.SP.4
Mathematics
Statistics & Probability

Leading Question

Do recycling businesses pay us for the materials we collect?

Procedure

1. Students will investigate what materials are recycled in their area. They will write a letter and/or an email to their local waste management operation to ask for the information. They will compile a list of items recycled. They will create a second list of other items they feel should be recycled. Is the second list of materials technically possible to recycle, but are not recycled in the area? What is the difference in the lists? Why are some items recycled and others not?
2. Look at the list of recycling businesses serving your area. Call, write and/or email several recyclers. Ask them what price they are receiving for each ton of material they deliver to market. Ask them what factors influence the price they are paid for recyclables. Do they pay citizens for recyclables collected? Students will compile a report on their findings.
3. Graph the information by both (a) and (b):

   (a) Type of material

   - glass (green, brown, clear or mixed)
   - paper (newsprint, corrugated cardboard, white ledger or mixed)
   - metals (steel cans, bimetal cans, aluminum cans, other metals)
   - plastics (HDPE, PET, others)

   (b) Prices being offered by recyclers.
4. Study price changes on a monthly basis.
5. Using the graphed information, which recyclers pay the most? If the prices are the same, discuss why this is so. Why might the price vary from month to month?
6. Students will consider and include in their findings summary the following: If the payoff is not monetarily profitable, how else might it be profitable? How can increased recycling be promoted to citizens?

Evaluation

Each student will complete a written summary and evaluation of recycling and their findings. They will consider the following questions, as well as others they have considered in their findings. Do some recyclers pay more than others for material? Do prices change from month to month? What factors might influence prices paid for recyclables? (Some recyclers may include transportation, storage containers, etc., in the price offered.) They will discuss and share their reports in class.

Classroom Activities

A. Compare transportation costs with the value of the materials being recycled.

B. Discuss the questions on the following worksheet

Name:______________________________ **Date:** ______________

The Business of Recycling

1. Why is the recycling center located where it is?

2. If there is not a recycling center in your town, where would be the best place for one?

3. How might location affect the price recycling center operators pay and/or receive for their recyclables?

4. What kinds of equipment are used at the recycling center? Who pays for their costs?

5. What kinds of transportation might be used to deliver recyclables to a manufacturer?

6. How might the cost of transportation of any one recyclable affect the profit of the recycling center operator?

7. What might affect the price a manufacturer pays a recycling center for its recyclable material?

8. Should resources be recycled at a financial loss? If so, who should subsidize the recycling center operators so they will do it?

9. Can you think of any subsidies that government provides the wood and plastics industries that make it difficult for recyclable materials to compete?

How Does Recycling Work?

Concept
Successful recycling depends in part on the availability of convenient recycling opportunities as well as dependable markets and market demand.

Objectives
Students will identify the destination and fate of their state's recyclables.

Method
Students will research their assigned material as a group and share their results.
Extra Activity Method: Students will produce maps of their state and US recycling markets.

Materials
Internet access, access to local recycling resource guides and information, county, state, US maps, list of places to recycle, mapmaking tools

Subjects
Social Studies, Business, Language Arts, Science

Skills
Gathering information, interviewing, problem solving, sharing research and writing

Time
Two - three classes and/or an overnight assignment

Vocabulary
Cellulose insulation, end-use

Resources
Local recycling businesses; Local solid waste agencies; Your state's department of natural resources or other environmental agency

3R's of the Common Core
Parallel Activities
4-6, Where to Recycle
7-8, Graphing Recyclables
Information
Components of the Waste Stream
Recycling
Resources
Solid Waste and Recycling
Waste Management Agencies by State

Background
Many of our recyclables are currently sent out of state or even abroad for processing and end-use. General market locations are as follows:

- 36% of plastic soda bottles were shipped overseas in 2003.
- The green bottles can be made into polyester fiber-fill as well. When necessary, the bottles are land banked for future use.
- Aluminum beverage cans are shipped to aluminum smelters in Texas, Pennsylvania and abroad. Aluminum scrap is used to make secondary aluminum scrap, billets, extrusions and lead and aluminum alloys and new beverage cans.
- Newsprint, corrugated and mixed paper is often bought by General Mills, who in turn sell the paper to other companies for use.

Leading Question
When you recycle, where does it all go? What does it become?

Procedure
1. Break students into groups and assign a different recyclable (plastics, glass, newsprint, paper, aluminum, tin cans, batteries, waste oil) to each group.
2. Student groups read and research their material, answering some or all of the following questions on the hand-out. They will create a group report with their findings. Each group will share their report with the class.
3. The class will discuss the difficulties of recycling, their causes and some possible solutions.
4. If the solutions involve contacting town officials and/or companies, students will create letters sharing their solutions to a recycling problem.

Common Core Alignments

GRADE 7

CC.RST.6-8.2
Reading in Science & Technical Subjects: Key Ideas & Details

CC.SL.7.1
Speaking & Listening: Comprehension & Collaboration

CC.WHST.6-8.4
Writing in History/Social Studies, Science & Technical Subjects: Production & Distribution of Writing

GRADE 8

CC.RST.6-8.2
Reading in Science & Technical Subjects: Key Ideas & Details

CC.SL.8.4
Speaking & Listening: Presentation of Knowledge & Ideas

CC.WHST.6-8.7
Writing in History/Social Studies, Science & Technical Subjects: Research to Build & Present Knowledge

Evaluation

What problems do we need to solve if recycling will work?

Classroom Activities

A. Trace the global exchange of recyclables and raw resources.

B. Investigate the garbage barge phenomenon. Is landfill space becoming an international commodity?

Name:____ Date: ______________________

When You Recycle Where Does It All Go?

1. Where is the closest recycling center which accepts your material?

2. What is the nearest commercial recycling business?

3. What businesses within the state use your material in manufacturing?

4. Where are the other end-users of the material in the United States and abroad?

5. What is the average distance required to send recyclables to market?

6. What are the transportation costs involved in shipping the material to its end-user?

7. What are the prices offered for the material?

8. What is the recyclable used to make?

9. Compare the costs of recycling to the costs of extracting, shipping and processing raw material.

How Can We Recycle Organic Waste?

Concept
Recycling by composting improves soil structure and fertility, reduces the volume of household solid waste requiring disposal.

Objective
Students will conduct experiments to test effects of too little water, nutrients, air and imbalance of material on producing good compost and will learn the basic principles necessary to construct a good compost pile.

Method
Class will construct six different compost situations and compare results.

Materials
Organic waste (manure), soil, five five-gallon buckets, thermometer, internet access

Subjects
Biology, Horticulture, Vocational Agriculture
Science, Technology, Language Arts

Skills
Collaborating, collecting data, communicating information, synthesizing

Time
A few weeks

Vocabulary
Composting, nitrogen, cycle

Resources
The Art of Composting; Stu Campbell, *Let It Rot;* Dick Francis and Robert Francis, *The Complete Book of Compost*

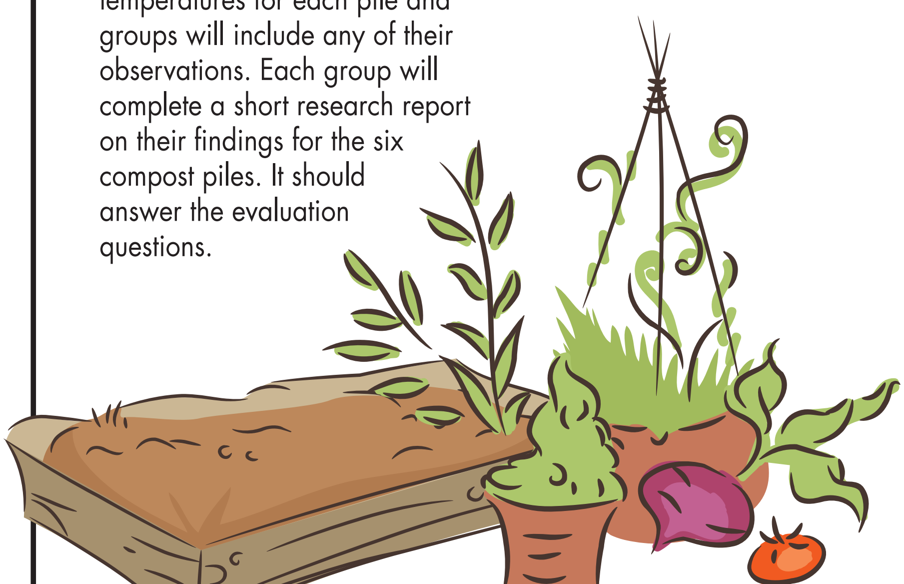
3R's of the Common Core
Parallel Activities
K-3, Take Me Out To The Compost
4-6, Mini Compost
9-12, Micro-Organisms
9-12, Effective Fertilizers
Information
Compost
Resources
General, Environmental Education and Educational Resources

Background
In a NH middle school trash analysis completed by NRRA in October 2015, 55% of the trash analyzed could have been diverted from the waste stream via recycling or composting.

Leading Question
What are the essential ingredients for a successful compost?

Procedure
Note: This activity should be begin in early Fall or Spring for best results.

1. Read about composting and the alternatives for construction of compost bins or containers. Choose the methods within your time and budget limitations. Try to keep compost piles about one cubic yard, or if necessary, use five five-gallon buckets with holes drilled in the sides.
2. Start six compost piles, each unique in one of the ways listed on the worksheet. Use grass clippings, leaves, manure, weeds, hay, sawdust and household organic wastes. Exclude bones, meat, grease or animal products that will cause odors or attract pests.
3. Have each group record the daily temperature of its pile and other observations for a few weeks. At the end of a few weeks students will create a chart of the six compost piles. Using a graph or another visual, it will show varying temperatures for each pile and groups will include any of their observations. Each group will complete a short research report on their findings for the six compost piles. It should answer the evaluation questions.



Common Core Alignments

GRADE 7

CC.RST.6-8.3
Reading in Science & Technical Subjects: Key Ideas & Details

CC.SL.7.4
Speaking & Listening: Presentation of Knowledge & Ideas

CC.WHST.6-8.4
Writing in History/Social Studies, Science & Technical Subjects: Production & Distribution of Writing

GRADE 8

CC.RST.6-8.3
Reading in Science & Technical Subjects: Key Ideas & Details

CC.SL.8.5
Speaking & Listening: Presentation of Knowledge & Ideas

CC.WHST.6-8.6
Writing in History/Social Studies, Science & Technical Subjects: Production & Distribution of Writing

4. Students will discuss their results and share their reports. They will also discuss all of the following questions.
    - Which experimental compost was most successful?
    - How is composting related to the concept of recycling?
    - What are the consequences of not recycling vital chemicals to their origins?
    - How can composting reduce waste?
    - Where does composting occur naturally?

Evaluation

Why did one pile break down wastes faster than others? What are the essential ingredients of a good compost system?

Classroom Activities

A. Discuss how the compost pile is an example of the nitrogen cycle and other natural cycles in our biosphere.

B. Test the effects of different soils on plant growth.

Compost choices: Each student group will pick one of these unique ways to build a compost pile.	
1. Low in Nitrogen a. No organic waste high in nitrogen b. Keep moist, don't soak with water c. Turn regularly, every three or four days at first, then once a week. d. Include a mixture of ingredients: garbage, clippings, leaves, weeds, etc. e. Critters	**4. Too Much of a Single Ingredient** a. Include nitrogen material b. Keep moist c. Turn regularly d. Use all bone meal or manure e. Critters
2. Not Enough Moisture a. Include manure and contents which are high in nitrogen b. Turn regularly c. Have a good mixture of ingredients d. Do not water or add moist garbage e. Critters	**5. No Little Critters** a. Use potting soil (sterilized) b. Turn regularly c. Keep moist d. Good mix of ingredients e. Include material rich In nitrogen f. No critters
3. No Air Circulation a. Include material high in nitrogen b. Keep moist c. Do not turn d. Balanced mixture of ingredients e. Critters	**6. Good Compost Pile** a. Include nitrogenous material (manure and blood meal are good sources) b. Keep moist c. Turn regularly d. Include a good mix of ingredients which are layered e. Critters (Earthworms should be added after temp drops.)

9-12 Activities

Brought to you by

Northeast Resource Recovery Association
2101 Dover Rd | Epsom, NH 03234
www.nrra.net | info@nrra.net
800-223-0150

NRRA School CLUB
www.schoolrecycling.net
theclub@nrra.net

USDA Rural Development
Committed to the future of rural communities.

Lesson Matrix Grades 9-12
3R's of the Common Core

Lesson	Leading Question	Objective	Common Core Alignments		Skills
9-12 **Sources of Waste** **I.A.1**	How do we determine the amount of waste we produce?	Research the sources of waste in society Trace the production of waste in industry	**Grade 9-10** CC.RI.9-10.7 CC.W.9-10.7 CC.HSS.ID.1	**Grade 11-12** CC.RI.11-12.7 CC.W.11-12.7 CC.HSS.ID.1	Analyzing Collecting and interpreting data Designing Researching
9-12 **Packaging Preferences** **I.A.2**	How have beverage containers changed over the years?	Evaluate the environmental impact of different packaging types	**Grade 9-10** CC.W.9-10.4 CC.WHST.9-10.7 CC.HSS.ID.1	**Grade 11-12** CC.W.11-12.4 CC.WHST.11-12.7 CC.HSS.ID.1	Evaluating Gathering information Graphing data Researching
9-12 **Nonrenewable Resources** **I.B.1**	How long will our natural resources last?	Compare estimated life expectancies of some nonrenewable natural resources Understand the role recycling and careful use play in meeting the demand for extending availability of these resources	**Grade 9-10** CC.L.9-10.6 CC.RST.9-10.7 CC.SL.9-10.2 CC.W.9-10.4	**Grade 11-12** CC.L.11-12.6 CC.RST.11-12.8 CC.SL.11-12.2 CC.W.11-12.4	Applying ideas to solve problems Explaining Interpreting data Predicting outcomes
9-12 **Shopper Survey** **I.C.1**	What things influence our purchasing choices? Why is there so much waste?	Assess typical purchasing criteria Determine the influence of packaging on consumer choices Determine if consumers consider waste disposal and recycling when making purchases	**Grade 9-10** CC. SL.9-10.3 CC.W.9-10.4 CC.HSS.IC.3	**Grade 11-12** CC. SL.11-12.3 CC.W.11-12.1 CC.W.11-12.4 CC.HSS.IC.3	Analyzing Gathering information Hypothesizing Interviewing
9-12 **Garbage** **I.C.2**	Name something that New York City produces more of than any other city in the world.	Read Katie Kelly's essay "Garbage" to examine author's use of analysis and persuasion Examine continuing problems of trash volume and disposal	**Grade 9-10** CC.RI.9-10.3 CC.SL.9-10.3 CC.W.9-10.4 CC.W.9-10.2 CC.HSS.ID.1	**Grade 11-12** CC.RI.11-12.6 CC.SL.11-12.1c CC.W.11-12.4 CC.W.11-12.7 CC.HSS.ID.1	Analyzing Evaluating Interpreting information Researching
9-12 **The Dump Ground** **I.C.3**	What do people mean when they use the expression, "One man's trash, another man's treasure"?	Interpret the themes of "The Dump Ground" and "Garbage" Derive history and culture of a people from the essays	**Grade 9-10** CC.RI.9-10.6 CC.RI.9-10.10 CC.SL.9-10.1c CC.W.9-10.4	**Grade 11-12** CC.RI.11-12.6 CC.RI.11-12.10 CC.SL.11-12.1c CC.W.11-12.4	Analyzing Comparing Evaluating Interpreting
9-12 **GNP(P):Great New Purchasing Power** **I.C.4**	Does a higher income cost more?	Detect general relationships between GNP/capita and energy consumption per capita Examine the specific factors encouraging high energy use Understand relationship between recycling and conserving energy	**Grade 9-10** CC.L.9-10.6 CC.W.9-10.4 CC.HSS.ID.6	**Grade 11-12** CC.L.11-12.6 CC.W.11-12.4 CC.HSS.ID.6	Evaluating Graphing data Interpreting data Recognizing patterns

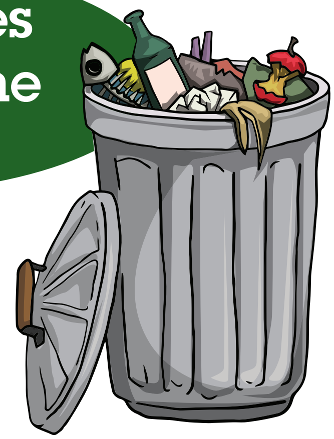
Lesson	Leading Question	Objective	Common Core Alignments		Skills
9-12 **New Landfills** **II.A.1**	If we need a new landfill, how will we go about siting and designing one?	Become familiar with local government, land-use planning, and complexities of solid waste planning process	**Grade 9-10** CC.RI.9-10.7 CC.SL.9-10.2 CC.WHST.9-10.8 CC.HSG.MG.3	**Grade 11-12** CC.RI.11-12.7 CC.SL.11-12.2 CC.WHST.11-12.8 CC.HSG.MG.3	Comparing solutions Designing Gathering information and data Problem solving
9-12 **Methane** **II.A.2**	Can we recover energy from solid waste?	Understand the energy-producing potential of some solid wastes Understand some systems of generating methane from waste	**Grade 9-10** CC.RST.9-10.3 CC.SL.9-10.1 CC.WHST.9-10.7	**Grade 11-12** CC.RST.11-12.3 CC.SL.11-12.1 CC.WHST.11-12.8	Carrying out investigation Interpreting data Observing Researching
9-12 **Spreading Sludge** **II.A.3**	Is it safe to put sludge on land all year round?	Determine the benefits and drawbacks of land application of sewage sludge	**Grade 9-10** CC.SL.9-10.1c CC.SL.9-10.4 CC.W.9-10.6 CC.W.9-10.7	**Grade 11-12** CC.SL.11-12.1c CC.SL.11-12.4 CC.W.11-12.6 CC.W.11-12.7	Evaluating Formulating questions Gathering information Hypothesizing Interviewing
9-12 **Toxic Waste in the Lab** **II.A.4**	Are there alternatives to disposal of toxic wastes in the solid waste stream?	Upgrade the school's lab cabinet	**Grade 9-10** CC.RST.9-10.3 CC.SL.9-10.4 CC.W.9-10.7	**Grade 11-12** CC.RST.11-12.3 CC.SL.11-12.4 CC.W.11-12.7	Carrying out investigation Evaluating Explaining Researching
9-12 **Community Solid Waste** **II.B.1**	How do we manage our solid waste?	Evaluate both the current solid waste disposal practices and future plans in their community	**Grade 9-10** CC.SL.9-10.2 CC.SL.9-10.4 CC.W.9-10.4	**Grade 11-12** CC.SL.11-12.2 CC.SL.1-12.4 CC.W.11-12.4	Communicating information Designing Gathering information and data Synthesizing
9-12 **Twenty Foot Swath** **III.A.1**	Have personal or global problems such as poverty or environmental pollution ever become so overwhelming that you were immobilized or driven to some action that actually aggravated the problem?	Discern the author's purpose in writing the essay Develop a plan for decreasing pollution in environment by setting realistic personal goals	**Grade 9-10** CC.RI.9-10.3 CC.SL.9-10.1c CC.W.9-10.4	**Grade 11-12** CC.RI.11-12.6 CC.SL.11-12.1d CC.W.11-12.4	Analyzing Applying ideas to solve problems Engaging in collaborative conversation Evaluating

Lesson Matrix Grade 9-12

3R's of the Common Core

Lesson	Leading Question	Objective	Common Core Alignments		Skills
9-12 Recycling Paper Pollution III.B.1	Does recycling solve all our solid waste problems?	Investigate methods of recycling paper and the technical problems encountered in the recycling industry	**Grade 9-10** CC.RST.9-10.3 CC.SL.9-10.1c CC.W.9-10.7 CC.HSS.ID.1	**Grade 11-12** CC.RST.11-12.3 CC.SL.11-12.1d CC.W.11-12.7 CC.HSS.ID.1	Carrying out investigation Communicating solutions Interpreting Researching
9-12 Collecting and Sorting III.B.2	What kind of recycling program would be best for our town or our school?	Understand some of the design considerations of establishing a recycling facility Use the information to design a hypothetical recycling center for their town or school	**Grade 9-10** CC.RI.9-10.7 CC.SL.9-10.2 CC.W.9-10.4 CC.HSG.MG.3	**Grade 11-12** CC.RI.11-12.7 CC.SL.11-12.2 CC.W.11-12.7 CC.HSG.MG.3	Applying mathematical concepts Designing Gathering information Problem solving
9-12 Speaking for Recycling III.B.3	What do we need to know about recycling?	Become more familiar with recycling and solid waste management issues Develop their public presentation skills	**Grade 9-10** CC.RI.9-10.8 CC.SL.9-10.4 CC.W.9-10.2	**Grade 11-12** CC.RI.11-12.8 CC.SL.11-12.4 CC.W.11-12.1	Communicating information Researching Sharing research and writing Synthesizing
9-12 The Cart Before the Horse? III.B.4	Why isn't everybody recycling?	Consider ways to reduce waste in the United States	**Grade 9-10** CC.RI.9-10.7 CC.SL.9-10.1 CC.W.9-10.4	**Grade 11-12** CC.RI.11-12.7 CC.SL.11-12.1 CC.W.11-12.1	Analyzing Engaging in collaborative conversations Gathering information Using evidence
9-12 Microorganisms III.C.1	Can you identify microorganisms responsible for the composting process?	• Relate the importance of healthy microorganism activity to composting	**Grade 9-10** CC.RST.9-10.3 CC.SL.9-10.1 CC.WHST.9-10.4	**Grade 11-12** CC.RST.11-12.3 CC.SL.11-12.1 CC.WHST.11-12.4	• Carrying out investigations • Collecting and interpreting data • Observing • Predicting
9-12 Effective Fertilizers III.C.2	What are fertilizers made of?	Rate the effectiveness of various organic and inorganic fertilizers	**Grade 9-10** CC.L.9-10.6 CC.SL.9-10.1 CC.WHST.9-10.4	**Grade 11-12** CC.L.11-12.6 CC.SL.11-12.1 CC.WHST.11-12.4	Carrying out investigation Hypothesizing Interpreting data Observing

Where Does Waste Come From?



Concept
All human activities produce waste. There are many different sources of waste in society.

Objective
Students will research different sources of waste in society and will trace the production of waste in industry.

Method
Students will research local business and industry.

Materials
Handout

Subjects
Social Studies, Science, Language Arts, Mathematics

Skills
Analyzing, collecting and interpreting data, designing, researching

Time
Several days; extended project

Vocabulary
Pre-consumer waste, manufacturing waste

Resources
Local industries; your state's Industry or Labor Department; Environmental Protection Agency; American Society of Civil Engineers; United States Census Bureau

3R's of the Common Core
Parallel Activities
K-3, Machine
4-6, What Kind of Waste Am I?
7-8, School Trash Analysis
Information
The Solid Waste Stream
Resources
Green Consumption, Consumerism and Sustainable Development

Background
According to the 2010 census, 19.3% (59,492,276 people) of the United States population resides in rural areas; in urban areas there are 249,253,271 residents, or 80.7% of the population. Americans work in the tourism industry, manufacturing of electronic products, printing and publishing, banks, engage in wholesale and retail trade of apparel and food and drink, sell insurance and real estate and provide lodging, food, educational, hospital and nursing care and other services within the state. According to the EPA, American Society of Civil Engineers and the Global Alliance for Incinerator Alternatives, environmental management activities across the country include 1,900 landfills, 14,780 wastewater treatment facilities and 113 incinerators. All of these facilities and the activities residents engage in every day produce waste.

Leading Question
How do we determine the amount of waste we produce?

Procedure
1. Review the attached flowchart with the class.
2. Have each student research one of your state's products such as foods, natural gas/minerals, furniture or printed material. Contact manufacturing plants to find out how much and what types of waste they produce. Include research findings in a written report along with answers to the following questions: What recycling and design strategies do they employ to fight waste? What are their waste disposal costs? Have they changed recently? How? Have students create flow charts to be shared in class along with the reports.

Evaluation
Students illustrate their findings in their own flow chart which tracks and identifies all the sources of waste in the item's production, use and disposal.

Common Core Alignments

GRADE 9-10

CC.RI.9-10.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.W.9-10.7
Writing:
Research to Build & Present Knowledge

CC.HSS.ID.1
Mathematics:
Statistics & Probability

GRADE 11-12

CC.RI.11-12.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.W.11-12.7
Writing:
Research to Build & Present Knowledge

CC.HSS.ID.1
Mathematics:
Statistics & Probability

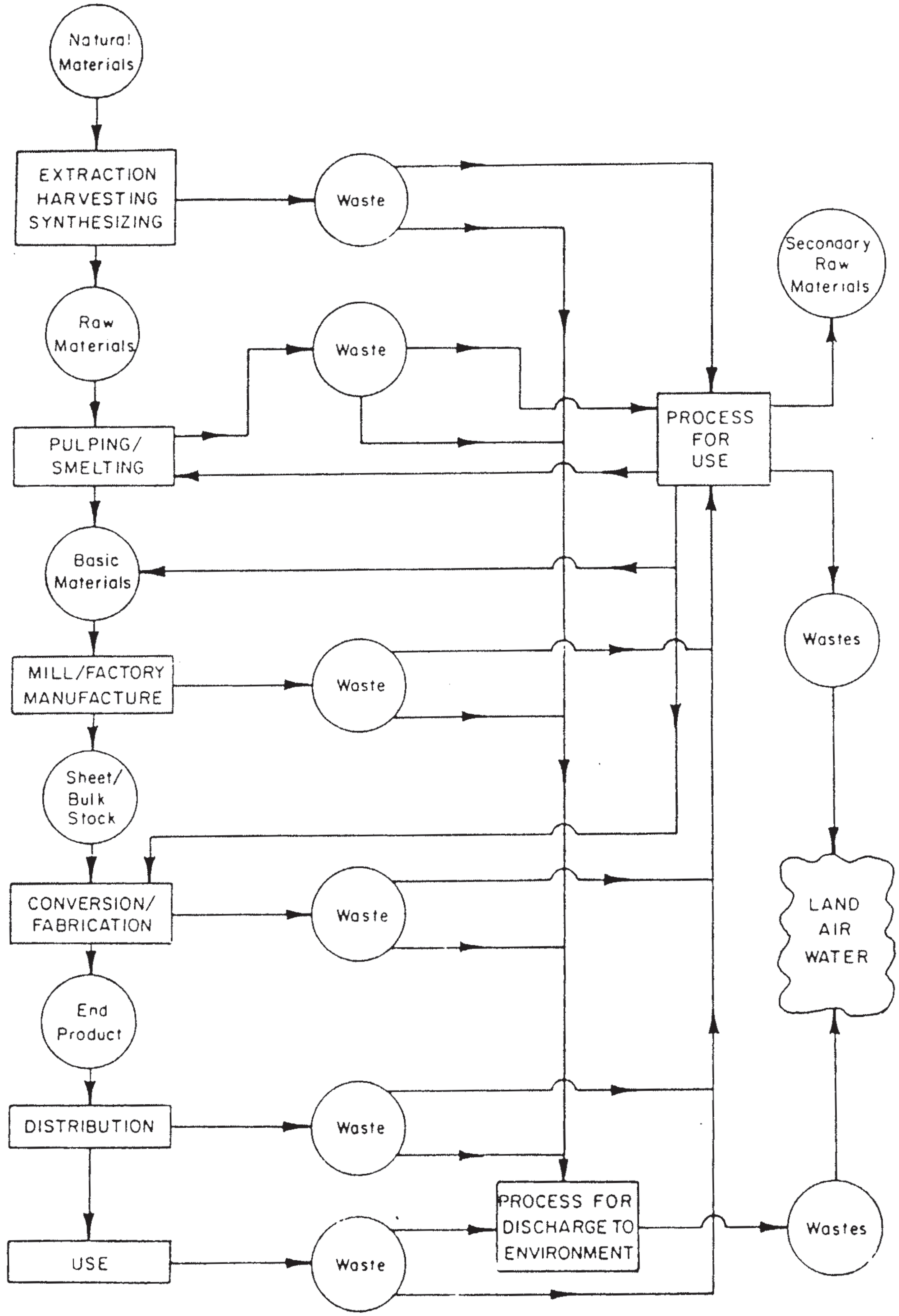
Classroom Activities

A. Design a waste reduction and/or recycling strategy for a local business or industry.

B. Design a new product out of the waste from a local business.

C. Have student record types and amounts of home waste on a daily basis for an extended period of time. Organize and display data using bar graphs, charts or tables. Analyze and interpret data to formulate conclusions about waste. Make estimates of yearly totals. Have students report their findings in class and discuss ways in which to reduce waste.

Sources of Waste in a Society



Source: State of Vermont Solid Wast Plan

How Does Packaging Contribute to Waste?

Concept
Some types of packaging are better for the environment than others.

Objective
Students will evaluate the environmental impact of different packaging types.

Method
Students will graph environmental costs of different containers.

Materials
Attached worksheets

Subjects
Mathematics, Social Studies, Science

Skills
Evaluating, gathering information, graphing data, researching

Time
One class period; one year-long project

Vocabulary
Thermoplastic, thermosetting, polymer, biodegradable, photodegradable

Resources
George Pess, *Thermoplastics in The Post-consumer Waste Stream*; articles on plastics

3R's of the Common Core
Parallel Activities
K-3, Egg Cartons
4-6, The Story of …
7-8, Potato Cakes
Information
Packaging
Resources
Green Consumption, Consumerism and Sustainable Development
Solid Waste and Recycling

Background
Plastics currently comprise about 12.7% of our solid waste stream, a figure that is steadily increasing. Plastics are not biodegradable or easily recycled, they are made from nonrenewable fossil fuels and some plastic produce toxins when burned. There are hundreds of different types of plastics in use today. Once they enter the waste stream, they are often contaminated with food and other substances and are practically impossible to identify and separate for recycling. PET soda bottles and milk and cider jugs as well as detergent and waste oil containers are beginning to find markets for recycling because they are made from one kind of plastic and are easily identifiable. But recycling for other plastic films, food container lids, wraps and tapes is still not easy. Most plastics are made primarily from hydrogen and carbon elements extracted from natural gas and crude oil.

> *"Biodegradable plastic are made by fermentation of natural substances such as sugar and other carbohydrates. One firm has produced biodegradable plastic with the help of a vigorous strain of bacteria found in canals. The bacteria are cultivated in vats and fed a sugary diet on which they thrive. In doing so they multiply and produce biological plastic rather like mammals make fat in their bodies as they grow. The plastic is extracted in fermentation vessels and is then dried and sold as granules. This plastic is readily broken down by algae, fungi or bacteria in the soil. A bag made from it will disappear within twelve or fifteen months or indeed within only three or four months if it is placed in a compost heap."*
>
> –John Seymour and Herbert Girardet

Leading Question
How have beverage containers changed over the years?

Procedure
Introduce the lesson and provide the background information. Distribute The Choice Is Clear worksheet. Have students read the information and create six bar graphs. Students will analyze the data to draw conclusions about the best beverage containers to use. Students will display bar graphs and concluded findings on a poster to be shared in class.

Common Core Alignments

GRADE 9-10

CC.W.9-10.4
Writing:
Production & Distribution of Writing

CC.WHST.9-10.7
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.HSS.ID.1
Mathematics:
Statistics & Probability

GRADE 11-12

CC.W.11-12.4
Writing:
Production & Distribution of Writing

CC.WHST.11-12.7
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.HSS.ID.1
Mathematics:
Statistics & Probability

Evaluation

What kind of containers are best for the environment?

Classroom Activities

A. Have students complete The Restaurant Garbage Counter worksheet as a homework assignment. Compare results from different restaurants. How can we encourage less packaging waste?

B. Send a letter to the restaurant with class suggestions for waste reduction and recycling.

C. Conduct a year-long research project to compare the decomposition time of biodegradable plastic bags and regular plastic bags. Set a goal and predict outcomes. Create a lab record worksheet to track the experiment taking into account the effects of sun, temperature, humidity, water, etc. Keep a journal of observations, questions and predictions. Analyze and interpret the records. Share the documentation and conclusions of this research project in class.

The Choice is Clear

Your grandparents may well remember when milk and soda came in glass bottles. The empty bottles were returned to the store. When the store collected enough bottles, they were trucked back to the bottling company. Sterilization guaranteed there would be no germs left on the bottles. Then each bottle was refilled and sent back to the store. Some bottles made this trip as many as 20 times. When the bottle broke or became too badly scratched, the glass was melted down and reformed.

In the 1970s things began to change. Milk started appearing on grocery store shelves in wax cartons and plastic jugs. The soda industry switched to plastic containers. Businesses made this choice based on cost. They found it cheaper to make millions of plastic bottles than to reuse glass ones. Perhaps, for the manufacturer, it does cost less. But what about us? We pay for this through energy and water consumed. Air pollution and increased solid wastes are also part of our cost.

Study the chart below. Use the information to create six bar graphs.

	Plastic	Glass	Aluminium	Cardboard/Paper	
Average container size	16.9 ounces	12 ounces	12 ounces	32 ounces	
Average container weight	18-20 grams	210 grams	14.9 grams	47 grams	
Recycling rate of packaging (2012)	13.8%	34.1%	38%	76.1%	
MMTCO2E*	217	1	6.3	85	
Equivalent of cars taken off the road	454 thousand	210 thousand	1.3 million	17.5 million	
Recycling 1 ton saves:				Cardboard	Paper
kWk energy	5,774	42	14,00	390	4,100
Gallons of oil	685	5	1,663	46	380
Btu's of energy	98 million	714,286	237 million	6.6 million	54 million
Cubic yards of landfill space	30	2	10	9	3.3

*Millions of metric tons of CO_2 Equivalent

Sources: "Recycling Facts and Tips," Waste Management, accessed June 13, 2016, https://www.wm.com/location/california/ventura-county/west-hills/recycle/facts.jsp

United States Environmental Protection Agency, Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2012, EPA-530-F-14-001 (Washington, D.C.: United States Government Printing Office: 2014

Name:______________________________ Date: ______________

The Restaurant Garbage Counter

There certainly are a lot of quick food restaurants around. The food is served quickly and you don't have to do any dishes. All you have to do is pay the bill. You really pay twice. One price is the money you pay at the cash register. The other cost is harder to calculate. It is an environmental cost. Fast food restaurants produce a lot of waste material. It has to be disposed of. You should understand the problem. You should know about the wastes that you cause in these restaurants.

Here's what to do:

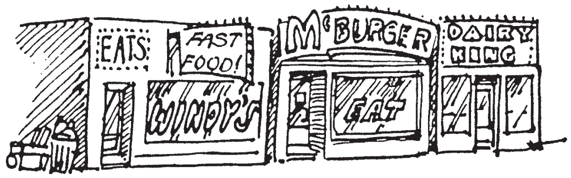
1. Write down each thing you receive when your order is filled.
2. Identify each item as either food or non-food.
3. For each non-food item, identify the material of which it is made.
4. State whether the material comes from a renewable or a nonrenewable resource.
5. Think about the waste that you produce.

Sample Grid:

ITEM	FOOD	NON-FOOD		
		Made of	**Renewable**	**Nonrenewable**
Paper Bag		Paper	x	
Box		Paper	x	
Paper Napkin		Paper	x	
Plastic Fork		Petroleum		x
Plastic Knife		Petroleum		x
3 Chicken Pieces	x			
1 Paper Container (salt)		Paper	x	
Salt	x			
1 Plastic Container (vinegar)		Petroleum		x
Vinegar	x			
French Fries	x			
1 Plastic Glass		Petroleum		x
1 Plastic Lid for Glass		Petroleum		x
Paper Wrapping (straw)		Paper	x	
Soft Drink	x			
Straw (plastic)		Petroleum		x
Foil Container (tart)		Aluminum		x
Tart	x			

Name: ______________________________ Date: ____________________

The Restaurant Garbage Counter



ITEM	FOOD	NON-FOOD		
		Made of	Renewable	Nonrenewable

Printed from: The Great Garbage Machine, Waste Management Advisory Board, Ontario, Canada

How Does Waste Affect Our Natural Resources?

Concept
Natural resources are limited.

Objective
Students will compare estimated life expectancies of some nonrenewable natural resources and will understand the role recycling and careful use play in meeting the demand for the extending availability of these resources.

Method
Students will complete worksheets and discuss.

Material
Attached charts and worksheets.

Subjects
Environmental Science, Social Studies, Language Arts

Skills
Applying ideas to solve problems, explaining, interpreting data, predicting outcomes

Time
One class period

Vocabulary
Nonrenewable resources, static use, life expectancy, reserve base

Resources
Donella and Dennis Meadows, *Limits to Growth*; Cynthia Pollack, *"Mining Urban Wastes: The Potential For Recycling,"* Worldwatch Paper 76

3R's of the Common Core
Parallel Activities
K-3, Machine
4-6, What Kind of Waste Am I?
7-8, School Trash Analysis
Information
The Solid Waste Stream
Resources
General

Background
Despite occasional drops in the market, the global demand for and consumption of most major nonfuel mineral commodities continues to rise. There is a limit to how long an increasing population can continue to make increasing demands on our finite resources. Concentrated, easily mined reserves of nonrenewable resources are being depleted. The availability of these resources can be extended by careful use and recycling.

Leading Question
How long will our natural resources last?

Procedure
1. Distribute copies of the chart Selected Nonrenewable Natural Resources: Their Life Expectancies and Prime Consumers. Have students complete the worksheet and/or discuss the questions in class.
2. Discuss Alternate Depletion Patterns For a Nonrenewable Resource.
   - How can we determine how long a given resource might last?
   - Any projections are based on two major set of assumptions: We must estimate the potentially available supply at existing (or future) acceptable prices and with existing (or improved) technology and we must estimate the annual rate at which the resource may be used.

Evaluation
What could be some effects of population growth, natural disasters, disease, and advanced technology systems on resource availability? What are some advantages and disadvantages of using renewable resources in place of nonrenewable resources?

Common Core Alignments

GRADE 9-10

CC.L.9-10.6
Language:
Vocabulary Acquisition & Usage

CC.RST.9-10.7
Reading in Science & Technical Subjects:
Integration of Knowledge & Ideas

CC.SL.9-10.2
Speaking & Listening:
Comprehension & Collaboration

CC.W.9-10.4
Writing:
Production & Distribution of Writing

GRADE 11-12

CC.L.11-12.6
Language:
Vocabulary Acquisition & Usage

CC.RST.11-12.8
Reading in Science & Technical Subjects:
Integration of Knowledge & Ideas

CC.SL.11-12.2
Speaking & Listening:
Comprehension & Collaboration

CC.W.11-12.4
Writing:
Production & Distribution of Writing

Selected Nonrenewable Natural Resources: Life Expectancies & Prime Consumers (2007)

Resource	*Reserve Base	Countries with highest reserve base	Countries with largest production	Largest consumer	**Life expectancy at current rate	Life expectancy at US consumption rate	recycling rate
Bauxite	32,000,000	Guinea, Australia, Jamaica, Brazil	Australia, China, Brazil	China	1027	510	49%
Copper	940,000	Chile, United States, China	Chile, Peru, United States	China	61	38	31%
Gold	90,000	South Africa, Australia, Peru, China	Australia, South Africa China	India, China	45	36	43%
Iron Ore	340,000	Ukraine, Russia, China	China, Brazil, Australia	China	N/A	N/A	N/A
Lead	170,000	Australia, China, United States	China, Australia, United States	China	42	8	72%
Silver	570,000	Poland, China, United States	Mexico, Peru, China	United States, India, China, Russia	29	9	16%
Tin	11,000,000	China, Brazil, Malaysia	China, Malaysia, Indonesia	China	40	17	26%
Chromium	N/A - exceeds 12 billion tons	Kazakhstan, South Africa	South Africa, Kazakhstan, India	China	143	40	25%
Platinum	80,000,000	South Africa, Russia, United States	South Africa, Russia, Canada	EU	360	42	0%

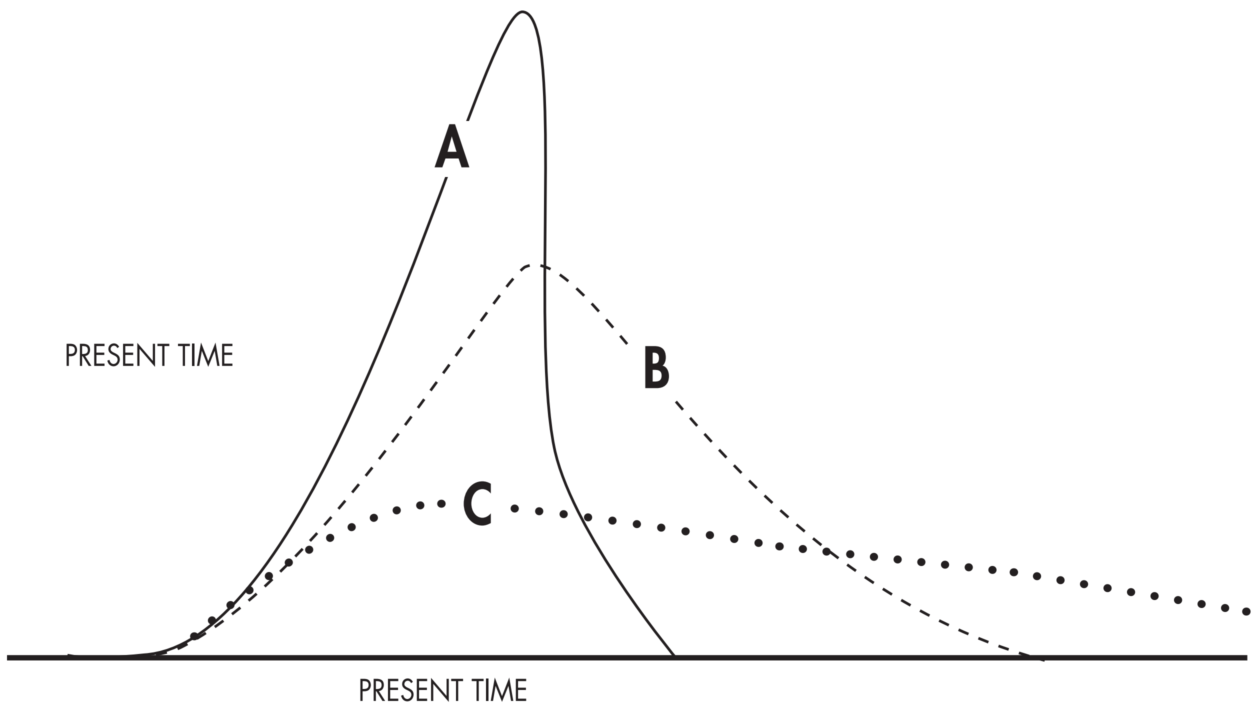
Sources: "Minerals Resources Program," US Geological Survey, accessed June 13, 2016, http://minerals.usgs.gov/.
"Peak Energy & Resources, Climate Change and the Preservation of Knowledge," Energy Skeptic, accessed June 13, 2016, http://energyskeptic.com/2013/how-long-will-minerals-last/
*All weight is in dry metric tons
**Life Expectancy is very subjective and cannot be accurately determined due to constant fluctuations in the markets, changing technologies and political climates.

Alternate Depletion Patterns for a Nonrenewable Resource

A. Mine, use and throw away

B. Recycle, improve mining technology to damage the environment less and use less concentrated mineral deposits

C. Recycle



SOURCE: Modified after Hubbert and Cloud.

"There is no danger whatever of humanity 'running out' of non-fuel mineral resources and I have not said there is. Humanity is not destroying them. What will run out, however, is the capacity of the environment to absorb the punishment associated with mining ever-lower grades of ore or reconcentrating what is already dispersed. Secondarily, the ability to do the job at an attractive cost will also 'run out.'"

– Paul Erlich

Name:____ Date: ______________________

Examine the chart Selected Nonrenewable Natural Resources: Their Life Expectancy and Prime Consumers. Then answer the following questions.

1. Which Life Expectancy in Years, current global rate or US rate, do you think is more accurate in estimating the length of time our nonrenewable natural resources will last?

2. What are some factors leading to the accelerated use of resources?

3. Examine the column under the heading Life Expectancy in Years. Which nonrenewable natural resource will be used up first?

4. Which countries have the highest reserves of the resource from question 3? Locate these countries on a world map.

5. Why does the United States need to be concerned with the depletion of this resource?

6. Which nonrenewable resource will last the longest according to the table?

7. Which countries have the highest reserves of this resource?

8. Which countries will the United States need to cooperate with in order to get the amount of this resource it needs?

9. List the resources that will probably be used up within the next 40 years given global usage rates.

10. What role do recycling and careful use play in extending the availability of these resources?

Shopper Survey

9-12, I.C.1

How Do Our Attitudes Affect Waste?

Concept
Each of us is responsible for the size and content of the waste stream.

Objective
Students will assess typical purchasing criteria, determine the influence of packaging on consumer choices and determine if consumers consider waste disposal and recycling when making purchasing decisions.

Method
Students will survey shoppers in a local supermarket.

Material
Attached worksheet questionnaire.

Subjects
Home Economics, Language Arts, Social Studies

Skills
Analyzing, gathering information, hypothesizing, interviewing

Time
Two class periods

Vocabulary
Purchasing criteria, recycling waste stream, packaging

Resources
Arthur Purcell, *The Waste Watchers*

3R's of the Common Core
Parallel Activities
K-3, Impressions with E.B. White
7-8, Art Reflecting the Environment
Information
Packaging
Recycling
Resources
Solid Waste and Recycling

Background
"Community-based social marketing draws heavily on research in social psychology which indicates that initiatives to promote behavior change are often most effective when they are carried out at community level and involve direct contact with people. The emergence of community-based social marketing over the last several years can be traced to a growing understanding that conventional social marketing, which often relies heavily on media advertising, can be effective in creating public awareness and understanding of issues related to sustainability, but is limited in its ability to foster behavior change."

- Doug McKenzie-Mohr and William Smith

Leading Question
What things influence our purchasing choices? Why is there so much waste?

Procedure
1. Discuss the leading question. Use the attached questionnaire or develop your own questions with the class to use in interviewing people in a grocery store to find out why they are purchasing the items in their cart. Hypothesize from class discussion what the outcome of the poll will be.
2. For homework, have students interview shoppers asking each about several items in their cart.
3. As a class, chart and analyze the results of the hypotheses. Identify the most common reasons for buying a food product. What percentage of the shoppers were concerned about waste disposal costs and options when deciding what to buy? How often was recyclability taken into account? How many shoppers knew of local recycling opportunities?

NOTE: Students could do this following a local recycling opportunities mapping activity. They could then give shoppers the information they would need to start recycling if they wanted.

Common Core Alignments

GRADE 9-10

CC. SL.9-10.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.9-10.4
Writing:
Production & Distribution of Writing

CC.HSS.IC.3
Mathematics:
Statistics & Probability

GRADE 11-12

CC. SL.11-12.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.11-12.1
Writing:
Text Types & Purposes

CC.W.11-12.4
Writing:
Production & Distribution of Writing

CC.HSS.IC.3
Mathematics:
Statistics & Probability

Evaluation

What are the major influences of consumer habits? How can we change our purchasing habits to reduce solid waste?

Classroom Activities

A. Have students interview family members to determine the same information as gleaned from the community.

B. Have students write a POSITIVE ACTION CHECKLIST for themselves or for others to help people become aware of solid waste problems and solutions.

C. Publish the class findings in the local newspaper.

D. State environmental agencies and related organizations call for the identification and evaluation of products which cause solid waste disposal problems, as well as consideration of product and packaging bans and/or tax incentives to help alleviate these problems. Find out what is happening in your state regarding this. Have students write an argumentative essay to convince others why packaging bans and taxation may or may not be viable solutions.

Name:______________________________ **Date:** ____________________

1. Which of the following factors influenced your decision to buy this product?
   a. The cost per pound
   b. It was on sale
   c. You saw it advertised
   d. High nutritional value
   e. Lack of artificial coloring, flavoring or preservatives
   f. Catchy packaging - visually attractive
   g. Uses less packaging than other brands
   h. You're familiar with the brand
   i. Other reasons

2. Does the recyclability of the product or its package play a part in determining what you buy?

3. When buying, do you think of how easy or difficult the product or its package will be to dispose of when you are finished with it?

4. Has this consideration of waste disposal changed at all in the last 25-30 years? Why?

5. Do you know where in this area you could recycle this item?

How Does Solid Waste Reflect Society?

Concept
"New York City, like every other city in this country, has more garbage than it can cope with." – Katie Kelly

Objectives
Students will read Katie Kelly's essay, "Garbage" and examine the author's use of analysis and persuasion. Students will use the essay to examine the continuing problems of Increasing trash volume and disposal.

Method
After reading this essay, students will discuss and write about how it is written and what information and opinions it contains. They will also consider the garbage issue from the local and national perspective.

Materials
"Garbage" by Katie Kelly and Study Guide to "Garbage" (attached)

Subjects
Language Arts, Social Studies
Mathematics

Skills
Analyzing, evaluating, interpreting information, researching

Time
One class period or more

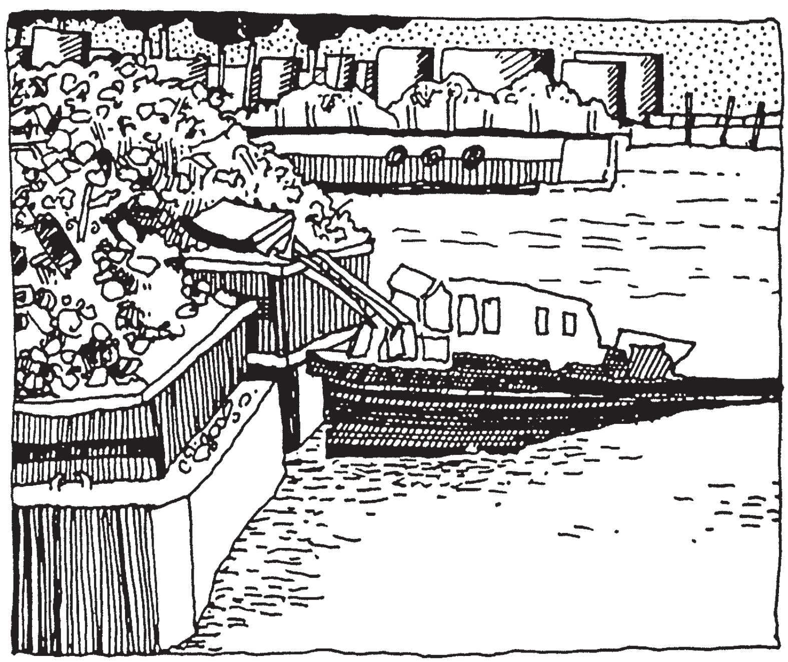
Vocabulary
Provincial, paltry, flamboyant, mundane, prodigious, residue, forlorn, kill

3R's of the Common Core
Parallel Activities
K-3, Grandparent's Toys
4-6, Then and Now
7-8, Trash Timeline.
Information
Waste and Society
Resources
General

Background
Raised in a small Nebraska town, Katie Kelly moved to New York City to work as a freelance writer. This essay was first published in *Saturday Review* (Sept. 9, 1972) the year before the publication of Kelly's book, T*he History and Future Of Garbage In America*. This is a historic lesson as the information in the article is very specific to the 1970s. After reading the essay and doing the following procedure, students could research how waste management in New York City has changed since the 1970s. Fresh Kills (from the Middle Dutch word kille, meaning "riverbed" or "water channel") is a stream and freshwater estuary in the western portion of the New York City borough of Staten Island. It is the site of the Fresh Kills Landfill, formerly New York City's principal landfill.

Leading Question
Name something that New York City produces more of than any other city in the world.

Procedure
Introduce the subject matter and the essay. Distribute the Study Guide



Common Core Alignments

GRADE 9-10

CC.RI.9-10.3
Reading Informational Text:
Key Ideas & Details

CC.SL.9-10.3
Speaking & Listening:
Comprehension & Collaboration

CC.W.9-10.2
Writing:
Text Types & Purposes

CC.W.9-10.4
Writing:
Production & Distribution of Writing

CC.HSS.ID.1
Mathematics:
Statistics & Probability

GRADE 11-12

CC.RI.11-12.6
Reading Informational Text:
Craft & Structure

CC.SL.11-12.1c
Speaking & Listening:
Comprehension & Collaboration

CC.W.11-12.4
Writing:
Production & Distribution of Writing

CC.W.11-12.7
Writing:
Research to Build & Present Knowledge

CC.HSS.ID.1
Mathematics:
Statistics & Probability

and Katie Kelly's essay "Garbage," and have the students read the essay and discuss it. Students will write about the topic using the questions in the Study Guide, or using an informative/explanatory essay or argumentative essay to convey ideas and analysis.

Evaluation

Teacher's choice.

Classroom Activities

The teacher may have students investigate and write about or report on any of the research topics on the attached Study Guide.

Name:______________________________ Date: ____________________

Study Guide to "Garbage" By Katie Kelly

Questions For Discussion Or Writing:

1. Is the one-word title, "Garbage," appropriate for this essay? Is it misleading? Inadequate? In what way does the generalness of the title add to the meaning of the essay?

2. Find examples that show how Kelly effectively used details and statistics. Why doesn't Kelly state which countries fall behind New York City in garbage production

3. How does Kelly establish herself as an authority and as a trustworthy reporter?

4. Although "Garbage" is a model analysis of a process and the author never directly states her personal opinion, she carefully sets a tone that makes this into a persuasive essay. What is the tone and how does she establish it? Where does she stand on this issue? What is her final message?

5. Describe the three major steps of the process outlined in this essay.

6. What is the irony and full significance of Fresh Kills, the name of the landfill described in the essay. (Check a dictionary to see what kill means when it is used in place names.)

7. What is immediately surprising about Fresh Kills? What is not mentioned in the description? What turns Jerome Kretchmer on about Fresh Kills?

8. Although this essay was written in 1972, it does not sound dated. Why not?

9. How does "Garbage" reflect contemporary American attitudes and lifestyles?

Research Topics:

1. How has the garbage situation in New York City changed since this essay was written? Volume? Costs? Landfill situation? Incineration? New problems? New solutions? Using your data create a comparative histogram for the 1972 and current data.

2. How does your community dispose of its garbage? How much does the community produce? What does it cost to dispose of it? Where does it go?

3. While describing Fresh Kills, Kelly alludes to F. Scott Fitzgerald's novel, The Great Gatsby. Examine how the ash heaps play an important role in the book.

"GARBAGE"

by Katie Kelly

New Yorkers are a provincial lot. They wear their city's accomplishments like blue ribbons. To anyone who will listen they boast of leading the world in everything from Mafia murders to porno movie houses. They can also boast that their city produces more garbage than any other city in the world. If fact, it produces more than many countries.

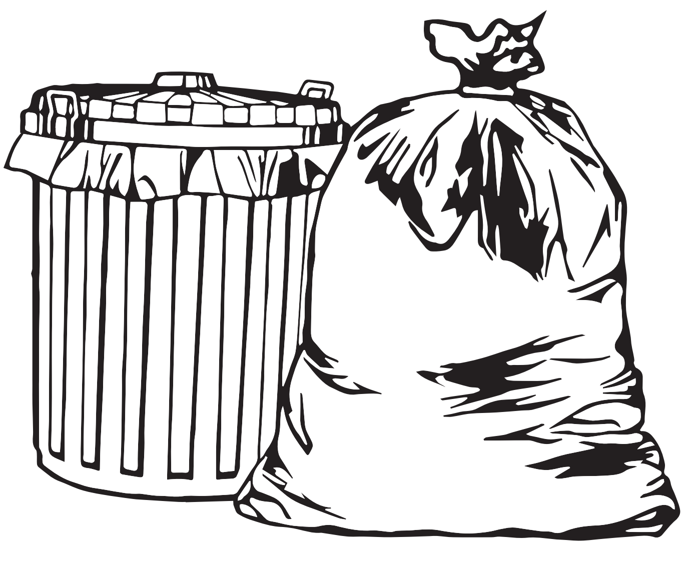
In its 1970-71 garbage season – a boffo season if there ever was one – New York City produced an average of 28,900 tons per day, as against a mere 4,800 tons per day for Los Angeles and a paltry 2,000 tons per day for San Francisco. But it is not only in quantity that New York excels. Fully 20 percent of the city's garbage consists of quality paper: canceled checks, rough drafts of Broadway hits, executive memos, IBM punch cards and so on. On Mondays alone seven million pounds of the Sunday Times are donated to New York garbage cans.

Then there's the packaging. According to the city's flamboyant environmental protection administrator, Jerome Kretchmer, in the rest of the country packaging accounts for under 20 percent of the total garbage; in New York for 40 percent. Much of this whopping total consists of flip tops, snack packs, variety packs, plastic cases, bottles, tin cans and other containers. Another big chunk is aluminum. If the aluminum the New Yorkers throw out every day were converted to Reynolds Wrap it would make a sheet more the 7,500 miles long – roughly the distance from New York to Samoa.

The remaining 40 percent of Fun City's garbage consists of such mundane leavings as egg shells, coffee grounds, wilted lettuce leaves and pot scrapings. Together with such odds and ends as textile scraps, tires, wood, glass, plastics, etc. (The 73,000 cars abandoned on New York City streets last year constitute a separate class of garbage. Though some find their way to the dump, most of these wrecks are bought up by scrap dealers.)

If New York produces more garbage than any other city in the world it stands to reason that the cost of getting rid of it must be correspondingly prodigious. It is. Last year the bill for pick up, processing and delivery came to $176,246,604. Though one would expect innovation from the undisputed leader in the field of garbage. New York is forced to dispose of its trash in ways familiar to every small town in the country: It burns the stuff in incinerators – about 30 percent of New York City garbage is incinerated–and/or or buried in its landfills.

The largest of the city's seven incinerators, the Brooklyn incinerator, is a yellow-brick building with high walls, few windows and two 200-foot-tall smokestacks, one of which is equipped with an electrostatic precipitator to reduce pollution. (Although a cut above the average in cleanliness, New York's incinerator stacks still spew thousands of pounds of soot over the city everyday.) Garbage trucks parade up to the Brooklyn plant, dumping their loads into a pit capable of holding 12,500 ton of garbage. A crane moves back and forth over this pit periodically clanking down to gouge out a one-ton bite. The crane then drops the garbage into conveyor belts, which in turn feed it into the incinerator ovens.



Measuring thirty by seven by two hundred feet, each of the Brooklyn incinerator's four ovens is capable of burning up to ten tons of garbage an hour at temperatures averaging 1,600 to 1,800 degrees F. The towering stacks create such an upward draft looking into one of the iron grate I felt as if I didn't hold on, I would be sucked into that fiery furnace.

After the garbage has been burned, the cooled residue is dumped onto barges, which are towed off by tugboats to

"GARBAGE" *Continued*

one of five landfill sites around the city. The largest of these is the 3,000-acre Fresh Kills site on the Staten Island.

Fresh Kills, which daily receives about 11,000 tons of garbage, is a strange place. Much of this former swampland resembles the ash heaps of The Great Gatsby. Vast, forlorn, endless. A vision of death. In the foreground, a discarded funeral wreath. A doll with outstretched arms. A man's black sock. A nylon stocking. And beyond, refrigerators, toilets, bathtubs, stoves.

Yet Fresh Kills also is – in places and in its own way – unexpectedly beautiful. Thousands of gulls wheel in the air. Banking sharply, they dip down one by one to settle in for a good feast. In areas where the garbage is fresh, there is an overpowering stench, but where it is older, its blanket of earth is covered with grass, bushes, shrubs, trees. Summertime in Fresh Kills is a time of flowers and birdsong. A volunteer vegetable garden flourishes in the landfill. Here, in the world's largest compost heap, the seeds and sprouts of kitchen scraps thrive. Come fall, offices all around New York's City Hall are decorated with gourds and pumpkins harvested at Fresh Kills. In the fall, too, quail and pheasants scurry through Fresh Kills' underbrush, creating a problem for the Department of Sanitation: Hunters try to poach on the municipal game preserve.

"Fresh Kills turns me on." Jerome Kretchmer said a few days after my visit to the site. Recently, he went on, he had taken his seven-year-old daughter's class out to Fresh Kills for a field trip. Even the sight of the barges heading off for the landfill sites excited him: "You can stand on the shore on Monday morning and watch the barges going out. And you know what went on in New York City over the weekend. There are fetuses and dead cats. Packages, boxes, cartons from fancy stores, dress scraps. Wow. man! Whatever went on in the city is going out to Fresh Kills. You can see it all. What we used. What we wasted."

Opened in 1948, Fresh Kills is already almost full to the brim for New York City, like every other city in this country, has more garbage than it can cope with. The city is in fact due to run out of landfill space – preferably swampland or a sandpit or gulley – in 1985. The solution: Pile it higher. But even here there are limits. As one city official put it: 'We have to leave some room between the sea gulls and the planes."

"It sure has changed out here," one worker, who has been at Fresh Kills for years, told me. 'Why there used to be fresh natural springs over there. He gestured out over the hundreds of acres of garbage. Natural crab beds once flourished in the area." Now they, too, are gone, buried under tons of garbage.

How Can Solid Waste Reflect Society?

Concept

"For a community may be as well judged by what it throws away – what it has to throw away and what it chooses to – as by any other evidence."
-Wallace Stegner.

Objectives

Students will interpret the themes of one or two essays and from them will derive the history and culture of a people. Students will consider and classify various forms of evidence in the study of a culture's past and in the structure of an essay.

Method

Students will read "The Dump Ground" and analyze the author's style, purpose, use of evidence and conclusions. Students will compare these points with Katie Kelly's essay, "Garbage."

Materials

"The Dump Ground" by Wallace Stegner, "Garbage" by Katie Kelly; Study Guide for "Garbage."

Subjects

Language Arts, Social Studies

Skills

Analyzing, comparing, evaluating, interpreting

Time

One or more class periods

Vocabulary

Traverse, artifact, alloy, flume, perambulator, welter, aesthetic

Resources

Archaeologists; local historical societies and museums; Lawrence Pringle, T*hrowing Things Away*; Martin Melosi, *Garbage in The Cities.*

3R's of the Common Core

Parallel Activities
K-3, Grandparent's Toys
7-8, Trash Timeline
Information
Waste and Society
Resources
General

Background

Essayist Wallace Stegner recounts growing up along the US/Canadian border around the turn of the century.

Leading Question

What do people mean when they use the expression, "One man's trash, another man's treasure?"

Procedure

1. Teachers may use this essay independently or as a follow-up to Katie Kelly's "Garbage." Students will read and discuss the essay to compare the author's style, purpose, use of evidence and conclusions with those expressed in "Garbage."
2. Have students write essays on one of these topics:
    - Compare the authors' styles, purposes, use of evidence and/or conclusions.
    - Summarize the themes of the two essays.
    - Use the "Garbage" Study Guide questions and research topics as stimuli for their own topics.

Evaluation

By teacher.

Classroom Activities

See "Garbage" list.

“The Dump Ground”

by Wallace Stegner

One aspect of Whitemud’s history and only one and a fragmentary one, we knew: the town dump it lay in a draw at the southeast corner of town, just where the river left the hills and where the old Mounted Police patrol trail (I did not know that was what it was) made a long, easy, willow-fringed traverse across the bottoms. That stretch of the river was a favorite campsite for passing teamsters, gypsies, sometimes Indians. The very straw scattered around those camps, the ashes of those strangers’ campfires, the manure of their teams and saddle horses, were hot with adventurous possibilities. The camps made an extension, a living suburb, of the dump ground itself and it was for this that we valued them. We scoured them for artifacts of their migrant tenants as if they had been archaeological sites potent with the secrets of ancient civilization. I remember toting around for weeks a broken harness strap a few inches long. Somehow or other its buckle looked as if it had been fashioned in a far place, a place where they were accustomed to flatten the tongues of buckles for reasons that could only be exciting and where they had a habit of plating the metal with some valuable alloy, probably silver. In places where the silver was worn away, the buckle underneath shone dull yellow: probably gold.

Excitement liked that end of town better than our end. Old Mrs. Gustafson, deeply religious and a little addled in the head, went over there once with a buckboard full of trash and as she was driving home along the river she saw a spent catfish: washed in from the Swift Current or some other part of the watershed in the spring flood. He was two feet long, his whiskers hung down, his fins and tail were limp – a kind of fish no one had seen in the Whitemud in the three of four years of the town’s life and a kind that none of us children had ever seen anywhere. Mrs. Gustafson had never seen one like him either. She perceived at once that he was the devil and she shipped up the team and reported him, pretty loudly, at Hoffman’s elevator.

We could still hear her screeching as we legged it for the river to see for ourselves. Sure enough, there he was, drifting slowly on the surface. He looked very tired and he made no great effort to get away when we rushed to get an old rowboat and rowed it frantically down to where our scouts eased along shore beckoning and ducking willows and sank the boat under him and brought him ashore in it. When he died we fed him experimentally to two half-wild cats, who seemed to suffer no ill effects.

Upstream from the draw that held the dump, the irrigation flume crossed the river. It always seemed to me giddily high when I hung my chin over its plank edge and looked down, but it probably walked no more than twenty feet above the water on its spidery legs. Ordinarily in summer It carried six or eight inches of smooth water and under the glassy surface of the little boxed stream the planks were coated with deep sun-warmed moss as slick as frogs eggs. A boy could sit in the flume with the water walling up against his back and grab a cross-brace above him and pull, shooting himself sled like ahead until he could reach the next cross-brace for another pull and so on across the river In four scoots.

After ten minutes in the flume he would come out wearing a dozen or more limber black leeches and could sit in the green shade where darning needles flashed blue and dragonflies hummed and stopped in the air and skaters dimpled slack and eddy with their delicate transitory footprints and there pull the leeches off one by one, while their sucking ends clung and clung, until at last, stretched far out, they let go with a tiny wet pop and snapped together like rubber bands. The smell of the flume and the low bars of the part of the river was the smell of wolf willow.

But nothing else in the east end of town was as good as the dump ground. Through a historical process that went back to the roots of community sanitation and that in law dated from the Unincorporated Towns Ordinance of the territorial government, passed in 1888, the dump was the very first community enterprise, the town’s first institution.

More than that, it contained relics of every individual who had ever lived there. The bedsprings on which Whitemud’s first child was begotten might be out there; the skeleton of a boy’s pet colt: books soaked with water and chemical in a house fire and thrown out to flap their stained eloquence in the prairie wind. Broken dishes, rusty tinware, spoons that had been used to mix paint: once a box of percussion caps, sign and symbol of the carelessness that most of us had in matters of personal or public safety. My brother and I put some of them on the railroad tracks and were anonymously denounced in

Common Core Alignments

GRADE 9-10

CC.RI.9-10.6
Reading Informational Text:
Craft & Structure

CC.RI.9-10.10
Reading Informational Text:
Range of Reading & Level of Text Complexity

CC.SL.9-10.1c
Speaking & Listening:
Comprehension & Collaboration

CC.W.9-10.4
Writing:
Production & Distribution of Writing

GRADE 11-12

CC.RI.11-12.6
Reading Informational Text:
Craft & Structure

CC.RI.11-12.10
Reading Informational Text:
Range of Reading & Level of Text Complexity

CC.SL.11-12.1c
Speaking & Listening:
Comprehension & Collaboration

CC.W.11-12.4
Writing:
Production & Distribution of Writing

the Leader for nearly derailing the speeder of a section crew. There were also old iron, old brass, for which we hunted assiduously, by night combing Junkmen's catalogs to find out how much wartime value there might be in the geared insides of clocks or in a pound of tea lead carefully wrapped in a ball whose weight astonished and delighted us.

Sometimes the unimaginable world reached out and laid a finger on us because of our activities on the dump. I recall that, aged about seven, I wrote a Toronto Junk house asking if they preferred their tea lead and tinfoil wrapped in balls, or whether they would rather have it pressed flat in sheets and I got back a typewritten letter in a window envelope advising me that they valued my business and were mine very truly. Dazed, I carried that windowed grandeur around in my pocket until I wore it out.

We hunted old bottles in the dump, bottles caked with filth, half buried, full cobwebs and we washed them out at the horse trough by the elevators, putting in a handful of shot along with the water to knock the dirt loose; and when we had shaken them until our arms were tired, we hauled them down in somebody's coaster wagon and turned them in at bill Christenson's pool hall, where the smell of lemon pop was so sweet In the dark pool-hall air that it sometimes awakens me in the night even yet.

Smashed wheels of wagons and buggies, tangles of rusty barbed wire, the collapsed perambulator that the French wife of one of the town's doctors had once pushed proudly up the plank sidewalks and along the ditchbank paths. A welter of foul-smelling feathers and coyote-scattered carrion, that was all that remained of somebody's dream of a chicken ranch. The chickens had all got some mysterious pip at the same time and died as one and the dream lay out there with the rest of the town's short history to rustle to the empty sky on the border of the Hills.

There was melted glass in curious forms and the half-melted office seat left from the burning of Joe Knight's hotel. On very lucky days we might find a piece of the lead casing that had enclosed the wires of the town's first telephone system. The casing was just the right size for rings and so soft that it could be whittled with a jackknife. If we had been Indians of fifty years earlier, that bright soft metal could have enlisted our maximum patience and craft and come out as a ring and medal and amulet inscribed with the symbols of our observed world. Perhaps there were too many ready-made alternatives in the local drug, hardware and general stores: in any case our artistic response was feeble and resulted in nothing better than crude seal rings with initials or pierced hearts carved in them. They served a purpose in juvenile courtship, but they stopped a good way short of art.

The dump held very little wood, for in that country anything burnable got burned. But it had plenty of old metal, furniture, papers, mattresses that were the delight of field mice and jugs and demijohns that were sometimes their bane, for they crawled into the necks and drowned in the rainwater or redeye that was inside.

If the history of Whitemud was not exactly written, it was at least hinted, in the dump. I think I had a pretty sound notion even at eight or nine of how significant was the first institution of our forming Canadian civilization. For rummaging through its foul purlieus I had several times been surprised and shocked to find relics of my own life tossed out there to blow away or rot.

Some of the books were volumes of the set of Shakespeare that my father had bought, or been sold, before I was born. They had been carried from Dakota to Seattle and Seattle to Bellingham and Bellingham to Redmond and Redmond back to Iowa and Iowa to Saskatchewan. One of the Cratchet girls had borrowed them, a hatchet-faced, thin eager, transplanted Cockney girl with a frenzy for reading. Stained in a fire, they had somehow found the dump rather than come back to us. The lesson they preached was how much is lost, how much thrown aside, how much carelessly or of necessity given up in the making of a new country. We had so few books that I knew them all: finding those thrown away was like finding my own name on a gravestone.

Any yet not the blow that something else was, something that impressed me even more with how closely the dump reflected the town's intimate life. The colt whose picked skeleton lay out there was mine. He had been incurably crippled when dogs chased our mare Daisy the morning after she foaled. I had worked for months to make him well, had fed him by hand, curried him, talked my father into having iron braces made for his front legs. And I had not known that he would have to be destroyed. One weekend I turned him over to the foremen of one of the ranches, presumably so that he could be better cared for. A few days later I found his skinned body, with the braces still on his crippled front legs, lying on the dump. I think I might eventually have accepted the colt's death and forgiven his killer, if it had not been for that dirty little two-dollar meanness that skinned him.

Not even finding his body cured me of going to the dump, though our parents all forbade us on palm of cholera or worse to do so. The place fascinated us, as it should have. For this was the kitchen midden of all the civilization we knew. It gave us the most tantalizing glimpses into our neighbors' lives and our own; it provided an aesthetic distance from which to know ourselves.

The town dump was our poetry and our history. We took it home with us by the wagonload, bringing back into town the things that town had used and thrown away. Some little part of what we gathered, mainly bottles, we managed to bring back to usefulness, but most of our gleanings were left lying around barn or attic or cellar until in some renewed fury of spring cleanup our families carted them off to the dump again, to be rescued and briefly treasured by some other boy. Occasionally something we really valued with a passion was snatched from us in horror and returned at once. That happened to the mounted head of a white mountain goat, somebody's trophy from old times and the far Rocky Mountains, that I brought home one day. My mother took one look and discovered that his beard was full of moths.

I remember that goat: I regret him yet. Poetry is seldom useful, but always memorable. If I were a sociologist anxious to study In detail the life any community I would get very early to its refuse plies. For a community may be as well judged by what it throws away – what it has to throw away and what it chooses to – as by any other evidence. For whole civilizations we sometimes have no more of the poetry and little more of the history than this.

How Does Our Society Affect Waste??

Concept
Economic success encourages increased energy consumption

Objective
Students will be able to detect general relationships between GNP/capita and energy consumption per capita and will examine the specific factors that encourage high energy use. Students will understand relationship between recycling and conserving energy.

Method
Students will analyze tables and charts showing GNP/energy usage patterns.

Materials
Charts and tables

Subjects
Science, Social Studies, Mathematics, Language Arts

Skills
Evaluating, graphing data, interpreting data, recognizing patterns

Time
Two class periods

Vocabulary
Gross national product, energy consumption, energy conservation, per capita

Resources
United States Energy Information Administration; The Atlas of Economic Complexity http://atlas.cid.harvard.edu/, local electric utilities

3R's of the Common Core Resources
Parallel Activities
K-3, Impressions with E.B. White
7-8, Art Reflecting the Environment
Information
The Solid Waste Stream
Waste and Natural Resources
Resources
General
Solid Waste and Recycling
Waste Management Agencies by State

Background
"If you drink two cans (aluminum) of soft drinks per day and fail to recycle the cans, you waste more energy than is used daily by each of a billion human beings in poorer lands."
–ConservAction, 1978 Family Energy Watch Calendar

"Throwing away an aluminum beverage container wastes as much energy as filling the same can half full of gasoline and pouring it out on the ground. Failing to recycle a daily edition of the New York Times or the Washington Post wastes just as much."
–William Chandler, "*Six Ounces of Gasoline in a Soda Can,*" Natural History; Apr 85, Vol. 94 Issue 4, p79.

Leading Question
Does a higher income cost more?

Procedure
1. Divide your class into small groups to start a discussion about the following graph created by OBIZMEDIA.COM and posted on www.reusethisbag.com/reusable-bag-infographics/all-about-recycling.php.

   What do your students deduce from this graphic?

   What does the heading infer? (RECYCLING: THE GOOD. THE BETTER. THE BEST.)

   Is it an attractive way to present the information?

   What does it tell the students about global waste management practices?

   How do you know the information is truthful?
2. Form small groups of students to research data to create a GNP/Capita (in U.S. $) chart representing the following countries - Afghanistan, Argentina, Brazil, Burundi, Canada, Egypt, Ethiopia, France, Greece, Haiti, India, Japan, Laos, Mali, Nepal, Pakistan, Saudi Arabia, Sweden, Switzerland, United States, South Yemen.
3. Have students graph all the data.

Common Core Alignments

GRADE 9-10

CC.L.9-10.6
Language:
Vocabulary Acquisition & Use

CC.W.9-10.4
Writing:
Production & Distribution of Writing

CC.HSS.ID.6
Mathematics:
Statistics and Probability

GRADE 11-12

CC.L.11-12.6
Language:
Vocabulary Acquisition & Use

CC.W.11-12.4
Writing:
Production & Distribution of Writing

CC.HSS.ID.6
Mathematics:
Statistics and Probability

4. Separate the listed countries into three groups (high, medium and low GNP/capita) at what appear to be natural dividing points.
5. Now, research the energy/capita for each country and divide the countries into three groups at what also appear to be natural dividing points. How close to being identical are your groups when done by GNP/capita and then energy/capita?
6. Look at your groupings and make some observations about the countries in each group. Consider such topics as geographic location, availability of resources, political systems, economic systems and cultural factors.
7. On your graph you can see that Sweden, Canada, Saudi Arabia and the United States are close in GNP/capita but have widely varying levels of energy consumption. Make some observations about why you think this discrepancy occurs. Consider their levels of industrialization, history, cultural preferences, availability of resources, political systems and geography.
8. If greater economic success encourages greater energy consumption, what problems do you foresee for the world's developing nations?
9. As each raises its standard of living, what are the implications? Do you think this increased energy expenditure is mandatory – that is, is it possible to be economically successful as a country and not significantly increase energy consumption? Why and how? or why not?

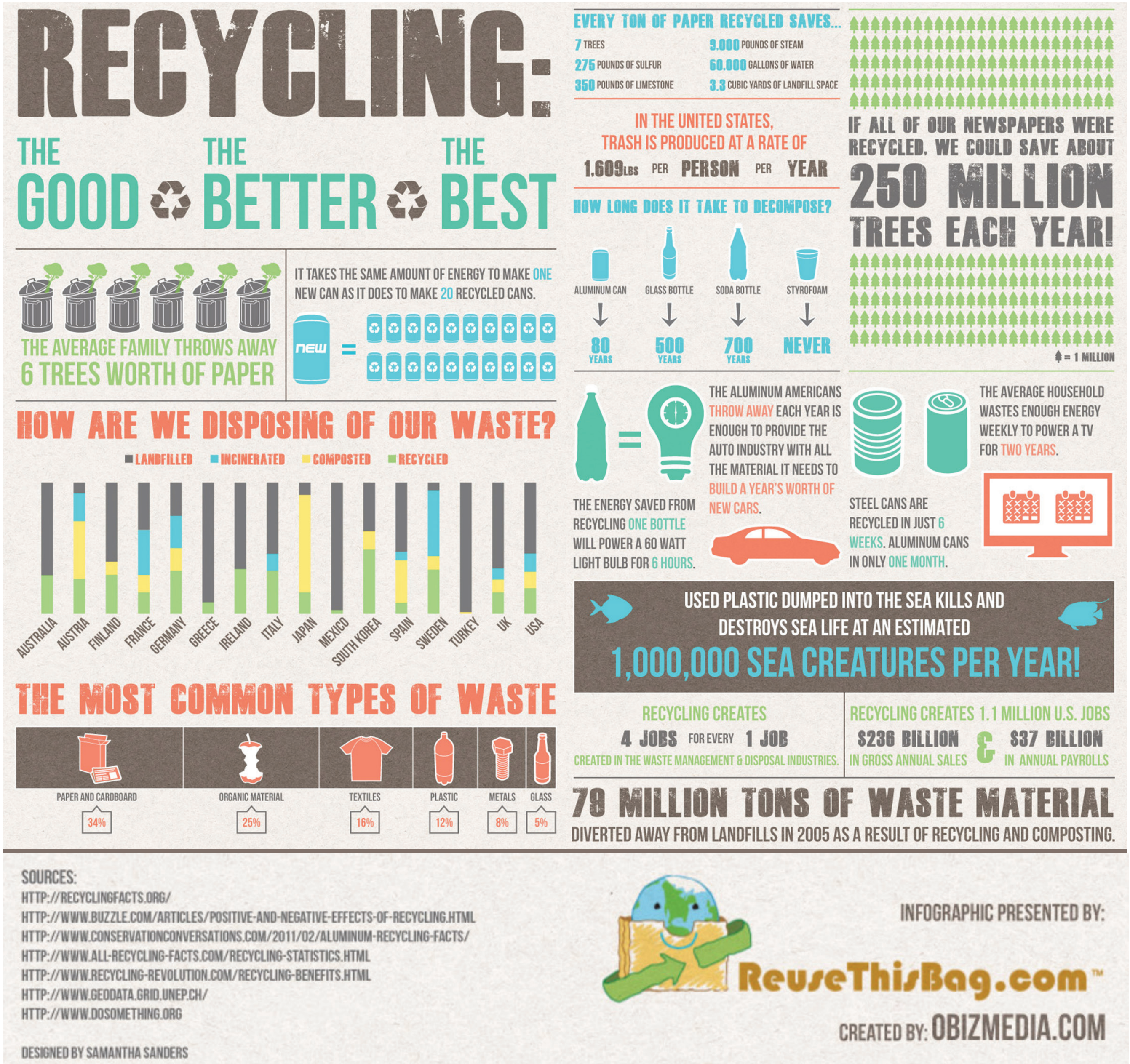
Evaluation

What country uses the most energy per person? Why? Name three countries with a GNP of less than $300 per year. Do you think these countries have a high or low level of energy use per person? Why?

Classroom Activity

Read the above Background quotes to students. Though dated, ask students if the information is still relevant. Have students research contemporary articles about recycling and energy savings. Ask them to share quotes from their readings.

Have students complete the attached handout, How Can We Personally Conserve Energy?



RECYCLING:
THE GOOD THE BETTER THE BEST
THE AVERAGE FAMILY THROWS AWAY 6 TREES WORTH OF PAPER
IT TAKES THE SAME AMOUNT OF ENERGY TO MAKE ONE NEW CAN AS IT DOES TO MAKE 20 RECYCLED CANS.
new =
HOW ARE WE DISPOSING OF OUR WASTE?
LANDFILLED INCINERATED COMPOSTED RECYCLED
AUSTRALIA AUSTRIA FINLAND FRANCE GERMANY GREECE IRELAND ITALY JAPAN MEXICO SOUTH KOREA SPAIN SWEDEN TURKEY UK USA
THE MOST COMMON TYPES OF WASTE
PAPER AND CARDBOARD 34%
ORGANIC MATERIAL 25%
TEXTILES 16%
PLASTIC 12%
METALS 8%
GLASS 5%
EVERY TON OF PAPER RECYCLED SAVES...
7 TREES
9,000 POUNDS OF STEAM
275 POUNDS OF SULFUR
60,000 GALLONS OF WATER
350 POUNDS OF LIMESTONE
3.3 CUBIC YARDS OF LANDFILL SPACE
IN THE UNITED STATES, TRASH IS PRODUCED AT A RATE OF
1,609LBS PER PERSON PER YEAR
HOW LONG DOES IT TAKE TO DECOMPOSE?
ALUMINUM CAN 80 YEARS
GLASS BOTTLE 500 YEARS
SODA BOTTLE 700 YEARS
STYROFOAM NEVER
IF ALL OF OUR NEWSPAPERS WERE RECYCLED, WE COULD SAVE ABOUT
250 MILLION TREES EACH YEAR!
= 1 MILLION
THE ALUMINUM AMERICANS THROW AWAY EACH YEAR IS ENOUGH TO PROVIDE THE AUTO INDUSTRY WITH ALL THE MATERIAL IT NEEDS TO BUILD A YEAR'S WORTH OF NEW CARS.
THE ENERGY SAVED FROM RECYCLING ONE BOTTLE WILL POWER A 60 WATT LIGHT BULB FOR 6 HOURS.
STEEL CANS ARE RECYCLED IN JUST 6 WEEKS. ALUMINUM CANS IN ONLY ONE MONTH.
THE AVERAGE HOUSEHOLD WASTES ENOUGH ENERGY WEEKLY TO POWER A TV FOR TWO YEARS.
USED PLASTIC DUMPED INTO THE SEA KILLS AND DESTROYS SEA LIFE AT AN ESTIMATED
1,000,000 SEA CREATURES PER YEAR!
RECYCLING CREATES
4 JOBS FOR EVERY 1 JOB
CREATED IN THE WASTE MANAGEMENT & DISPOSAL INDUSTRIES.
RECYCLING CREATES 1.1 MILLION U.S. JOBS
$236 BILLION IN GROSS ANNUAL SALES & $37 BILLION IN ANNUAL PAYROLLS
78 MILLION TONS OF WASTE MATERIAL
DIVERTED AWAY FROM LANDFILLS IN 2005 AS A RESULT OF RECYCLING AND COMPOSTING.
SOURCES:
HTTP://RECYCLINGFACTS.ORG/
HTTP://WWW.BUZZLE.COM/ARTICLES/POSITIVE-AND-NEGATIVE-EFFECTS-OF-RECYCLING.HTML
HTTP://WWW.CONSERVATIONCONVERSATIONS.COM/2011/02/ALUMINUM-RECYCLING-FACTS/
HTTP://WWW.ALL-RECYCLING-FACTS.COM/RECYCLING-STATISTICS.HTML
HTTP://WWW.RECYCLING-REVOLUTION.COM/RECYCLING-BENEFITS.HTML
HTTP://WWW.GEODATA.GRID.UNEP.CH/
HTTP://WWW.DOSOMETHING.ORG
DESIGNED BY SAMANTHA SANDERS
INFOGRAPHIC PRESENTED BY:
ReuseThisBag.com™
CREATED BY: OBIZMEDIA.COM

Name:______________________________ Date: ______________

How can we personally conserve energy?

Using the attached list, check off the appliances you and your family use. List any others not included. (Check for wattage printed on the UNPLUGGED appliance.)

Estimate your hours of usage and find the total consumption per day. Then check off the appliance you think you could do without. Compare the new list with the original. What are the environmental costs per kilowatt hour consumed?

ITEM	AVERAGE WATTAGE
Air conditioner (Central Air)	3,500
Blanket, electric	100
Boiler (Electric, 1000sf, warm climate)	7941
Clock radio	4
Clothes dryer	4,400
Coffee maker	900
Dehumidifier	300-700
Dishwasher	3,600
Disposal (sink)	750
Fan	75
Food blender	300-1,000
Food freezer	500-800
Frying pan	1,150
Heater, portable	1,322
Humidifier	177
Iron	1,100
Lighting	100
Microwave oven	1,200
Personal computer	170
Radio	71
Refrigerator	817
Self-cleaning oven	1178
Sewing machine	100
Television	150-340
Toaster	1,100
Vacuum cleaner	630
Washing machine	2,100
Water heater, (electric)	3,800

How Do Landfills Work?

Concept
It is complicated and controversial toproperly site a new landfill.

Objective
Students will become familiar with local government, land-use planning and the; complexities of the solid waste planning process.

Method
Students will simulate the siting of a landfill in their area.

Materials
Town and state topographic, geologic and soils maps, GIS, local zoning regulations, landfill regulations from EPA and local agencies

Subjects
Science, Social Studies, Language Arts

Skills
Comparing solutions, designing, gathering information and data, problem solving

Time
Several weeks

Vocabulary
Landfills, siting

Resources
The Technology of Trash (film); town clerk; regional planning commissions; local engineers; state waste agencies; Lawrence Pringle, *Throwing Things Away*; Geraldine and Harold Woods, *Pollution*

3R's of the Common Core
Parallel Activities
4-6, Landfills
7-8, Mini Landfills
7-8, Landfill Soil
9-12, Methane
Information
Landfills
Public Planning and Policy.
Resources
Solid Waste and Recycling
Waste Management Agencies by State

Background
Many American communities are facing closing landfills and must find alternative disposal methods. While recycling and composting can divert a substantial portion of the waste stream and incineration and other processing methods can further decrease the volume and weight of trash, there will always be a need for land disposal of the residuals. Siting new landfills is difficult because there are so many geological, social and political factors to consider. The location of existing and planned land developments, protection of ground and surface water, road suitability and accessibility by haulers, opposition of local residents, the expense of current landfill construction and other problems all make siting a new landfill controversial and complicated.

Leading Question
If we need a new landfill, how will we go about siting and designing one?

Procedure
1. Review how landfills work and the potential problems involved. Obtain current requirements for sanitary landfills from any agency in your state that handles solid waste.
2. Divide students into small groups to research one of the following topics. Each group will clearly organize their findings onto a one-page sheet to be collated into a packet to be distributed to each group.
   a. Determine local landfill history and schedule for closure.
   b. Determine current and projected pollution and waste generation figures. How many communities will the landfill serve? How many residents and businesses will be contributing to the waste stream? What are the current and projected levels of recycling? Are any other waste processing facilities existing or planned? What will their effect be on the size of the waste stream?
   c. Determine local geology and current land use plans and restrictions.
3. To determine the size landfill required, assume this:
   a. Each resident produces 2.87 pounds (after recycling and composting) of trash per day, that's 1049.53 pounds each year.
   b. 800 pounds = one cubic yard (approximate trash produced per person per year.)

Common Core Alignments

GRADE 9-10

CC.RI.9-10.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.9-10.2
Speaking & Listening:
Comprehension & Collaboration

CC.WHST.9-10.8
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.HSG.MG.3
Mathematics:
Geometry

GRADE 11-12

CC.RI.11-12.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.11-12.2
Speaking & Listening:
Comprehension & Collaboration

CC.WHST.11-12.8
Writing in History/Social Studies,
Science & Technical Subjects:
Research to Build & Present Knowledge

CC.HSG.MG.3
Mathematics:
Geometry

c. One acre of landfill space, ten feet deep = 16,133 cubic yards capacity.
d. Determine volume for the number of people your landfill will be serving.
e. Determine the length of time the landfill will be in operation. Ten years, fifty years?
f. Determine number of acres needed.

4. Using the class-created information packet and the landfill requirements, write a proposed plan for a new landfill. Share the proposals in class. Compare proposals and what your town and/or solid waste district is proposing.

Evaluation

What is the current landfill situation facing your community? List the major considerations involved in siting and designing a new landfill.

Classroom Activity

Design a use for the old landfill once it is closed.

How Can We Recover Energy from Solid Waste?

Concept
Energy can be recovered from waste.

Objective
Students will understand the energy producing potential of some solid wastes and will understand some systems of generating methane from waste.

Method
Students will construct a class room-size model methane generator

Materials
Three beakers, vaseline, organic slurry, balloon, three rubber stoppers, one foot of glass tubing or a U tube, three feet of surgical tubing; the nozzle from a medicine dropper, one pinch clamp

Subjects
Science, Social Studies, Language Arts

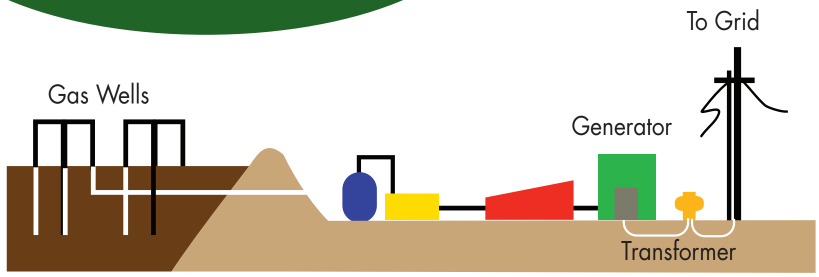
Skills
Carrying out investigation, interpreting data, observing, researching

Time
Several days

Vocabulary
Methane, slurry, anaerobic, decomposition

Resources
"The Fascinating World of Trash" National Geographic 1983.

3R's of the Common Core
Parallel Activities
4-6, Landfills
7-8, Mini Landfills
7-8, Landfill Soil
9-12, New Landfills
Information
Landfills.
Resources
Waste Management Agencies by State



Background
Once buried, organic wastes decompose anaerobically. Carbon dioxide, methane, ammonia and hydrogen sulfide gases are all produced as microorganisms break waste down. Trapped beneath the landfill surface, these gases become potential health and safety threats if not properly vented. To avoid explosions or lateral migration of methane beneath the surface of the landfill vents are installed to reduce pressure build-up of the gases.

Methane is the largest component of natural gas. If the landfill volume is great enough (at least one million tons), the methane produced can be captured, purified by removing carbon dioxide and water and sold to gas utility suppliers. Capturing methane from landfills may not turn a profit, but it can help to defray the landfill's operating costs. As of 2015, there are at over 640 methane recovery systems operating or under construction in the United States and an additional 440 that would make good candidates for methane recovery according to the EPA.

Leading Question
Can we recover energy from solid waste?

Procedure
Complete the following experiment to create a model methane generator:

1. Fill digester about one-half full with an organic slurry (i.e. manure and/or ground grass clippings, etc., mixed with water until a thick, but pourable, consistency is reached). Keep it warm. Wear safety goggles.
2. Bore two holes in a rubber stopper with a cork borer.
3. Run a tube to a gas storage container. (NOTE: Make sure all connections are tight. Use vaseline on cork holes.) The container's lid should have two holes, one for the tube coming from the digester and one for a nozzle and clamp – this is your flare.
4. Run a tube to a pressure relief system. Use an easily expandable container or a balloon that's been blown up several times. Make sure tube from digester extends down into water. This arrangement will prevent an excess of gas from feeding back into the digester.

Common Core Alignments

GRADE 9-10

CC.RST.9-10.3
Reading in Science & Technical Subjects: Key Ideas & Details

CC.SL.9-10.1
Speaking & Listening: Comprehension & Collaboration

CC.WHST.9-10.7
Writing in History/Social Studies, Science & Technical Subjects: Research to Build & Present Knowledge

GRADE 11-12

CC.RST.11-12.3
Reading in Science & Technical Subjects: Key Ideas & Details

CC.SL.11-12.1
Speaking & Listening: Comprehension & Collaboration

CC.WHST.11-12.8
Writing in History/Social Studies, Science & Technical Subjects: Research to Build & Present Knowledge

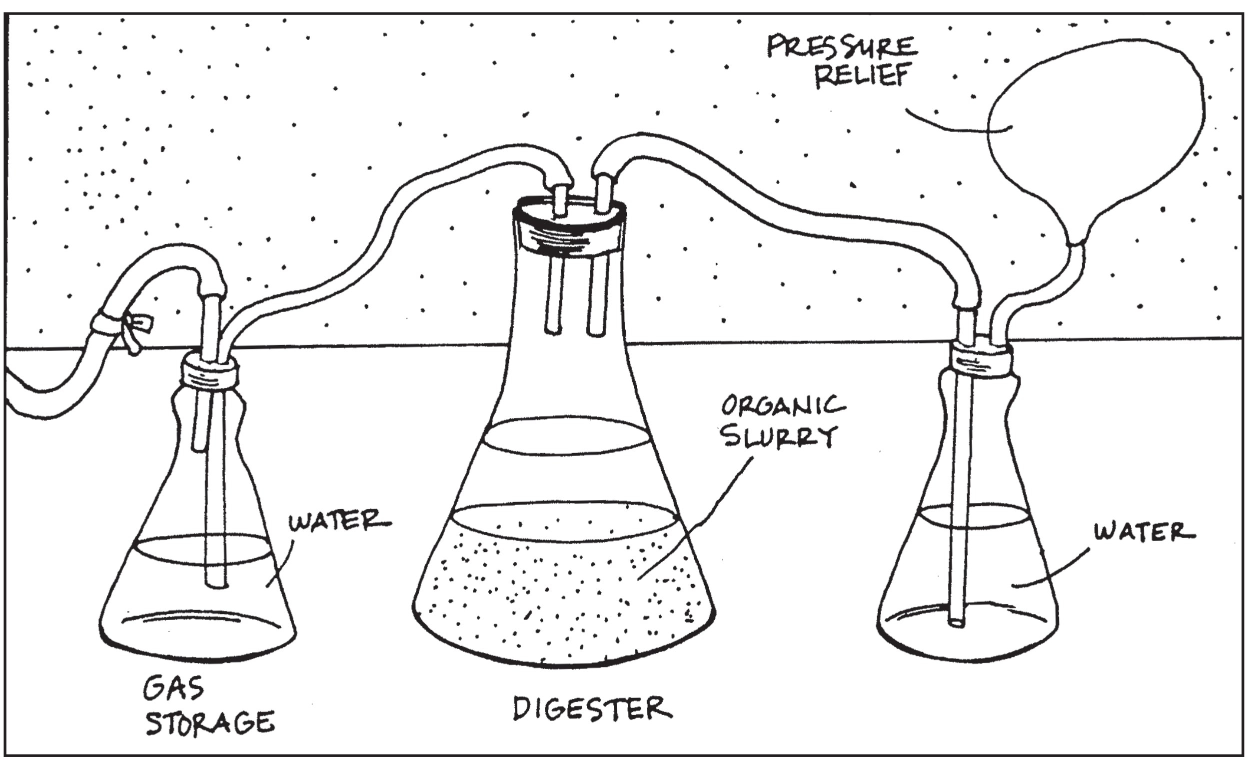
5. In small groups build four or five models and have students test different organic wastes. Each group will set up a lab report worksheet to track the results of the experiment. Which produces the most gas the fastest? Which waste produces the best fuel? Analyze the data. Discuss interpretations and observations and formulate conclusions with small group partners. Each group will orally present findings and conclusions in class.

Evaluation

What is methane? How is it produced? List materials that can be used to generate methane. Describe another means of using solid waste to produce fuel.

Classroom Activities

1. Have students research the historical uses of methane gas digesters, write a report and share it in class. For example, in Holland a tarp was placed over a portion of a swamp with a hose running from under the tarp to the house for light and heat.
2. Research modern methane technology, write a report and share it in class.
    a. Use of digester in your state.
    b. Use of basic design in the developing world (examples: China, India)
    c. Study resource recovery technology to learn how industrial fuel is created from solid waste by pyrolysis.



Can We Recover Resources from the Waste Stream?

Concept
Sewage sludge and manure can be applied to the land to reduce solid waste and return nutrients to the earth.

Objective
Students will determine the benefits and drawbacks of land application of sewage sludge.

Method
Students will gather information on quantities and methods of sludge disposal in their community.

Material
No special materials.

Subjects
Social Studies, Science, Language Arts

Skills
Evaluating, formulating questions, gathering information, hypothesizing, interviewing

Time
One class period for presentation, three days of research.

Vocabulary
Sewage, sludge, land application

Resources
Local engineering firms, local sewage treatment facilities, local residents, firms that produce fertilizer from sewage sludge.

Leading Question
Is it safe to put sludge on the land all year round?

Procedure
1. Introduce the subject matter and distribute the information sheet Spreading Sludge. Have the students read and discuss the information.
2. Contact sewage treatment plant operators and sanitary engineers. Arrange to interview them or invite them to the classroom. Create a list of questions to ask in order to determine the quantity of sludge in the community and the methods of sludge disposal.
3. Have students interview farmers who apply sludge to their fields. Develop a list of questions to ask to determine the benefits and drawbacks of land application of sewage sludge.
4. Have students interview neighbors for their opinions on this subject.
5. Have students write summary reports and create visual representations using technology to recap the information learned in the interviews.

Evaluation
Students should be able to discuss the nature of sludge material and disposal in their communities and the advantages and disadvantages of land application. Evaluate school grounds for sludge application.

Classroom Activities
A. Invite a waste management engineer to the class to explain site selection for sludge spreading.

B. Students can investigate sludge composting systems and brainstorm ways to recycle organic wastes on a large scale.

C. Have students research different composting toilets and make a list of the benefits and drawbacks of each. Have students design a composting toilet system for a home or camp and share their reports, lists and designs with their classmates.

D. Have students investigate sources of commercially-available compost.

E. Have students investigate alternative wastewater treatment technologies. Take a field trip to a local company involved in this industry.

Common Core Alignments

GRADE 9-10

CC.SL.9-10.1c
Speaking & Listening:
Comprehension & Collaboration

CC.SL.9-10.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.9-10.6
Writing:
Production & Distribution of Writing

CC.W.9-10.7
Writing:
Research to Build & Present Knowledge

GRADE 11-12

CC.SL.11-12.1c
Speaking & Listening:
Comprehension & Collaboration

CC.SL.11-12.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.11-12.6
Writing:
Production & Distribution of Writing

CC.W.11-12.7
Writing:
Research to Build & Present Knowledge

One large component of the waste we produce daily is our bodily waste. Because of modern plumbing and septic systems, we are able to conveniently divorce ourselves from the product of our biological functions. However, each time we flush a toilet, we typically send about five gallons of clean water, as well as matter full of minerals and nutrients, down the drain. Both water and rich organic matter are wasted. Of the 25 billion gallons of sewage sludge produced daily in the United States, approximately 60% is used as fertilizers, the rest is either discarded or burned.

Only about 20% of Americans use household septic tanks-leach field systems, to treat their septic wastes. Other on-site treatment includes dry wells, outhouses and composting toilets. The remaining 80% make use of municipal and non-municipal sewage treatment plants, drinking water treatment plants and septate haulers. Various industrial activities such as papermaking and cheesemaking also generate sludges requiring treatment and disposal.

Sewage can be processed and used as soil conditioner, an option more communities are taking advantage of to save disposal costs and the nutrient value in sewage. Sewage sludge is dewatered and composted to produce soil conditioner or fill. Once sterilized, the material can be used as fill in landfills or spread on fields.

Most sewage sludge in the United States is applied to agricultural land. Sludge on land maximizes its soil enriching value and lessens the concentration of potentially hazardous materials. In winter, sludge must be stored to prevent pollution.

Septic sludge contains pathogenic (disease-causing) bacteria, viruses and other microorganisms from human wastes. Soil conditioners made from septic wastes fed with commercial industrial waste are often contaminated with heavy metals such as cadmium, mercury, as well as pesticides, such as DDT and PCBs. There is differing opinion as to whether sludge and/or compost from this kind of sludge poses a health threat. The EPA has regulations for the correct treatment and management of sewage sludge, or biosolids. These regulations and their actual outcomes are overseen by the National Academy of Sciences. According to them "the use of these materials in the production of crops for human consumption when practiced in accordance with existing federal guidelines and regulations, presents negligible risk to the consumer, to crop production and to the environment."

Nonetheless, such sludge or biosolids should never be used on land producing crops for human consumption. Treated or composted sludge can also be packaged and sold as organic fertilizer. Sludgenews.org has a list of branded products that contain sewage sludge/biosolids.

Can We Safely Dispose of Toxic Chemicals?

Concept
Safe disposal of common toxic substances is expensive and difficult, inappropriate disposal can harm the environment and people.

Objective
Students will upgrade the school's lab cabinet.

Method
Students will select some waste chemicals or unneeded chemical supplies for neutralization.

Material
Selected chemicals, safety goggles, Flinn Catalog

Subjects
Chemistry, Language Arts

Skills
Carrying out investigation, evaluating, explaining, researching

Time
Varies, some procedures take several days.

Vocabulary
Toxic, hazardous, neutralization, chemicals

Resources
Flinn Scientific Inc. http://www.flinnsci.com/; Ken Giles, *School Science Laboratories: A Guide To Some Hazardous Substances* (Free from United States Consumer Product Safety Commission - the PDF is available online).

3R's of the Common Core
Parallel Activities
K-3, What's Hazardous?
Resources
Environmental Education and Educational *Information*
Hazardous and Toxic Waste

Background
Many chemical experiments formerly done at the high school level are no longer done because of safety concerns. Chemicals produced in many labs cannot be disposed of easily. Neutralization is often the best solution – to remove the chemical from the waste stream before it is mixed in with other wastes.

Leading Question
Are there alternatives to disposal of toxic wastes in the solid waste stream?

Procedure
1. Select a chemical for neutralization. Use either a product of a lab or a chemical bottle from the chemical cabinet that is old or for which no use is planned.
2. Read and follow neutralization plan on Flinn website where worksheets are also available. NOTE: Some procedures should be demonstration only.

Evaluation
Given a certain chemical, have students explain the neutralizing process and the chemistry behind each step.

Classroom Activities
A. Do a complete inventory of the chemical cabinet and rate dangers using the Flinn website. Organize the cabinet correctly using the Flinn explanations and date all chemicals.

B. Have students work in groups to research how to set up a household hazardous waste collection program for your community. Working collaboratively the students will write a report with their research findings and a plan for their own community waste collection program. Students will orally share their findings and plans in class.

Common Core Alignments

GRADE 9-10

CC.RST.9-10.3
Reading in Science & Technical Subjects:
Key Ideas & Details

CC.SL.9-10.4
Speaking & Listening:
Presentation of Knowledge and Ideas

CC.W.9-10.7
Writing:
Research to Build & Present Knowledge

GRADE 11-12

CC.RST.11-12.3
Reading in Science & Technical Subjects:
Key Ideas & Details

CC.SL.11-12.4
Speaking & Listening:
Presentation of Knowledge and Ideas

CC.W.11-12.7
Writing:
Research to Build & Present Knowledge

How Do We Manage Our Waste?

Concept
Beginning to solve solid waste problems requires understanding our community's present solid waste management practices and future plans.

Objective
Students will evaluate both the current solid waste disposal practices and the future solid waste plans in their community.

Method
Students will interview local recyclers, solid waste management planners and state officials to determine the status of solid waste management planning in their community.

Subjects
Social Studies, Science, Language Arts

Skills
Communicating information, designing, gathering information and data, synthesizing

Time
Several days

Vocabulary
Solid waste management, planning

Resources
Town officials, local landfills and transfer stations, regional planning commissions, solid waste agencies, recycling groups and businesses, EPA

3R's of the Common Core
Information
Public Planning and Policy
Recycling, Composting
Resources
General
Environmental Justice, Advocacy and Policy
Solid Waste and Recycling
Waste Management Agencies by State

Leading Question
How do we manage our solid waste?

Procedure
1. Use the following questionnaire to guide an exploration of solid waste management in your community.
2. Contact recyclers, landfill site managers, disposal company representatives, county environmental health officers and planning officials. Invite officials to speak to the class.

Evaluation
Where does your waste material go for disposal? What is the cost your household pays for solid waste disposal? What are the real costs of this disposal and who pays them? How much does your town pay for disposal including pickup, hauling and landfilling/incinerating?

Classroom Activities
Have students write an alternative solid waste management plan for the community. Plans can be revealed in letters to be sent to the local solid waste district commission or as letters to the editor to be published in the local paper. All plans are presented in class and the students choose the best letters to be sent or published.

Common Core Alignments

GRADE 9-10

CC.SL.9-10.2
Speaking & Listening:
Comprehension & Collaboration

CC.SL.9-10.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.9-10.4
Writing:
Production & Distribution of Writing

GRADE 11-12

CC.SL.11-12.2
Speaking & Listening:
Comprehension & Collaboration

CC.SL.11-12.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.11-12.4
Writing:
Production & Distribution of Writing

Name: ______________________________ **Date:** ______________

Waste Management Choices

Type of waste management technology: ________________________________

1. What percentage of the waste stream can this process handle?

2. What are the costs per ton of processing the waste?

3. What is the projected lifetime of the facility?

4. What is the expense of constructing the facility and how can it be financed?

5. What is the estimated cost of maintenance and who will pay these costs?

6. What, if any, are the environmental or public health problems associated with the technology?

7. Is the method convenient and will the public endorse its use and participate in it operation?

8. Does this technology allow for and encourage the greatest reduction, reuse and recycling of the waste stream prior to treatment and disposal, as prescribed by your state's regulations?

9. Is this technology well suited to your area? Can you recommend its use for your solid waste district?

How Can We Revise Habits to Reduce Waste

Concept
Each person on every level of society, industry and government contributes to our solid waste problems and can help solve them.

Objective
Students will discern the author's purpose in the essay and will develop a plan for decreasing pollution in their environment by setting realistic personal goals.

Method
Students will read an essay, develop and adopt a personal positive action plan and record the results in journal and essay form.

Materials
Attached essay

Subjects
Language Arts, Health, Social Studies

Skills
Analyzing, applying ideas to solve problems, engaging in collaborative conversation, evaluating

Time
One class to start. A few weeks journal writing out of class. One class to end.

Vocabulary
Environmental pollution, myopic, swath

Resources
Charles Butterfield/Social Values

3R's of the Common Core Resources
Parallel Activities
K-3, Egg Cartons
4-6, Wise Use of Paper
7-8, Packaging Design
Information
Public Planning and Policy
Recycling

Background
"People are not powerless in the face of these complex problems. By reducing the amount of waste they produce and recycling large share of their discards, individuals can become part of the solution. But consumers cannot affect widespread changes on their own. They need the assistance of industries willing to manufacture recyclable products and and governments willing to alter their waste management practices. The cumulative waste management decisions made by local and national governments affect global energy use, the rate at which the atmosphere warms and the amount of pollution emitted into the environment. The degree to which people and nations act together to conserve raw materials and energy resources will determine the rate at which the global environment is altered."

– Cynthia Pollack

Leading Question
Have personal or global problems such as poverty or environmental pollution ever become so overwhelming that you were immobilized or driven to some action that actually aggravated the problem?

Procedure
1. Discuss the above question. List areas that apply.
2. Have students read the article "My Twenty Foot Swath." Examine the author's ideas, the points made, the impact of his writing style and the solution to his dilemma. Jot notes to use in discussion. What is the author's purpose in writing this essay?
3. Have students relate similar personal experiences. As a class, brainstorm different ways to expand positive action from a personal level to the world community.

Classroom Activities
A. Building on the lessons of this activity, the class could develop a plan for solving solid waste and other environmental problems on a school, community, state, national and international level.

B. Have each student select a problem about which she/he feels helpless, research when appropriate, outline a positive action plan, keep a daily journal documenting experiences and write the results after time in essay form.

Common Core Alignments

GRADE 9-10

CC.RI.9-10.3
Reading Informational Text:
Key Ideas & Details

CC.SL.9-10.1c
Speaking & Listening:
Comprehension & Collaboration

CC.W.9-10.4
Writing:
Production & Distribution of Writing

GRADE 11-12

CC.RI.11-12.6
Reading Informational Text:
Craft & Structure

CC.SL.11-12.1d
Speaking & Listening:
Comprehension & Collaboration

CC.W.11-12.4
Writing:
Production & Distribution of Writing

"My Twenty Foot Swath"

By Kenneth V. Lundberg, Covenant Companion

"I worried so much about world hunger today that I went home and ate five cookies." Did personal or global problems ever become so overwhelming that you were immobilized, or driven to some action that actually aggravated the problem? Have you experienced such frustration about the hopelessness of solving the problems of poverty, environmental pollution or human suffering that you could avoid it only be deciding that you were powerless to do anything about their alleviation? This is called Responsibility Assumption Overload. Here's how I dealt with this feeling. I park my car away from my building at work. That way I get both exercise and a parking space, as everyone else competes for spots next to the entrance.

My morning and late afternoon strolls take me on a stretch of lawn between the tennis courts and the soccer field and across an occasionally used softball diamond. The lawn is twenty feet wide, more or less. Soft and green, it was originally very littered. Tennis players discard tennis ball containers (and their flip tops), worn out sweat socks, broken shoelaces and old candy bar wrappers. Soccer game spectators leave behind beer bottles and junk food cellophane.

In my early days it disgusted me and my thoughts centered on ways of correcting the situation writing letters to the campus newspaper (no doubt totally ignored); campaigning for anti-litter regulations (who would enforce them?); organizing a "Zap-Day" cleanup (leaving 364 days of littering). All my noble efforts would have demonstrated my indignation, raised by blood pressure and attracted attention, but they would not have changed the appearance and/or condition of the area. So, I decided to take ownership, I would be the solution. I did not tell anyone of this; it was probably against some rule or another. I decided that I would be responsible for the environmental quality of this twenty-foot swath. I did not care what other parts of the campus were like. They were someone else's problem. But each day, going from and to my car, I picked up litter.

At first, it was as much as I could conveniently carry. Then I made a game of it, limiting my picking to ten items each way. It was an exciting day when I realized I was picking faster than "they" were littering. Finally, the great day arrived when I looked back on my twenty feet of lawn, now perfectly clean. Where did I put the litter?

At first, I brought it into a waste basket in the building, or took it to the car to bring home. Then a curious thing happened. One day, large orange barrels appeared at each end of my swath. Someone in maintenance had become my silent conspirator-periodically emptying and replacing the barrels.

He, too, knew the wisdom of keeping a low profile about it all. I've done this for several years now. Has general campus appearance changed? Not much! Have litterers stopped littering? No! Then if nothing has changed why bother?

Here lies the secret. Something has changed. My twenty-foot swath and me! That five minute walk is a high spot of the day. Instead of fussing and stewing and storing up negative thoughts, I begin and end my workday in a positive mood. My perspective is brighter. I can enjoy my immediate surroundings - and myself - as I pass through a very special time space. "It" is better because of me. I am better because of "it." "We" enjoy the relationship. Maybe, even, "it" looks forward with anticipation to my coming.

My learning - and the twenty-foot swath - does not stop at the building door. There is an important principle that follows wherever I go. I cannot solve man's inhumanity to man, but I can affirm, with a smile and a word of appreciation, those who feel burdened by the need to work at lowly jobs. I cannot right the imbalances of centuries of discrimination, but I can "lift up" someone who feels the weight of a poor self-image. I can treat women as equals without solving the problems of sex discrimination. I can seek out the social and economic litter in my own "twenty-foot swath" without demanding of myself that I "clean up the whole world."

I now practice a discipline of leaving each time-space capsule of my life a little better than when I entered it. Each personal contact, each event, each room I enter becomes a small challenge. I want to leave it improved, but more important. I am responsible to myself to be improved; and thereby, maybe - just maybe - my having been there will make life better for someone else.

I am becoming more and more disenchanted and suspicious of revolutionaries, crusaders, militants and do-gooders. Many, if not most, seem to be more concerned about being right than being loving or effectual. The zealot, no matter how well-intentioned, often leaves a trail of wounded people while in pursuit of the cause.

Is this all too myopic - shutting one's eyes to the greater concerns? It does not need to be! I now have a twenty-foot swath. Next year it may be forty, or sixty, or eighty feet wide. Ten talents were not required of him who had been given only one. Too many people stumble by taking on causes too great for their level of discernment and discipline. They need to begin to catch the vision of the important promise that the meek shall inherit the earth, not the indignant or frustrated.

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How Does Recycling Work?

Concept
Recycling saves money and resources, reduces waste and pollution, but does not eliminate pollution problems altogether.

Objective
Students will investigate methods of recycling paper and the technical problems encountered in the recycling industry and will discuss the issues of water pollution and the treatment and disposal of toxic and solid wastes.

Method
Students will make recycled paper and test the remaining water for sediment content pollutants.

Materials
Several different sheets (at least 9"x12") of different types of paper (e.g.: newsprint, colored newsprint, white office paper, construction paper, envelope with tape.) See 4-6, Papermaking for additional materials.

Subjects
Earth Science, Biology, Science, Language Arts

Skills
Carrying out investigation, communicating solutions, interpreting, researching

Time
One class to make the paper, one class to test the water for contaminants.

Vocabulary
Pollution, de-inking, recycling

Resources
Tom Watson, "New Inks Causing Concern for Newspaper De-inkers" Resource Recycling, Nov/Dec 1987; your state's department of health; your state's department/agency of water quality; Right to Know Information; paper mills

3R's of the Common Core
Parallel Activities
4-6, Making Paper
Information
Paper, Recycling
Resources
Green Consumption, Consumerism and Sustainable Development
Pulp and Paper
Solid Waste and Recycling

Background
Recycling saves landfill space by reducing the volume of waste paper requiring disposal and it also saves natural resources and energy. It may reduce pollution problems and transfer them to other parts of the cycle, but it does not eliminate them. Used paper fibers must be de-inked and contaminants removed. Black printing inks used in newspapers are composed of about 30% pigment (usually carbon black) and about 70% petroleum-refined oil. Colored pigments used in magazines and increasingly in newspapers contain heavy metals. New low-rub inks and laser printing cause additional problems because they are difficult to remove from paper. The paper-making process requires large amounts of water, all of which must be cleaned of contaminants before release into the environment. The remaining paper sludge must also be disposed of properly.

Leading Question
Does recycling solve all our solid waste problems?

Procedure
1. Using the procedure in Activity 4-6, III.B.2, Making Paper, each group of students will make recycled paper out of a different type of waste paper. They will save the water used and test it for toxicity.
2. Students might also measure volumes and weights of waste paper before and after the recycling process by filtering the remaining water and letting the sludge dry. Students could also compare the fiber content (length of fibers) of paper made from virgin fibers, recycled and paper-making residue. Students can create a graph illustrating which types of paper recycle most efficiently.
3. Discuss the results. Should the remaining paper sludge be treated as solid waste or hazardous waste? How can we reduce pollution problems?

Evaluation
What problems are encountered in the making of recycled paper? Does recycling eliminate pollution problems?

Despite any problems, is recycling paper on balance better environmentally than making paper from virgin wood? Why?

Common Core Alignments

GRADE 9-10

CC.RST.9-10.3
Reading in Science & Technical Subjects:
Key Ideas & Details

CC.SL.9-10.1c
Speaking & Listening:
Comprehension & Collaboration

CC.W.9-10.7
Writing:
Research to Build & Present Knowledge

CC.HSS.ID.1
Mathematics:
Statistics & Probability

GRADE 11-12

CC.RST.11-12.3
Reading in Science & Technical Subjects:
Key Ideas & Details

CC.SL.11-12.1d
Speaking & Listening:
Comprehension & Collaboration

CC.W.11-12.7
Writing:
Research to Build & Present Knowledge

CC.HSS.ID.1
Mathematics:
Statistics & Probability

Classroom Activities

A. Visit a papermaking plant.

B. Have students research the pollution control methods used in paper making plants. Gather information using print and digital sources as well as information gained through queries by telephone or letter. Write a report and share in class.

How Can We Recycle Our Resources?

Concept
Designing an efficient system for handling recyclables will enhance the success of any recycling project.

Objective
Students will understand some of the design considerations of establishing a recycling facility and will use this information to design a hypothetical recycling center for their town or school.

Method
Students will design and make scale drawings of hypothetical recycling facilities in their community.

Materials
Paper, pencils, presentation materials, rulers, population figures, local maps

Subjects
Social Studies, Industrial Arts, Art, Living Arts, Language Arts

Skills
Applying mathematical concepts, designing, gathering information, problem solving

Time
One week

Vocabulary
Recycling, sorting, collecting, buy-back, curbside collection, reverse vending machines

Resources
Local governments, local waste haulers, local recycling groups and businesses.

3R's of the Common Core
Parallel Activities
K-3, What's Recyclable?
4-6, Where to Recycle
7-8, Source Separating
Information
Transportation and Processing Recycling
Resources
Solid Waste and Recycling
Waste Management Agencies by State

Background
There are several options for the collection and processing of recyclables.

- Drives are one-shot collections usually organized for one material and requiring little ongoing processing or storage if organized well.
- In curbside collection programs, each household separates its recyclables from the trash, prepares them for recycling and the trash hauler or recycler picks the separated materials up with the trash.
- Mixed recyclables can be collected, with separation occurring at the processing facility.
- Citizens can drop off their recyclables at bins, sheds or boxes located in the community for easy access and unsupervised collection.
- Automated collection of beverage containers occurs at reverse vending machines which operate similarly to soda vending machines. Containers are inserted and money is dispensed.
- Buy-back centers will exchange payment for materials delivered.

Leading Question
What kind of recycling program would be best for our town or for our school?

Procedure
1. Have students collect information on local waste and recycling practices to determine needs for recycling. Divide students into groups with each given the task of considering one of the following: the amounts of waste and recyclable generated, market funding sources, storage spaces, community support available, etc. Have students use a variety of sources in the research process including online searches, telephone interviews and written requests for information. Collect and organize information to share with classmates.
2. Invite a local recycler or town official planner from your solid waste district or regional planning commission to talk to the class and/or visit a recycling center. Prior to a visit, have students create a list of questions to ask regarding the local waste management program and the specific regulations required.

Common Core Alignments

GRADE 9-10

CC.RI.9-10.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.9-10.2
Speaking & Listening:
Comprehension & Collaboration

CC.W.9-10.4
Writing:
Production & Distribution of Writing

CC.HSG.MG.3
Mathematics:
Geometry

GRADE 11-12

CC.RI.11-12.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.11-12.2
Speaking & Listening:
Comprehension & Collaboration

CC.W.11-12.7
Writing:
Research to Build & Present Knowledge

CC.HSG.MG.3
Mathematics:
Geometry

3. Using this information, decide as a class on the best type of activity (e.g.: buy-back, curbside) for the town. Once this decision is reached, proceed to design a program for storage, collection, processing, etc., of the recyclable(s) to be handled. Design a facility the town or school could use. Create visual displays as well as written information that explain the activity and facility.

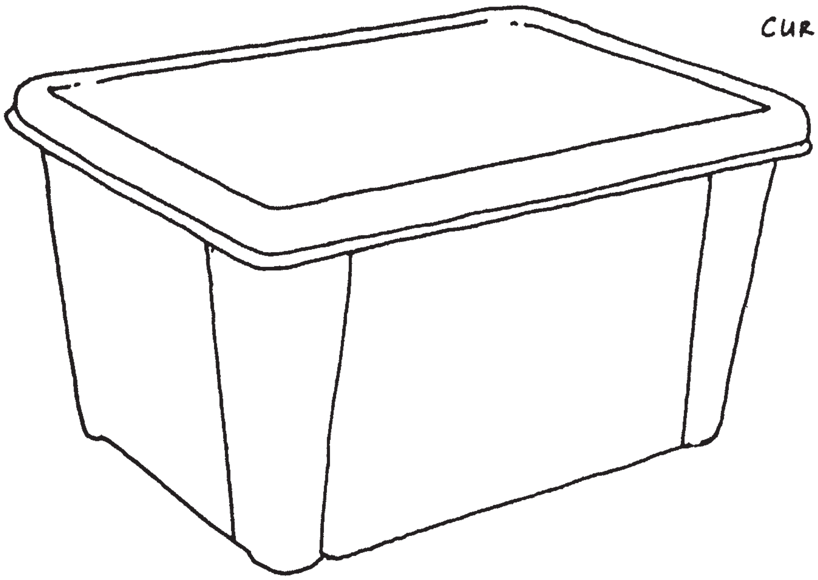
Evaluation

Students should be able to identify the major considerations in designing a recycling program and should be familiar with the waste management picture in their area.

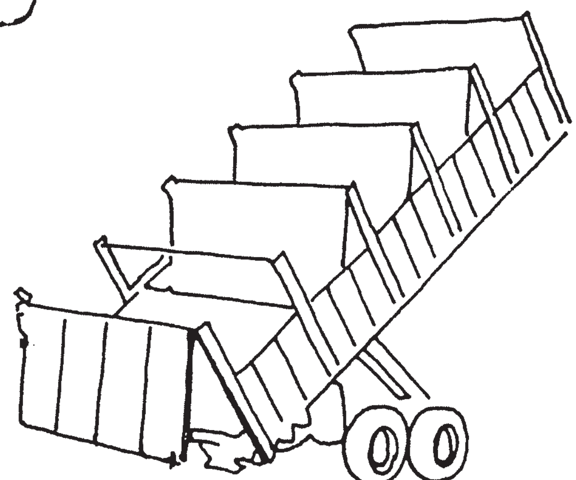
Classroom Activities

A. Present information and plans to town officials, local planning groups and the school board. Students will contact organizations and present their ideas.

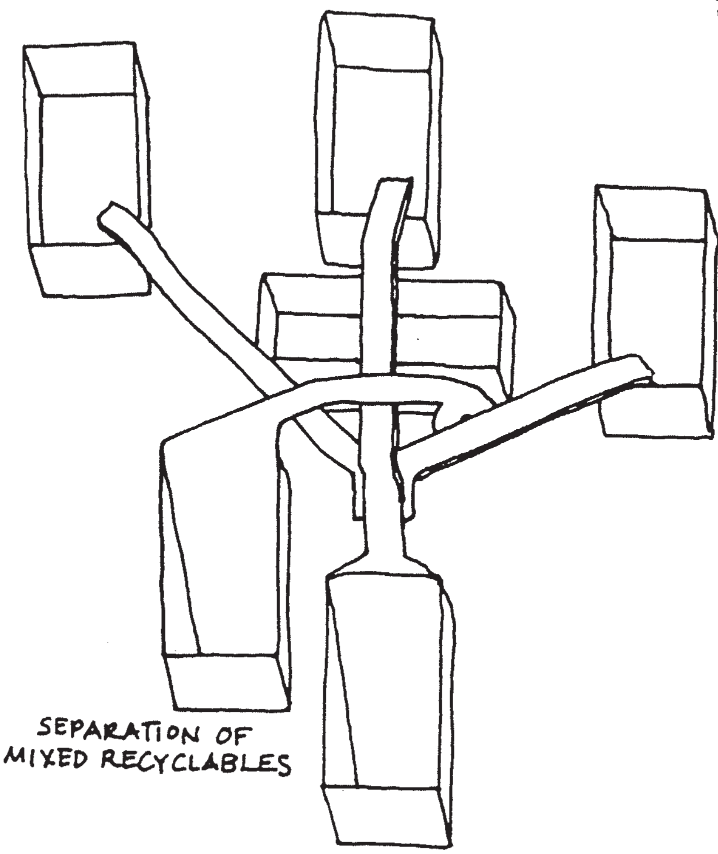
B. Visit other recycling facilities, find out how they started, operate, etc.



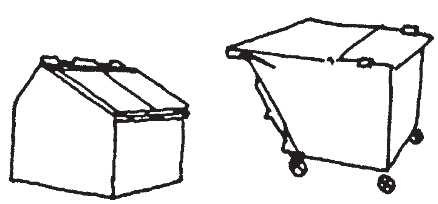
CURBSIDE CONTAINERS



EAGER BEAVER



SEPARATION OF MIXED RECYCLABLES



BINS and DUMPSTERS

How Can We Make Less Waste?

Concept
Communicating a knowledge of recycling to an audience.

Objective
Students will become more familiar with recycling and solid waste management issues and will develop their public presentation skills.

Method
Students will present an informational speech relating to recycling.

Materials
Research materials, note cards

Subjects
Language Arts, Speech, Social Studies, Science

Skills
Communicating information, researching, sharing research and writing, synthesizing

Time
One class period plus library time

Vocabulary
Recycling

3R's of the Common Core
Information
All of the Information Section.
Resources
Solid Waste and Recycling
Waste Management Agencies by State

Leading Question
What do we need to know about recycling?

Procedure
Students will:

1. Research some aspect of recycling or solid waste management.
2. Write a speech outline using collected information that includes an introduction, supporting evidence and conclusion.
3. Put the supporting material on notecards.
4. Practice delivering the speech to the class or another group.

Topics might include:

- Why is home source separation easy?
- How does an Eager-Beaver Trailer (or other recycling equipment) work?
- What are plastic soda bottles (or any other recyclable material) made into?
- How does composting work?
- What are the benefits of recycling to society? The drawbacks?
- How recycling works in our town?
- What economic problems work against recycling?
- What changes in society, in national policy would promote recycling?

Evaluation
Students will be evaluated on the quality of research, depth of information presented, delivery of speech and class reaction.

Common Core Alignments

GRADE 9-10

CC.RI.9-10.8
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.9-10.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.9-10.2
Writing:
Text Types & Purposes

GRADE 11-12

CC.RI.11-12.8
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.11-12.4
Speaking & Listening:
Presentation of Knowledge & Ideas

CC.W.11-12.1
Writing:
Text Types & Purposes

Classroom Activities

A. Focus on specific recycling topics such as aluminum, glass, etc.

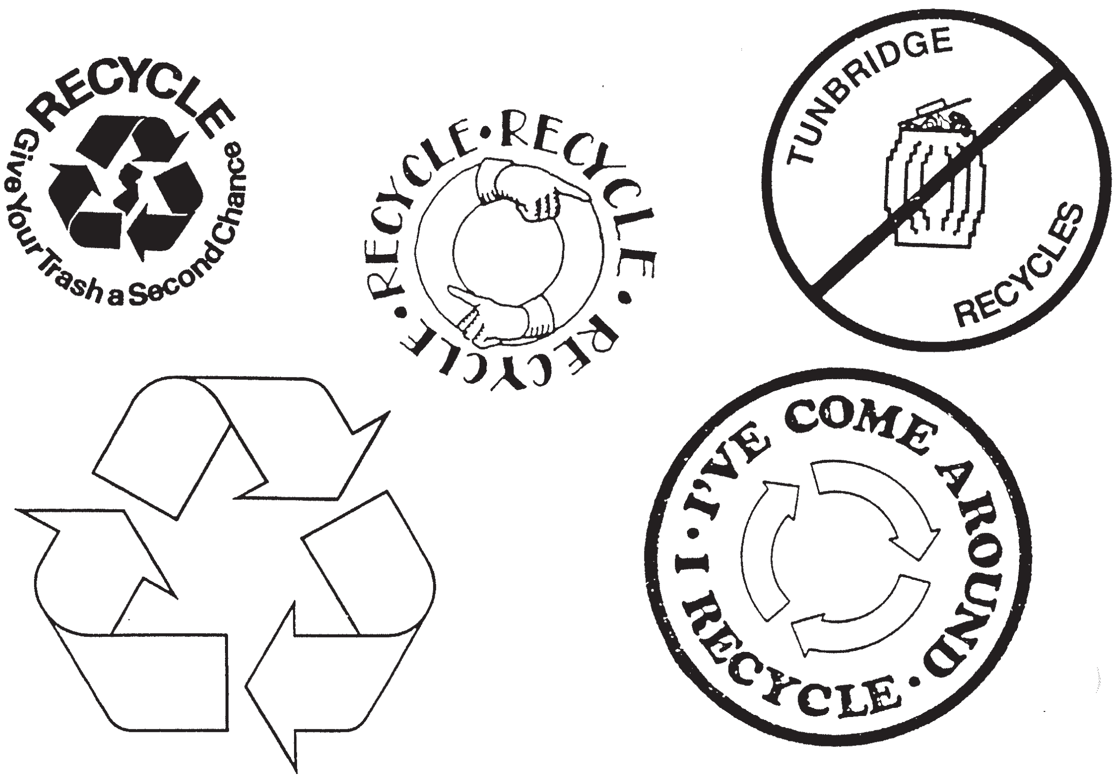
B. Present speech to other groups: (e.g.: community groups, school board, town officials, service groups.)

C. Attend various public hearings and evaluate information.

D. Develop an informational speech into a persuasive speech. Persuasive topics might include: Recycling should be mandatory in our town, Non-recyclable beverage containers should be banned by the state, Recycling should not be mandatory until it is cheaper than landfilling waste.

E. Look at the logo and slogan samples on the following page and create your own recycling logo for your town or school.

Name:____ Date: ____________________



Give your trash a second chance. Recycle.

Give a bottle a decent break. Recycle.

Save a can from a life on the street. Recycle.

Turn your old paper into good news. Recycle.

Give your dirty oil a clean start. Recycle.

Send your leaves to a mulch better place. Recycle.

How Can We Recycle Our Resources?

Concept
We need to redesign laws and revise habits in order for recycling to work.

Objective
Students will consider ways to reduce waste in the United States.

Method
Students will listen to quotes, read the articles and discuss ways to reduce waste and increase recycling.

Materials
Educators choice

Subjects
Social Studies, Economics, Language Arts

Skills
Analyzing, engaging in collaborative conversations, gathering information, using evidence

Time
One class period

Vocabulary
Policy, secondary recycled materials, redesign, tax advantages, economic competition.

Resources
Local recycling groups; your state's department of natural resources; your state's waste management department or agency

3R's of the Common Core
Parallel Activities
4-6, Where to Recycle
7-8, Graphing Recyclable
Information
Public Planning and Policy
Redesign and Reuse
Recycling
Resources
Solid Waste and Recycling
Waste Management Agencies by State

"An inventory of the world's discards would reveal metals more valuable than the richest ores, paper representing millions of hectares of forests and plastics incorporating highly refined petrochemicals. That these products rich in raw materials and concentrated energy are frequently considered worthless is indicative of a distorted economic waste in the United States."
—Cynthia Pollock

"We do not buy scrap out of altruism or patriotism. Neither do we buy it just because it saves energy or is good for the environment. It's nice if those benefits follow along but we don't have much patience with those who not only advocate, but would legislate, putting the cart before the horse."
— J.J. Ferrigan.

"A city the size of San Francisco disposes of more aluminum than is produced by a small bauxite mine, more copper than a medium copper mine and more paper than a good sized timber stand. San Francisco is a mine."
—David Morris, Worldwatch Paper #76

Leading Question
Why isn't everybody recycling?

Procedure
1. Discuss the background quotes. If recycling saves energy and resources, saves landfill space, reduces pollution, why doesn't it seem to be economically feasible? Does business pay the full costs of producing, transporting and disposing of its products? What are these costs and if not business, who does pay them?
2. Students research the National Recycling Coalition, http://nrcrecycles.org/ and answer questions on worksheet.

Evaluation
Worksheet.

Common Core Alignments

GRADE 9-10

CC.RI.9-10.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.9-10.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.9-10.4
Writing:
Production & Distribution of Writing

GRADE 11-12

CC.RI.11-12.7
Reading Informational Text:
Integration of Knowledge & Ideas

CC.SL.11-12.1
Speaking & Listening:
Comprehension & Collaboration

CC.W.11-12.1
Writing:
Text Types & Purposes

Classroom Activities

A. Develop a flow chart tracing all the costs of an object from extraction of a raw resource to disposal. Include environmental costs and subsidized costs. What would happen if the manufacturer were forced to pay the hidden costs? Why isn't this the case?

B. Choose one recyclable. Check several different markets and haulers to see what prices, if any, are being offered for the material. What prices are they being paid for the materials by the end-user?

C. Write an essay defending or refuting any of the three given quotes.

Name:____ Date: ______________________

A National Recycling Policy?

1. What reasons does the NRC give for pursuing recycling as a necessity?

2. Why do secondary recycled materials have difficulty competing with virgin materials?

3. What policies does NRC suggest to help secondary recycled materials compete?

4. What could a national recycling database be used for?

5. What does the NRC mean by Design for Recyclability?

6. What principles does the NRC suggest that a national recycling education policy should emphasize?

7. What specific recommendations does it make for its national policy for recycling education?

8. Do you agree with these recommendations? What other measures do you think would help recycling?

How Can We Recycle Organic Waste?

Concept
Microorganisms are essential to the recycling of organic matter.

Objective
Students will relate the importance of healthy microorganism activity to composting.

Method
Students will view slide samples under the microscope and sketch observations.

Materials
Two trays, soil, 12 slides, water, containers, violet or methyl blue, cosine, microscopes, wax pencil

Subjects
Science, Biology, Language Arts

Skills
Carrying out investigation, collecting and interpreting data, observing, predicting

Time
Three weeks

Vocabulary
Microorganisms, compost

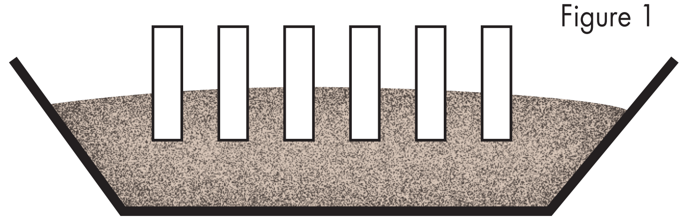
Resources
Mary Appelhof, *Worms Eat My Garbage;* Cecil E. Johnson, "Wild World of Compost," National Geographic, August, 1980 (archive.nationalgeographic.com)

3R's of the Common Core
Parallel Activities
K-3, Take Me Out To The Compost
4-6, Mini Compost
7-8, Making Good Compost
9-12, Effective Fertilizers
Information
Compost
Resources
Green Consumption, Consumerism and Sustainable Development
Solid Waste and Recycling

Leading Question
Can you identify microorganisms responsible for the composting process?

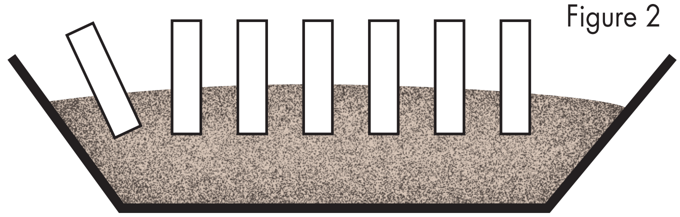
Procedure
1. Introduce the lesson. As a class or individually, create a lab report worksheet onto which experiment information can be recorded for each week. Include space for predictions, dates, amount of water added to each tray, drawings, observations, weekly conclusions and final concluding paragraph.
2. Fill a tray with dry soil. Fill another with soil plus 5-10% organic matter, well mixed. Insert six slides vertically into each container as in Figure 1.

Figure 1



3. Six slides in each container will permit observation of each sample at the end of one, two and three weeks. Each observation requires two slides, one stained dark and one stained light. Adjust the moisture content to about 20% water by adding a volume of water corresponding to about 1/5 of the volume of soil. Keep moisture content as constant as possible by adding water as needed.
4. After one week, two slides from each container will be studied according to the following procedure. Dig soil away from one side of the slide, then tilt the same slide toward the hole and lift it out as in figure 2.

Figure 2



5. The slide will now have a film of soil and microorganisms on one side. Clean the other side with a cloth. Label the slide with a wax pencil and prepare a second slide in the same way.

Common Core Alignments

GRADE 9-10

CC. RST.9-10.3
Reading in Science & Technical Subjects: Key Ideas & Details

CC.SL.9-10.1
Speaking & Listening: Comprehension & Collaboration

CC.WHST.9-10.4
Writing in History/Social Studies, Science & Technical Subjects: Production & Distribution of Writing

GRADE 11-12

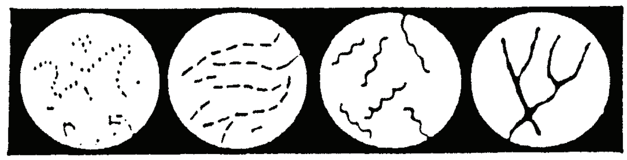
CC. RST.11-12.3
Reading in Science & Technical Subjects: Key Ideas & Details

CC.SL.11-12.1
Speaking & Listening: Comprehension & Collaboration

CC.WHST.11-12.4
Writing in History/Social Studies, Science & Technical Subjects: Production & Distribution of Writing

6. The preparation on the slide is fixed by passing the slide over a flame - one or two passes should be sufficient. Stain one slide dark, using gentian violet or methylene blue. Stain the other slide light, with eosine.
7. Examine each slide for the presence of bacteria with the low and high powers of a microscope. If present, spirilla will probably not be seen unless the field is darker. Sketch the observations and have students compare them to Figure 3 in order to identify the morphological class of the bacteria.

Figure 3



Cocci Bacilli Spirilla Actinomycetes

8. Have students determine whether there are differences in the number the types of microorganisms in the two samples.
9. At the end of the second week repeat the procedures with another pair of slides from each sample. Have students determine if the number and types of bacteria in the samples have changed significantly and help them to account for the changes.
10. At the end of the third week repeat the procedures and make further observations. Have students share their observations in groups of two during the third week and their final conclusions related to composting in a classroom discussion.

Evaluation

Students will be evaluated on the number of samples found and the lab report worksheet complete with documentation and conclusions regarding the microorganisms responsible for the composting process.

Classroom Activities

A. Share the Food Web of Compost Pile with students. Discuss its ramifications on composting and, if possible, assemble some of the consumers for direct observation.

B. Culture samples on nutrient agar in petri dishes. Observe what grows.

C. Grow a mold garden.

How Can We Recycle Organic Wastes?

Concept
Organic and mineral wastes can be recycled into effective fertilizer.

Objective
Students will rate the effectiveness of various organic and inorganic fertilizers.

Method
Students will test growth rates of different plants.

Materials
Six bean seedlings ready for transplanting and six pots per student or group of students, stock amounts and solutions of some or all of the following: manure, fish fertilizer, algae, rabbit tea -a bag of rabbit manure and water mixed, potting soil, any balanced organic fertilizer.

Subjects
Biology, Science, Horticulture, Language Arts

Skills
Carrying out investigations, hypothesizing, interpreting data, observing

Time
Three weeks for seeds to germinate, four weeks experiment.

Vocabulary
Composting, fertilizer, blood meal, phosphate, organic, solubility, residuality

Resources
Robert Rodale. Ed., *The Basic Book of Organic Gardening*; Catharine Foster, *The Organic Gardener;* National Gardening Association.

3R's of the Common Core
Parallel Activities
K-3, Take Me Out To The Compost
4-6, Mini Compost
7-8, Making Good Compost
9-12, Effective Fertilizers
Information
Compost
Resources
Green Consumption, Consumerism and Sustainable Development
Solid Waste and Recycling

Background
Some common fertilizers: BONE MEAL is a powdered, crushed bone. It can be sprinkled around growing plants. BLOOD MEAL is dried, powdered blood. It has a high nitrogen content and should be used sparingly. FISH EMULSION is liquid fertilizer made from fish. It is a good source of both nitrogen and phosphorus and should be diluted in water before pouring around plants. GRANITE DUST is powdered granite and a good source of potash. It can be mixed with soil or added on the side. ROCK PHOSPHATE is a powdered rock rich in phosphorous, calcium, iron, sodium, magnesium, boron and iodine which can be mixed with soil or added on the side.

Leading Question
What are fertilizers made of'?

Procedure
1. Introduce the lesson. As a class create a lab report worksheet onto which experiment information can be recorded. Include space for hypotheses, dates, fertilizer added, amount of water added and measurement of growth. Have students keep a journal with their hypotheses, observations and conclusions about the best fertilizers to use.
2. Germinate bean seeds by soaking overnight and planting in soil 2-3 cm deep. Keep warm and moist. After three weeks pick plants of equal health for fertilizing and transfer to individual pots.
3. Have students state hypotheses about the effect of different fertilizers on plant growth. Discuss the nutrients in each fertilizer. Emphasize the recycled origin of most of these fertilizers. Discuss solubility and residuality of fertilizers. Discuss measurement of growth (e.g.: height, number and color of leaves, roots).

OPTION: Number fertilizers: don't tell students which plant corresponds with which fertilizer. This will make the experiment exciting and more valid.

4. Add recommended doses of fertilizer and maintain one control group of six. Have students water all plants at the same time, with the same amount. Record results once each week for four weeks. Have class compile results after one month. Discuss accuracy of class results vs. individual results. Determine rating scheme and reveal the winner. Discuss what other recycled materials could be used for fertilizer.

Common Core Alignments

GRADES 9-10

CC.L.9-10.6
Language:
Vocabulary Acquisition & Use

CC.SL.9-10.1
Speaking & Listening:
Comprehension & Collaboration

CC.WHST.9-10.4
Writing in History/Social Studies,
Science & Technical Subjects:
Production & Distribution of Writing

GRADES 11-12

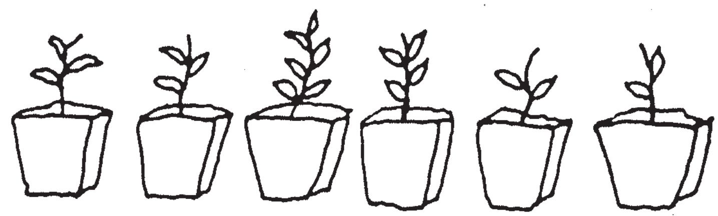
CC.L.11-12.6
Language:
Vocabulary Acquisition & Use

CC.SL.11-12.1
Speaking & Listening:
Comprehension & Collaboration

CC.WHST.11-12.4
Writing in History/Social Studies,
Science & Technical Subjects:
Production & Distribution of Writing

Evaluation

Name three kinds of fertilizers suitable for growing beans from seed. Which would you choose? Why? What are fertilizers made of? How is fertilizing a form of recycling? What does organic mean?



"This project began in the Fall of 1987 when I convinced the Board of the Association of Vermont Recyclers to allow me to undertake this project. To learn how to best go about developing a guide that would be most useful, I then consulted George Tanner of the Vermont Department of Education, who I cannot thank enough for his consideration, guidance, and patience throughout the project. During the fundraising that followed, John Casella made a key financial contribution, encouraging match-monies. The participation of four Supervisory Union school districts–Orange-Windsor, Springfield, Windham Central, and Washington Central–made possible further substantial aid. And Ed Leonard and Pat Parenteau of the Department of Environmental Conservation then lent the support of the Agency of Natural Resources. During the subsequent activity evaluation and testing portions of this project, I had the help of an immense number of knowledgable and interested people in fashioning the final activity selections found in the Guide...I thank them all."

—Susan Pedicord, Education Coordinator, Association of Vermont Recyclers, 1st ed. 1989.

Brought to you by

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www.nrra.net | info@nrra.net
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UNITED STATES SOLID WASTE

Figure 1. Total MSW Generation (by material), 2014
258 Million Tons

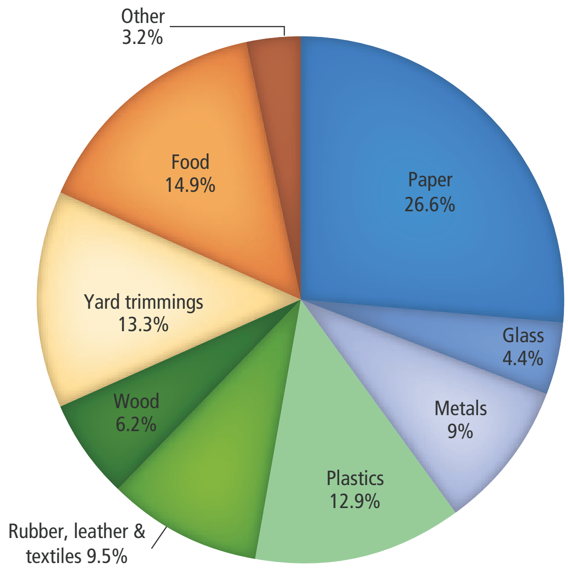


Figure 2. Total MSW Recycling and Composting (by material), 2014
89 Million Tons

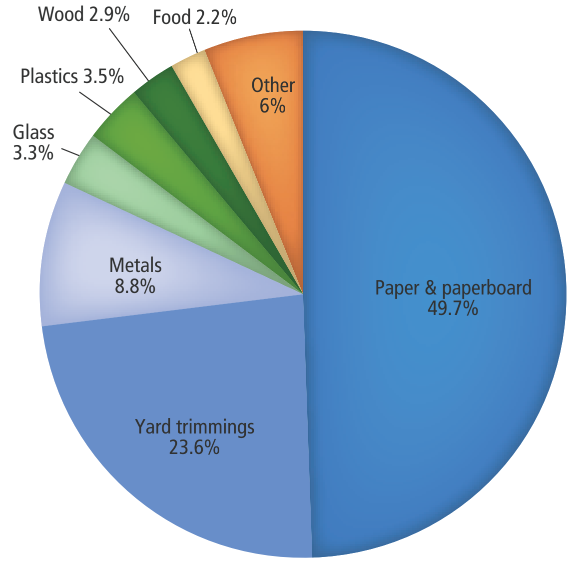


Figure 3. Total MSW Combusted with Energy Recovery (by material), 2014
33 Million Tons

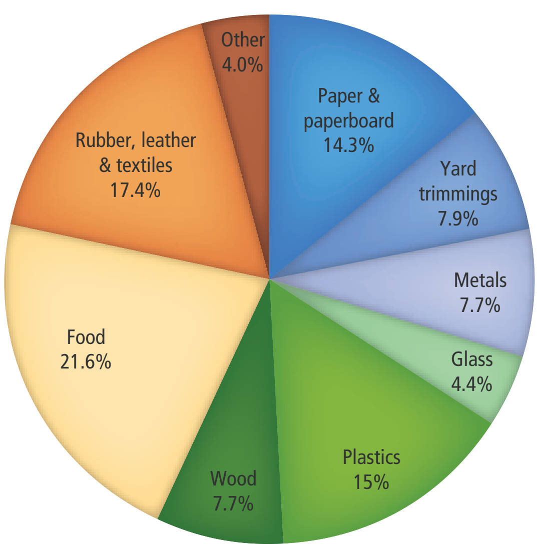
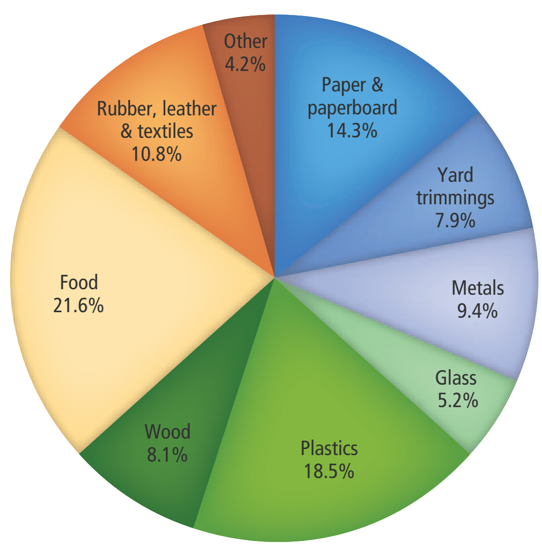


Figure 4. Total MSW Landfilled (by material), 2014
136 Million Tons



Source: United States Environmental Protection Agency, *Advancing Sustainable Materials Management: 2014 Fact Sheet Assessing Trends in Material Generation, Recycling, Composting, Combustion with Energy Recovery and Landfilling in the United States*, EPA530-R-17-01 (Washington, D.C.: United States Government Printing Office: 2016), 7.

Waste Generated/Recycled by Material in United States, 2012
In Millions of Tons and Percent of Generation by Each Material

Material	Weight Generated	Weight Recovered	Recovery as Percent of Generation	Weight Discarded
Paper and paperboard	68.62	44.36	64.6%	24.26
Glass	11.57	3.20	27.7%	8.37
Metals				
Steel	16.80	5.55	33.0%	11.25
Aluminum	3.58	0.71	19.8%	2.87
Other nonferrous metals†	2.00	1.36	68.0%	0.64
Total metals	**22.38**	**7.62**	**34.0%**	**14.76**
Plastics	31.75	2.80	8.8%	28.95
Rubber and leather	7.53	1.35	17.9%	6.18
Textiles	14.33	2.25	15.7%	12.08
Wood	15.82	2.41	15.2%	13.41
Other materials	4.60	1.30	28.3%	3.30
Total materials in products	**176.60**	**65.29**	**37.0%**	**111.31**
Other wastes				
Food, other‡	36.43	1.74	4.8%	34.69
Yard trimmings	33.96	19.59	57.7%	14.37
Miscellaneous inorganic wastes	3.90	Negligible	Negligible	3.90
Total other wastes	**74.29**	**21.33**	**28.7%**	**52.96**
Total municipal solid waste	**250.89**	**86.62**	**34.5%**	**164.27**

* Includes waste from residential, commercial, and institutional sources.
† Includes lead from lead-acid batteries.
‡ Includes recovery of other MSW organics for composting.
Details might not add to totals due to rounding.
Negligible = Less than 5,000 tons or 0.05 percent.

Source: Municipal Solid Waste Generation, Recycling and Disposal in the United States: Fact and Figures for 2012, 6.

UNITED STATES USE OF GLOBAL RESOURCES

The United States, with only 4.5% of the Earth's population, uses about one-quarter of all of the fuel consumed by human activity in the world every year and produces about half of the solid waste in the world every year. This chart shows US share of specific items.

Source: Roddy Scheer and Doug Moss, "Use It and Lose It: the Outsized Effect of US Consumption on the Environment," *Scientific American*, September 14, 2012, http://www.scientificamerican.com/article/american-consu mption-habits/.

US Consumption of World Resources

Paper	33%
Coal	23%
Aluminum	27%
Oil (Petroleum)	25%
Copper	19%

The History of Paper

The first paper was made about 300 million years ago by wasps. Wasps chew wood into a pulp and use the paste to make the walls of their houses. Humans began experimenting with paper-like substances only a few thousand years ago in an effort to find a more convenient writing and drawing surface than stone.

Animal skins were cleaned and pounded and stretched to make parchment. The inner bark from trees was peeled and pounded into thin sheets and silk, woven into fabric, was also used as a painting surface. Papyrus reeds were also layered and pounded together to form lightweight sheets.

Paper gets its name from papyrus, but the two are made quite differently, though they both contain the key element of cellulose. Cellulose is the major building block of all plant cell walls. To make papyrus, whole plants were layered and pounded together. To produce a sheet of paper, cellulose is broken down into individual fibers by beating them and mixing them with water. The water is then drained away, leaving an interwoven mass of fibers in a thin sheet.

The first real paper was probably made by the Chinese in 105 C.E. out of mulberry tree bark, hemp, fishnets and rags. The first paper mill built on European soil was erected by the Moors (Arab settlers) in Xativa, Spain in 1151 C.E. It would take a few more centuries for papermaking to create a foothold in Christian Europe. The use of linen and cotton rags for making paper became commonplace in Europe.

Paper was made by hand: screens were dipped into large vats of paper pulp, pulled out and drained into thin sheet of fibers. In 1799, the Fourdrinier brothers patented a machine that produced an endless roll of paper automatically. The paper-making machinery used today is basically the same as what was developed two centuries ago.

About the same time that the Fourdriniers were developing their machine, Matthew Lyon of Fair Haven, Vermont had developed a method for making paper, not from used clothing fibers, but from the bark of the basswood tree and saw dust. Today most of the paper we use comes from trees and the United States has become the largest producer of paper and paper products in the world.

From What Natural Resources is Paper Made?

Wood, some of which is unsuitable for use as lumber and lumber mill waste are used to manufacture paper. It takes about 17 medium-sized trees to produce one ton of paper. Most of this fiber comes from fir and pine forests of the Pacific Northwest and pine forests of the South. In the Midwest, North and New England areas, hardwood trees are used as well. Three thousand six hundred eighty-eight pounds of wood, 28 billion BTUs of energy, (equal to 224,000 gallons of gasoline), 216 pounds of lime, 76 pounds of soda ash, 360 pounds of salt cake and 24,000 gallons of water are used to make just one ton of paper.

How is Paper Made Commercially from Trees?

To save transportation costs, paper mills are often located near the forests where the wood is harvested. The trees are debarked, chipped, mixed with chemicals and processed in a large steam heated pressure cooker called a digester. This helps to break the wood down into cellulose fibers. The fibers are then rinsed with water to remove chemicals, unwanted wood contaminants and dirt.

The remaining water-wood mixture, called slurry, is fed onto a screen and shaken to intermesh the cellulose fibers. Water drains off through the screen and the remaining sheet of paper passes through a series of rollers where it is pressed and dried. The continuous rolls of paper are produced by the machine at a rate of 30 feet per second and can be 16 feet wide.

What Effects Does Paper Manufacture Have on Our Environment

About half of the world's annual commercial wood harvest is used to produce paper and this share is growing. Although wood is a renewable resource, we are presently using more of our forest resources than we are replacing. US government subsidy of lumbering activity keeps the cost of wood products artificially low, encouraging their continued depletion. The annual world consumption of paper has risen from 14 million tons in 1913 to over 250 million tons in the 1990s to 397.6 million tons in 2013 according to worldwatch.org. [1]

In addition to depleting natural resources, manufacturing paper pollutes the environment. According to one estimate, producing one ton of paper creates 84 pounds of air pollutants, 36 pounds of water pollutants and 176 pounds of solid waste. Disposing of used paper pollutes again, as litter, air pollution from burning, or groundwater contamination from leachate.

Chlorine Bleaching

Chlorine compounds are used in some paper mills to bleach the pulp to make it whiter. These chlorine compounds react with substances in the wood pulp to form dioxins, cancer-causing chemicals. This results in dioxin-related discharges into waterways and paper mill sludge and dioxin residues in paper products, all of which may threaten the health of people and wildlife. In addition to causing cancer, dioxin is believed to interfere with the actions of hormones and to disrupt reproductive; developmental and immune systems.

According to an EPA study, there is no safe level of exposure to dioxin. In 1993, the American Public Health Association (APHA) unanimously passed a resolution urging American industry to stop using the chemical chlorine and called for a measurable and progressive reduction toward the elimination of the use of chlorine-based bleaches in the pulp and paper industry. More than 20 years later chlorine is still widely used in paper manufacturing.

The Basics of Chlorine Free Paper

Elemental Chlorine (EC)
Elemental Chlorine (EC), the traditional method for paper bleaching, uses chlorine gas (elemental chlorine) to whiten paper. This process produces large amounts of dioxins. EC paper can contain either virgin or recycled fibers.

Elemental Chlorine-Free (ECF)
Elemental Chlorine-Free (ECF) uses chlorine derivatives, such as chlorine-dioxide and achieves reductions in dioxins. ECF paper can contain either virgin or recycled fibers.

Totally Chlorine-Free (TCF)
Totally Chlorine-Free uses a combination of oxygen delignification with hydrogen peroxide or ozone as the bleaching agent. Paper that is made from TCF pulp is made with 100% virgin fibers, including wood and alternative fibers such as kenaf (see below). The TCF label should not be used on recycled paper because the content of the original paper is unknown.

Processed Chlorine-Free (PCF)
Processed Chlorine-Free contains up to 100% recycled content which has been rebleached with a process that does not use chlorine compounds. Any virgin fiber in these papers is TCF. Since it is impossible to tell whether their recycled content has been bleached with chlorine in the past, PCF papers cannot be labeled totally chlorine free.

Unbleached Paper
Unbleached paper can be light brown or gray in color and is chlorine-free because the paper has not been bleached. It also can contain up to 100% recycled content. Unbleached products include mailing labels, bath tissue, paper towels, napkins, file folders and coffee filters. These unbleached paper products function similarly to bleached products, but lack the bright white color.

Alternative Paper

As mentioned above, a fiber shortage may occur given that we are depleting trees faster than we are replacing them. There is an ever-increasing need to find alternatives for paper and wood products. Below are some potential resources that might partially replace wood pulp for paper.

[1] Michael Renner, "Paper Production Levels Off," *Vital Signs*, January 20, 2015, http://vitalsigns.worldwatch.org/vs-trend/paper-production-levels .

Hemp
Hemp is a viable option legally grown in China, England and France that is not dependent on wood pulp. It is perhaps the oldest type of paper in existence. There are many advantages to growing hemp. It is a low-maintenance, high-quality fiber crop that requires no weeding and few, if any, chemicals. Hemp plants grow six to 16 feet tall in 70 to 110 days, yielding three to eight tons of dry stalk per acre. Herbicides are not necessary as these plants shade out weeds, leaving the field weed-free for the next crop. Hemp responds well to organic fertilizers such as compost, manure or biosolids. Its tops and leaves can be returned to the field to help replenish the soil. An annual crop of hemp grown on one acre of land may spare up to four acres of forest from being clear-cut. [2]

Hemp paper can be whitened safely using hydrogen-peroxide. It is naturally acid-free and therefore doesn't require acid treatments that limit the lifespan of wood-pulp paper. It can last for centuries - the Declaration of Independence and the original Bill of Rights were both printed on hemp paper. Hemp was legal in the United States until 1937. Since then, the government has considered hemp a controlled substance since it is a by-product of the plant which marijuana comes from. Hemp is not marijuana. Although both are from the same family, hemp has very low levels of THC, the ingredient in marijuana responsible for psychoactive properties. According to the European Economic Community standards, hemp plants must contain no more than 0.3% THC, producing no psychoactive effects.

Kenaf Paper 3
Kenaf is a tall, fast-growing plant indigenous to West Africa. In·the United States, it is grown and processed into paper by Vision Paper in New Mexico. Due to small-scale production, kenaf paper is very expensive compared to paper from hard and soft woods. However, if you consider environmental costs involved in the wood, pulp and paper industries - the destruction of ancient forest ecosystems, fragmentation of wildlife habitat due to clear cutting and the pollution of waterways - kenaf is much less expensive.

Kenaf pulp production is comparable to hemp. It grows 12 to 18 feet in 150 days and produces three to eight tons of dry fiber per acre. It can be bleached using hydrogen peroxide and uses less chemicals, heat and energy in the paper making process than paper from wood. However, if grown by agribusiness in large monoculture plots, kenaf farming. May become more chemically intensive. Both kenaf and hemp are best suited to small-scale farming.

Uses of Paper

1980 Containers: boxes, drums, crates, cans and buckets
1981 Printing and publishing: books, newspapers, magazines
1982 Electronics: plugs, speaker cones, panel boards, telephone sets, instrument cases, fiber conduits
1983 Mechanical: gaskets, packing, tire cord, oil filters
1984 Construction: pressboard, insulation, sheathing papers
1985 Textiles and apparel: rayon, acetate, clothing, shoes, arch supports, blankets, bed sheets, diapers
1986 Household: towels, tissues, cups, furniture, pressboard, plates, trays
1987 Farming: seed starters, egg containers, poultry feeders and produce crates
1988 Miscellaneous: twines, cords, binders, clock facings, oil proof aprons
1989 Special: absorbent wadding, surgical gowns, fluorescent papers, gas and flameproof paper, washable paper cups
1996 Money: polymer bank notes begin to circulate in Australia
2004 Security: All States required to print birth certificates on security paper

Other products from paper making:

- Tall Oil: used to make soaps, paints, varnishes, printing inks and waterproofing agents
- Turpentine: paint thinner and solvent

[2] United States Department of Agriculture, *Industrial Hemp in the United States: Status and Market Potential,* AGES-001E (Washington, D.C.: Government Printing Office: 2000).

[3] Linda McGraw, "New Uses for Kenaf," Agricultural Research, August 2000, http://agresearchmag.ars.usda.gov/2000/aug/kenaf.

Why Recycle Paper?
If we recycled half of the paper used in the world today we would meet almost three-quarters of the demand for new paper and as a result might save ten million acres of forest. According to one estimate (which most likely does not assess the transportation and processing effects), a ton of paper made from 100% recycled paper saves 24 trees, 11,000 gallons of wastewater, 11 million BTUs of energy, 2,000 pounds fewer greenhouse gases released, three cubic yards of landfill space and disposal fees. [4]

How is Paper Recycled?
Recovered paper must be sorted prior to recycling to ensure the best quality end product and to eliminate inks and adhesives that can damage machinery. Care must also be taken to store it out of sunlight and away from water that can break down cellulose fibers and make the paper unusable.

At recycling centers, paper is baled for shipping and transported to one of over 300 paper mills in the United States. At the mill, bales of waste paper are dumped into a pulper, either alone or in blends with virgin pulp. The pulper is similar to an enormous kitchen blender that uses large rotors to mix the paper with warm water. The action breaks the cellulose fibers back down into slurry. Plastic, wax, non-water soluble glue, carbon and similar substances do not break down and may clog the rotors.

Once the rotor has thoroughly mixed the paper-water solution, a sieve catches contaminants such as paper clips and staples. The mixture then travels on through centrifugal cleaning tanks and is bleached and de-inked. Chemical de-inking can contribute to increased water pollution problems, as can loss of short paper fibers through the screens. Once cleaned, the slurry is deposited on screens, sent through rollers and formed into the finished sheets of recycled paper in much the same way the original paper was made.

What is Recycled Paper Used for?
Recovered paper is usually recycled into a lower grade product than the original, as wood fibers breakup and deteriorate with each use. Hence, unlike aluminum and glass, the quality of the fiber of a given quantity of wood fiber eventually weakens to the point that it does not have the strength required to make paper. The following products are often made from recycled fibers: writing and printing paper and newsprint, roofing felt, insulation board, fiberboard, other construction materials, fruit trays, flower pots, egg cartons and other products molded from paper pulp, Kraft paper, tissue, corrugated cardboard and cardboard boxes.

Waste newspaper can be shredded and re-used as animal bedding or packing material. Or it can be shredded, fluffed and treated with fire-resistant chemicals for use as building insulation.

Is Recycled Paper as Good as Paper from Virgin Fibers?
Some people think the quality of recycled paper is not as high as paper made from virgin materials. Printers cite problems with lint from short broken fibers causing a poor quality print and a high moisture content causing paper-feeding problems. However, Earth Care Paper Company argues that recycled paper is superior to paper made from virgin fibers. They point out that the recycled fibers are more conditioned, the paper has greater flexibility, stands up better to humidity and temperature changes, has greater opacity, holds clay better and is easier to feed on printing presses than non recycled papers.

A Recycling Outlook
Recycled paper became more acceptable in the 1990s. In fact, federal legislation has helped to encourage use of recycled and recycled unbleached paper. Executive order 12873, signed by President Clinton in October 1993, was the first Buy Recycle executive order, which required federal agencies to purchase copier paper containing at least 20% post-consumer paper by the end of 1994, increasing to 30% post-consumer paper by the end of 1998. [5]

In 1984, Americans recycled only 25% of their paper. In 2012, the recycling rate for paper and paper products reached almost 70%, and corrugated boxes reached 90% in 2014. According to the American Forest and Paper Association, even though paper consumption has increased, significantly less paper is going to landfills - 11 million fewer tons in 1993 than in 1987. Recent statistics from the Environmental Protection Agency (EPA) also support the

[4] Susan Kinsella, "Paperwork: Comparing Recycled to Virgin Paper," (working paper, Conservatree and Environmental Paper Network's RePaper Project, April 2012), http://conservatree.org/learn/WhitePaper%20Why%20Recycled.pdf .

[5] Executive Order No. 12,873, 58 FR 5911 (January 22, 1993).

notion that less paper is being discarded. In 2014, the disposal amount of paper and paper products decreased to 19 million tons. In 2001, 45.130 million tons of paper were discarded, just over ten years later in 2012, 24.26 million tons were discarded. In addition, American Forest and Paper claims that US paper recovery saved more than 90 million cubic yards of landfill space. [6]

However, it is difficult to judge the success of these gains. Statistics from paper manufacturers and industry trade associations do not always match the figures that EPA uses. Paper recycling continues to be an uphill battle. The forest industry is heavily subsidized through government tax policies and the leasing to logging companies of public land below cost. Further, freight taxes are lower for virgin materials than for recycled fiber. These artificial structures hide the real economic and environmental costs of using virgin material.

In 1997, of the 500 paper mills in the United States, over 200 use recycled fibers exclusively and another 80% of these use some recycled fibers. Additionally, the United States has been exporting an increasing amount of scrap paper. According to Mills Online, a project of the Center of Paper Business and Industry Studies there are currently only 345 mills in operation in the United States. According to the American Forest and Paper Association, in 2011, 76% of paper mills used recycled fibers and 113 mills used only recycled fibers. [7]

National Center for Appropriate Technology. Sophie Diven, illustrator.

[6] "Fun Facts," American Forest and Paper Association, accessed May 24, 2016. http://www.afandpa.org/fun-facts.

[7] Ibid.

COMPONENTS OF THE WASTE STREAM, *GLASS*

History of Glass

Who knows what inspired humans to first make glass? Perhaps they observed that lightning strikes on a beach melted the sand, making the first crude glass. According to some sources, glassmaking began about 3,500 B.C.E. We do know that three to four thousand years ago, Egyptians and Mesopotamians used opaque glass as a glazing for pots and that they made beads and small bottles.

The technique of glassblowing was developed in Syria several hundred years later, producing the first transparent glass. The art of glassmaking spread to the Roman Empire and then throughout Europe in the following centuries, becoming a widespread and highly crafted art form. The first known established glass house in America was founded in 1739 in New Jersey. Early glass factories in America mostly produced simple useful glass objects such as window panes and bottles. The production of glass was not automated until the mid-nineteenth century.

From What Raw Materials is Glass Made?

The production of one ton of glass requires 1,330 pounds of silica sand, 433 pounds of soda ash, 433 pounds of limestone, 151 pounds of feldspar and the energy equivalent to 126 gallons of gasoline. Major deposits of white sand suitable for making glass are found in Illinois, New Jersey, the Alleghenies and the Mississippi valley. Most soda ash comes from Wyoming and 65% of the US feldspar comes from California and North Carolina.

Soda ash (sodium carbonate) and cullet (broken scrap glass) are added to lower the melting point of silica and to create a good consistency. Limestone (calcium carbonate) is added to stabilize the mixture and keep it from dissolving in water. Limestone also makes the glass stronger. Different colored glass is produced by adding small amounts of other substances such as iron, copper and cobalt. Green glass, for instance, is made by adding iron. These additives change the melting point of glass, which is one of the reasons glass is separated by color when collected for recycling.

How are Glass Containers Made?

The entire mixture of ingredients used to make glass is called a batch. The batch is heated at temperatures reaching 2800 degrees Fahrenheit until the ingredients are completely melted and the mixture transparent. The batch is then cooled to about 1800 degrees Fahrenheit and the molten glass moved out of the furnace into a glass-forming machine which presses or blows it into its final shape.

In the glass-forming machine, compressed air pushes a gob of molten glass down into a mold. More compressed air is forced into the middle of the mold pushing the glass out against its walls. The container is then transferred to another mold where one last blast of compressed air forms the rough container into its final shape. The containers then pass through a tunnel called an annealing lehr. If glass containers cool too quickly, they may shatter; annealing prevents breakage by passing the newly-formed containers through a tunnel which reheats the glass and allows it to cool slowly.

How Much Glass Do We Produce?

A third or more of the 90 glass bottle manufacturing plants operating in the United States in the mid-1980s (making over 29 billion bottles a year) closed over the following ten years. The Glass Packaging Institute (GPI), reports that as of 2012, there are only 46 glass manufacturing plants currently operating in the United States. Many manufacturers have shifted from glass bottled to other types of containers, particularly plastic because it is lightweight and won't shatter. It should be noted, however, that over the past 30 years the weight of glass bottles has reduced 40% as a means to compete with lighter weight plastics.

In 2012, Americans used and discarded 11.57 million tons of glass, of which only 3.8 million tons were recovered. Glass production for beverage containers is decreasing as plastics become more popular. Another change is that refillable glass beer and soda bottles that were once designed to handle up to 30 round trips from manufacturer to consumer have become throwaway containers. This means that all the energy and raw materials used to produce the glass bottle are wasted, unless recycled.

We can conserve resources by reusing glass at home and industries could save energy by cleaning and refilling bottles, although this would be partially offset by the energy required for transporting returned bottles. The next best thing after reusing glass is recycling. In 1981, only one in fifteen of the 46 billion bottles and jars produced was melted down along with fresh material to make new bottles and jars. Thanks to bottle bill legislation, Americans now recycle one in four glass containers.

Bottle bill states charge a deposit fee for soda and beer containers. This deposit is returned if the consumer brings empty containers to a redemption centers or beverage store. In Vermont it is estimated that almost nine out of every ten glass bottles covered by the bottle bill is returned and reused or recycled. Other bottle bill states include CA, CT, DE, IA, MA, MI, ME, NY and OR. In Bottle Bill states the recovery rate for glass beverage containers is 63%. In non-Bottle Bill states, the recovery rate is 24%. [8]

Why Recycle Glass?

Although the raw materials from which glass is made are plentiful, their collection and transformation into glass require a large amount of energy. It takes about 7,600 BTUs of energy (equal to 1/17 of a gallon of gasoline) to produce just one pound of glass. Also created in the production of just one ton of glass are about 385 pounds of mining waste and 28 pounds of air pollutants.

Using cullet saves energy because it melts at lower temperatures than virgin mix. For each 10% portion of cullet used, the furnace temperature can be lowered ten degrees. Some manufacturers have been successful with up to 83% cullet in the batch mix.

Using one ton of recycled glass will save 1.2 tons of raw materials. Using recycled glass in manufacturing new glass results in 79% less mining waste and reduces energy consumption by 28% - 32% (equivalent to nine gallons of fuel oil). Water consumption can be cut in half, water pollution reduced by 50% and air emissions reduced by 20%. [9]

How is Glass Recycled?

To prepare glass for recycling, containers should be rinsed clean of any organic waste, aluminum and plastic caps and lead wrapping removed and the glass separated by color. Window glass, ceramics, Pyrex, light bulbs, mirrors and other non-container glass should never be included because the different chemical compositions will cause visual inconsistencies and structural imperfections in new glass.

Glass can be recycled over and over again. Once collected, glass is broken into very small pieces called cullet. Clear glass is the most valuable. The cullet is sorted to remove remaining contaminants such as metal and plastic caps, lids and rings. Organic waste, ceramics, dirt and rocks must be removed because they can cause flaws and impurities in the new glass. It is important for recyclers to collect only clean glass, because one damaged batch could eliminate a market.

Once collected and shipped to manufacturing plants, any remaining contaminants must be removed. Cleaned cullet is added to a batch of raw materials and melted in furnaces. Any remaining paper labels are burned off at this point. Once heated, the molten glass is poured into molds to form new bottles and jars.

Other Uses for Recycled Glass

In addition to new beverage containers, cullet can be used to make fiberglass insulation, concrete, polymer composite sewer pipe, decorative applications such as costume jewelry, picture frames, as well as ceramic, brick and terrazzo tiles. It is used as an aggregate substitute added to concrete or pavement. This material, called glasphalt, is used in paving roads, parking lots, as a drainage medium and as backfill for landscaping. Both container and non-container glass can be melted down into melted glass pellets or beads and used in reflective paints on highways.

Glass can be ground into a powder and used for lubricants, as additives and fluxes in foundry work and fabrication (to help metals fuse together, as in soldering) and as binders in ceramics industry. Recycled glass is also used as a frictionator - the surface for lighting matches or firing ammunition. [10]

[10] Ibid.

COMPONENTS OF THE WASTE STREAM, ***METALS***

What is Aluminum?

Aluminum is a silvery white metal that constitutes 8% of the earth's crust. It is the third most common element after oxygen and silicon. It is widely dispersed through most clays and rocks, most commonly as hydrated aluminum oxide. It is never found naturally in its metallic state.

There are several characteristics that make aluminum a valuable resource. It is light, strong and while flexible, can be made more rigid by alloying it with small amounts of other metals. Because of its affinity for oxygen, it resists corrosion by forming a protective coating of aluminum oxide when exposed to the air. Aluminum is a good conductor and insulator.

From What Raw Natural Resources is Aluminum Made?

The greatest concentrations of aluminum are found in bauxite ore, where it is found as alumina in combination with oxide, titania and silica. Most of the world's bauxite reserves are located in the subtropics where heat and water weather away silica and other contaminants, leaving a higher percentage of aluminum.

Substantial bauxite deposits are located in Guinea, Australia, Vietnam, Jamaica and Brazil. The limited US reserves are located in Arkansas, Georgia and Alabama. The United States imports nearly all of its bauxite.

How is it Made into Metallic Form?

Surface mining of bauxite produces solid waste, waterborne waste, air pollution and hazardous waste. It also takes energy to run the mining equipment and transport the raw material to the smelter factories. Once taken out of the ground, it is transported to refineries around the world. It must then be refined into alumina. In 2014, the United States produced 1,720 thousand tons, about 3.4% of the world's total production.

The oxygen in the alumina is separated out through electrolysis. Then the alumina is combined with small amounts of other metals to strengthen it. The metal is then poured into bars called billets or blocks called ingots. It is then transferred to manufacturing plants that re-melt and form the aluminum into various items.

The following resources are used to produce one ton of aluminum: 8,766 pounds of bauxite, 1,020 pounds of petroleum coke, 966 pounds of soda ash, 327 pounds of pitch, 238 pounds of lime and 197 million BTUs of energy (equal to burning 1,976 gallons of gasoline. The pollutants created include: 3,290 pounds of red mud, 2,900 pounds of carbon dioxide, 81 pounds of air pollutants, 789 pounds of solid waste.

What Do We Use it for?

Aluminum is used in packaging, construction, automobiles and aircraft. Other applications include electrical transmission and appliances and other durable consumer products.

Why Recycle Aluminum? [11]

Recycling aluminum saves 95% of the energy required to produce it from virgin materials. Using recycled aluminum instead of bauxite, the aluminum industry makes 20 more cans with the same amount of energy. Currently, recycling one ton of aluminum saves approximately 21 barrels of oil. Since 1995, the energy required to produce aluminium has decreased by 25%. Recycling aluminium also means that 95% of the air pollution is eliminated and 100% of the solid waste is diverted from disposal.

The amount of aluminum used in cars made in the United States increased from 78 pounds per car in 1972 to 139 pounds in 1985, then to 327 pounds in 2009. This number is set to reach 550 pounds by 2025. From 80 to 90% of the truck trailers in use have aluminum bodies. Aluminum is the primary aircraft material, making up about 80% of the structural weight of today's jetliners.

The metal industry has been very successful with lightweighting products made of aluminum. Lightweighting is the process of using less material in a product, sometimes replacing a heavier metal with a lighter metal. In cars, trucks and airplanes, steel has been replaced with aluminum. The amount of aluminum in cars has risen from 0.6% to 5% to 10% to 16%. Aluminum cans have almost half the aluminum they did 25 years ago: a 47% decrease in material. In the early 1970s, it took a pound of aluminum to make 22 cans. In the 1990s a pound of aluminum makes 32 cans.[11] Currently, a pound of aluminum may yield approximately 34 cans.

How is Aluminum Recycled? [12]

According to The Aluminum Company of America, ALCOA, the turn around time for an aluminum can is only 60 days: from manufacturing the can, to filling it, delivering it to the store, being purchased, emptied, recycled by the consumer, shipped to a processing plant, made into can sheet, made into an aluminum can, shipped to the filler, filled and shipped to the store.

Aluminum cans are 100% recyclable. Scrap dealers who receive aluminum from recycling centers sell recycled aluminum to smelters. The smelters must chemically analyze the aluminum they purchase and shred and decontaminate it. Steel is removed from shredded aluminum as it passes over magnetized conveyor belts. Contamination of more than 1% non-aluminum metals makes the aluminum unusable in a smelter.

Once shredded and decontaminated, the aluminum scrap is melted for 18 hours during which time, impurities are removed periodically. The molten metal is then poured into forms and allowed to cool. The resulting ingots are transported to manufacturing plants, re-melted and formed into new products.

A Recycling Outlook

Throughout the 1950s and 1960s, about 75 to 80% of all recycled aluminum was new scrap, or industrial scrap, removed from fabrication plants. However, growing attention to environmental protection and energy conservation in the 1970s coupled with the enormous growth of aluminum beverage can recycling, made aluminum scrap an increasingly large proportion of the total aluminum supply. In 1984, about 30% of the total aluminum supply in the United States was scrap aluminum, approximately two million net tons, 54% of which was recovered by aluminum manufacturers during fabrication and 46% came from recyclers. Current international figures from World-Aluminium.org put the total amount of aluminium produced at 56 million tons, 18 million tons of which is derived from recycled scrap.

OTHER METALS

What are Iron and Steel? [13]

Iron is a naturally occurring pure chemical element. Steel is produced by adding carbon to iron. Other elements are added to this basic recipe to form different grades of steel. Steel is the most widely used metal today. After iron, the most widely used and recycled metals are aluminum, copper, zinc and lead. According to World Watch Paper 23, "after five cycles, only one quarter of the metal remains in circulation. After ten cycles, less than one one-thousandth of one percent remains."

What are Tin Cans? [14]

What we call "tin" cans are really steel cans with a very thin coating of tin. The tin protects the steel from corroding or rusting. Bi-metal cans are tin cans with an aluminum top and they used to be common throughout the country. Bi-metal cans were less expensive to make than aluminum cans, but were not easily recyclable because they are made from two metals that needed to be separated for recycling. Few products now are packaged in bi-metal cans. One way to tell the difference between tin (steel) cans and aluminum is with a magnet. Magnets will attract steel but not aluminum. Tin and bi-metal cans both attract magnets.

[11] "Recycling," The Aluminum Association, accessed May 25, 2016, http://www.aluminum.org/industries/production/recycling .

[12] Ibid.

[13] "Goal: Steel, Our Most Sustainable Material," American Iron and Steel Institute, accessed May 25, 2016, http://www.steel.org/sustainability.aspx .

[14] Ibid.

Why Recycle Scrap Metal? [15]

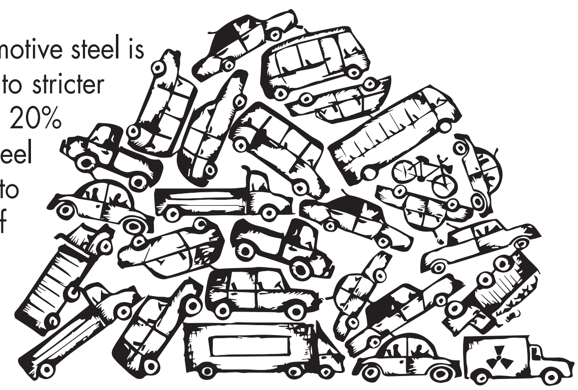
In the last 20 years the production of steel from scrap has increased significantly while raw steel production has declined. Steel is now the world's and the United States' most recycled material. In 1990, 24.6% of steel cans were recycled. That figure rose to 58.2% in 1996 and to 70.8% in 2012. The total recycling rate for steel in the United States was 65.2% in the 1990s and is currently 69% according to the American Iron and Steel Institute.

Two kinds of technologies are available for recycling steel. The first, called Basic Oxygen Furnace (BOP), uses 25-30% of old steel to make new steel and creates products - such as automotive fenders, refrigerator casements and packaging, such as soup cans, five-gallon pails and 55-gallon drums.

The Electric Arc Furnace, or EAF, process uses 100% recovered steel to make new steel and produces structural beams, steel plates and reinforcement bars, whose major characteristic is strength. An increasing amount of scrap steel is being sent out of the country to minimills using EAFs. They bypass the initial stages of mining and processing ore and proceed directly to the fabrication of new products.

By doing this they are able to save significant amounts of energy and expense. Mining iron ore and producing steel is hard on the environment and energy-intensive, however, it should be noted that the amount of energy required to produce one ton of steel has dropped 34% since 1972. Using scrap instead of iron ore to make new steel reduces air pollution by 86% and water pollution by 76%, saves 74% of the energy and 40% of the water required to make virgin steel and can reduce the need for virgin materials by 90%. In 1996, for example, enough energy was saved to power 18 million households. The Steel Recycling Institute currently puts this figure to 20 million households.

Automotive and Appliance Recycling [16]



According to the American Iron and Steel Institute, 96.5% of all automotive steel is recycled. Appliance recycling increased threefold in the 1990s due to stricter legislation. The Steel Recycling Institute reports that in 1988, only 20% of steel appliances were recycled. In 1996, the recycling rate for steel appliances had risen to 76.4%. In the early 2000s this rate rose to about 90% but has dropped back to 82% since 2013. About 75% of an appliance is made of recyclable steel: mechanical and electrical appliances encased in steel shells, or various operating parts made of steel or iron. Washing machines, dryers, dishwashers, ranges, air conditioners, refrigerators, freezers and water heaters can all be recycled.

The following states have either landfill bans, incinerator/generator bans regarding appliances, or have mandatory recycling laws for appliances: CA, CT, FL, IN, LA, ME, MA, MO, MN, NE, NJ, NY, NC, ND, PA, RI, SC, SD, VT, WI. In Mississippi local landfills will often pull appliances from landfills for recycling, despite that there is no mandatory recycling law.

Federal law requires that: (1) all refrigerant be recovered prior to dismantling or disposal (40 C.F.R. § 82 .150-.169); and (2) universal waste (e.g., mercury), used oil and PCBs be properly managed and stored (40 C.F.R. § 273, § 279, § 761). The majority of regulation regarding the disposal of appliances is left up to individual states.

A Recycling Outlook

Large magnets are used to remove ferrous contaminants from aluminum scrap and to isolate ferrous scrap from mixed materials at material recovery facilities. In 2012, 70.8% of steel cans were recycled compared to 54.6% of aluminium cans.

Steel/tin cans are collected at nearly all of the collection centers nationwide. Currently, all collected and processed tin cans are sent out-of-state to manufacturers who make any number of new steel products, including I-beams, sheet metal, specialty parts and new cans. [17]

[15] Ibid.

[16] "Disposing of Appliances Properly," United States Evironmental Protection Agency, accessed May 25, 2016 https://www.epa.gov/rad/disposing-appliances-responsibly.

[17] "Steel Markets," American and Iron Steel Institute, accessed May 25, 2016, http://www.steel.org/the-new-steel.aspx.

History of Rubber

Mayans extracted rubber from trees and used it to make waterproof shoes, clothing, bottles and balls. Rubber made its way to Europe via the Spanish Conquistadors, however it garnered little interest until the 1700s, when the French conducted many experiments on it to try to take advantage of its elastic and waterproof characteristics. The Mackintosh was an early attempt to waterproof coats by coating them in rubber. But a major stumbling block in the development of rubber was its intolerance for the weather extremes of Europe and North America.

In 1844, Charles Goodyear accidentally discovered a way to make rubber sturdy, long lasting and impervious to temperature extremes. He added sulfur to rubber and subjected it to heat, producing a chemical change. Goodyear named the process after Vulcan, the Roman god of fire. Because of that discovery, rubber is now used for over 50,000 different applications.

Where Does Rubber Come from?

Plantations in Thailand, Indonesia and Malaysia produce most of the natural rubber used today, about 72%. Rubber trees produce a milky liquid called latex that runs in veins beneath the outer bark. The latex contains pure rubber, water, minerals and sugars. Trees are tapped in a way similar to the way we tap trees to produce maple syrup. One rubber tree can produce enough latex in a year to make about 12 pounds of rubber. Rubber is composed primarily of tiny particles of carbon and hydrogen held together in long twisted strings. When pulled, these strings stretch out straight giving rubber its elastic quality.

Once the latex is collected, it is strained, poured into large tanks and mixed with acid to cause the rubber particles to mass together. The masses are cut into large slabs and sent through large rolling machines where the water is squeezed out. The rubber is then pressed into bales and shipped to factories.

How is Rubber Made?

At the factory, the blocks of rubber are cut into smaller pieces and squeezed flat between heated drums in a milling machine. Sulfur, other chemicals and pigments are added and the rubber, which is naturally light in color, darkens. The mixture is rolled out flat and fed through an extruder to achieve the desired shape. Talcum prevents it from sticking as it is further processed. It is fed into a Vulcanizer which heats and chemically changes it, making it sturdy, long-lasting and impervious to weather extremes. Finally, the talcum is cleaned off and the rubber cut to size.

Tires

Synthetic rubber and its chemical additives are manufactured in the United States from oil and natural gas. Automobile tires that constitute 60% of the US rubber market are made from a blend of natural and synthetic rubbers. They also contain a reinforcing fabric made from cloth, plastic and steel and a bead of wire around the rim. In 2003, the United States used and disposed of some 290 million tires.

Tires cause disposal problems because they resist compaction and take up a disproportionate amount of space in a landfill. Methane gas, given off by decaying wastes, can collect in the tire cavities, causing them to float to the surface. The Environmental Protection Agency now requires tires to be exposed and not landfilled.[18] This has resulted in stockpiles of tires that breed mosquitoes, spread disease, attract rodents and present fire hazards. Since used tires have no positive sale value, illegal dumping on private land has become more frequent. Many nation-wide companies such as Emterra Tire Recycling, Lankin Tire and Liberty Tire will pick up tires and see to it that they are disposed of or recycled properly.

[18] United States Environmental Protection Agency, Tires, Waste Reduction Model Version 13, March 2015, https://www3.epa.gov/warm/pdfs/Tires.pdf.

What Can We Do with Used Tires?

Rubber can be burned. Because of their high carbon and hydrogen content and BTU value tires are considered acceptable to burn. Tire derived fuel has proven to be a good market for scrap tires in the United States, Japan and Europe.[19] Environmentalists however, voice concern about toxic emissions produced by incinerating tires.

Emissions, in addition to particulate matter include volatile organic chemicals (VOCs) such as benzene, chloroform and heavy metals such as lead, mercury, chromium and zinc. Moreover, new chemical by-products called Products of Incomplete Combustion are created, including dioxins. The VOCs, heavy metals and dioxins are well known carcinogens.

Advocates argue that the high temperatures incinerators generate, combined with pollution control devices, render tire incineration reasonably safe. Tires have more heat value by weight than coal and burn comparatively cleaner.[20] According to one source, about 20% of the energy used to make a tire can be reclaimed through incineration, but the material properties of the rubber are lost. Recent studies have shown that the above assertions are misleading. When burned with coal, tire derived fuel emits substantially more dioxin than coal alone. The studies conducted by the EPA in the 1990s on power plants that utilized tire derived fuel did not record the true daily emissions of these plants, instead they record the emissions of a 'trial burn' during which the plant makes sure that high standards of efficiency and environmental protection are upheld. On a day-to-day basis, the true conditions of the plant may be much different. According to Genan, the largest scrap tire recycler in the world, burning one kilogram of tire will yield the same amount of energy as burning one kilogram of oil, however six kilograms of oil were used to make one kilogram of tire, meaning very little of the tire's energy is actually reclaimed through incineration.

Retreads

In the 1980s about 20% of the tires produced in the United States were retreaded, by the late 1990s this figure had dropped to 2.5%. While retreads may last up to 90% as long as new tires, the perception exists that retreads are lower quality. According to Dennis Hayes, a notable environmental activist, "If all tires were retreaded once, the demand for synthetic rubber would be cut by about one-third, tire disposal problems would be cut in half and substantial energy savings would be realized. Jobs would be lost in the synthetic rubber and new tire industries, but new jobs would be created in the tire recapping business." Many commercial trucking companies use retreaded tires, nationally, this saves over three billion dollars every year. Retreading also saves oil. It takes about 22 gallons of oil to produce one new tire, but only seven gallons are required for retreading.

Recycling Tires

Tires can be cut into pieces and used as washers, muffler hangers, handbags, shoe soles, boat dock cushions, or doormats. Whole tires are used to build artificial reefs, floating breakwaters and highway crash barriers. In rural areas they are often seen as weights holding down plastic coverings on feed bunkers and are used in combination with sand as a floor base in dairy barns.

Scrap tires can also be recycled into crumb rubber. In 2007, 300 million pounds of rubber tires were converted into crumb rubber. In one process, the rubber, steel and fiber are separated after being pulverized or frozen and shattered. Another procedure tears the materials apart at room temperature. Crumb rubber can be used as a substitute for virgin rubber in a variety of rubber-based products including bonding tape, irrigation pipes, carpet underlay, footwear, recreational surfaces, waterproofing compounds for roofs and walls, as well as joint and crack sealant.[21]

Crumb rubber can also be mixed with hot asphalt and used to pave roads, track and airport runway surfaces. Preliminary tests were made on Interstate 89 in the 1980s near Springfield, Richmond and Derby, Vermont. These initial trials suggested that the best roadway applications for the rubber asphalt are parking lots, driveways and running tracks, where heavy traffic is avoided, but other states use rubber in major roads with great success. Interest in rubberized asphalt, or crumb rubber-modified asphalt (CRM) has renewed in recent years. In 1995, 44% of the crumb rubber produced in the United States was incorporated scrap tire rubber into asphalt paving materials. Texas paved more than 2,500 miles of roadway and airstrips with rubber-modified asphalt. [22]

[19] Ibid.

[20] ibid.

[21] "Tire Crumb Questions and Answers," United States Environmental Protection Agency, accessed May 25, 2016, https://www.epa.gov/chemical-research/tire-crumb-questions-and-answers.

[22] Ibid.

Crumb rubber is well suited for running tracks, athletic fields and golf courses because of its durability and resiliency. Surfaces made of scrap tire chips are economical and are easy to maintain. Crumb rubber reduces the need for fertilizer, pesticides and water by 30%. It suppresses weed growth, does not decay and has roughly twice the cushioning effect of other materials. Crumb rubber also reduces soil compaction and lasts 25 to 50 years. [23]

Further, crumb rubber can replace wood chips in the composting of municipal sewage sludge and serves as a very effective mulch by conserving moisture, suppressing weed growth and reducing the need for pesticides, fertilizers and water. For example, TireCycle, a process of recycling rubber by adding it to virgin rubber, has operated in Minnesota and accepts tires for free. The plant produced about 1.25 million pounds of new rubber using less than 100,000 old tires. The plant could accommodate up to four million tires, but needs to further develop its markets for the new product.[24]

Research since 2006 indicates that using rubber for athletic and recreational environments may not be as clean as initially thought as many of the compounds found in crumb rubber have been linked to cancer. A 2015 study conducted by Yale University found that 12 known carcinogens as well as other toxic chemicals are present in crumb rubber. These chemicals include Fluoranthene, Heptadecane, mercaptobenzothiazole, Phenol, 4-(1,1,3,3-tetramethylbutyl), Phenanthrene, Phthalimide, Pyrene 1-methyl, Tetratriacontane,Pyrene, Mercaptobenzothiazole, Dimethylanthracene and Bis(2-ethylhexyl) phthalate. Water runoff from rain storms and snow that comes in contact with crumb rubber contains toxic levels of zinc and increased levels of copper, barium, manganese and aluminum. Companies within the crumb rubber industry insist that the amount of exposure to these compounds is not significant enough to contribute to any ill health effects. As of 2016 the debate is continuing on whether or not this material is safe to use.

[23] "The Many Uses of Crumb Rubber," Texas Office of Waste Management, accessed March

[24] Ibid.

COMPONENTS OF THE WASTE STREAM, *PLASTICS*

Plastics

The use of plastics has tripled in the last 20 years. Plastic packaging has replaced and superseded glass. Plastic has many advantages - it can be formed into products that are durable, lightweight, waterproof, convenient and relatively inexpensive to produce. Their chemical properties can be manipulated to achieve just the right combination of properties for any application.

How are Plastics Made?

The very first plastics were made from corn starch, but most plastics today are made from natural gas and crude oil. They are made by linking together small single chemical units called monomers in repetition to build one large molecule called a polymer. The plastic monomers are made from hydrogen and carbon elements in combination with small amounts of oxygen, nitrogen and other organic and inorganic compounds. When rearranged chemically, they produce a solid resin. The resins are used to make hundreds of different plastics, some of which are described below.

#1 - Polyethylene Terephthalate (PET or PETE)
PET is clear, tough and has good gas and moisture barrier properties. Some of this plastic is used in PET soft drink bottles and other blow molded containers, although sheet applications are increasing. Cleaned, recycled PET flakes and pellets are in great demand for spinning fiber for carpet yarns and producing fiberfill and geotextiles. Other applications include strapping, scouring pads, auto parts, paint brushes and geotextiles such as landfill liners, industrial paints, molding compounds and both food and non-food containers.[25]

#2 - High Density Polyethylene (HDPE)
HDPE refers to a plastic used to make bottles for milk, juice, water and laundry products. Unpigmented HDPE bottles are translucent and have good barrier properties and stiffness. They are well suited to packaging products with short shelf lives such as milk. Pigmented HDPE bottles generally have better stress crack and chemical resistance than bottles made with unpigmented HDPE. These properties are needed for packaging such items as household chemicals and detergents, which have a longer shelf life.

Injection-molded HDPE is resistant to warpage and distortion. It is used for products such as margarine tubs and yogurt containers. HDPE is commonly recycled into construction materials such as railroad ties, parking blocks, piping, beams and other construction materials. Other recycled products from HDPE include detergent and engine oil bottles, trash cans, recycling bins, drums and pails, flower pots, kitchen drain boards and hair combs.[26]

#3 - Polyvinyl Chloride (PVC)
Because of the physical nature of this versatile plastic, vinyl can be rigid or flexible, weather or heat resistant, impact resistant, thick or thin and any color of the rainbow. Here's just a few of the many products made from vinyl: electronics/appliances, construction materials, automotive components, fencing, handrails, house siding, tiles, sewer pipes, traffic cones, garden hoses, consumer goods, packaging and medical products.[27]

#4 - Low Density Polyethylene (LDPE)
LDPE is used predominantly in film applications due to its toughness, flexibility and relative transparency. LDPE has a low melting point, making it popular for use in applications where heat sealing is necessary. Typically, LDPE is used to manufacture flexible films such as those used for plastic retail bags and garment dry cleaning and grocery bags. LDPE is also used to manufacture some flexible lids and bottles and it is widely used in wire and cable applications for its stable electrical properties and processing characteristics.[28]

[25] "FAQ's,"Pet Resin Association,accessed May 25, 2016, http://www.petresin.org/faq.asp.

[26] Professor Plastic, "High Density Polyethylene (HDPE): So Popular" Plastics Make It Possible (blog), The American Chemistry Council, May 21, 2015,

https://www.plasticsmakeitpossible.com/about-plastics/types-of-plastics/professor-plastic-high-density-polyethylene-hdpe-so-popu lar/.

[27] "Definitions of Resins - Polyvinyl Chloride," The Plastics Industry Trade Association, accessed May 25, 2016, https://www.plasticsindustry.org/AboutPlastics/content.cfm?ItemNumber=1409&navItemNumber=1128.

[28] Professor Plastic, "Professor Plastic: Highlights of Low-Density Polyethylene," *Plastics Make it Possible* (blog), The American Chemistry Council, September 2, 2015,https://www.plasticsmakeitpossible.com/about-plastics/faqs/professor-plastic/professor-plastic-highlights-of-low-density-polyethyl ene/.

#5 - Polypropylene (PP)
Polypropylene has excellent chemical resistance, is strong and has the lowest density of the plastics used in packaging. It has a high melting point, making it ideal for hot-fill liquids. PP is found in auto parts, new automotive battery cases, bird feeders, furniture, pails, water meter boxes, bag dispensers, golf equipment, carpets, refuse and recycling containers, grocery cart bundles and industrial fibers.[29]

#6 - Polystyrene (PS)
Polystyrene is a very versatile plastic that can be rigid or foamed. General purpose polystyrene is clear, hard and brittle. It has a relatively low melting point. Typical applications include protective packaging, insulation board, office and desk accessories, household products, license plate frames, packing peanuts, waste baskets, videotape cassette containers, lids, cups, bottles, trays and tumblers.[30]

#7 - Other
Plastic #7 is the "catch-all/other" category. It includes those resins that do not fit into categories 1-6. Many of these plastics are multi-layered resins and common materials include plant-based and bio-based plastics made from corn, potato or sugar derivatives.[31]

Why is the Use of Plastics Increasing?

Plastics are made from a nonrenewable resource. Although some plastics are relatively inexpensive to manufacture, the crude oil and natural gas from which they are made comes from limited supplies, the increasingly complicated extraction of which often have serious, negative environmental and political impacts.

The same characteristics that make plastic an attractive packaging material also make it a special problem in the waste stream. Though lightweight, plastic is bulky and difficult to compact for shipping or for burial in landfills. Plastic will not biodegrade. Photodegradable plastics may break down into smaller pieces when exposed to enough sunlight, but will never really disappear.

Plastic litter causes particular problems in our oceans and on our beaches. Thousands of fish, sea mammals and birds have died because they have eaten or gotten tangled in discarded fishnets, six-pack rings, plastic bags and other packaging material. Virtually all our beaches and waterways are now polluted with unsightly plastic waste.

Approximately half of all foam packaging before 1990 was inflated with chlorofluorocarbons (CFCs). Both the manufacturing process and the packaging itself released CFCs into the atmosphere. Rigid foam products accounted for a quarter of the world's use of the two most ozone-threatening CFCs. By 1990 manufacturers in the United States were required to stop the use of CFCs. In the following two decades CFCs have declined in developing countries as well.

Because they are made from fossil fuels, plastics also have a high BTU value and so can be said to be a good burning fuel. However some plastics emit toxic fumes when burned. Polyvinyl chloride, for instance, when burned, releases chlorine compounds into the atmosphere, if not controlled. These contribute to depletion of the ozone layer, a global problem receiving increasing attention. Other plastic ingredients can clog the inner workings of incinerators.

What are Photodegradable and Biodegradable Plastics?

Photodegradable plastics are plastics which have some of their chemical bonding made with compounds that disintegrate with prolonged exposure to sunlight. These plastics are being used for beverage six-pack rings, shopping bags and in some commercial agricultural applications (drying trays for raisins). They do deteriorate into smaller pieces of plastic, but do not decompose.

[29] "Definitions of Resins - Polypropylene," The Plastics Industry Trade Association, accessed May 25, 2016, http://www.plasticsindustry.org/AboutPlastics/content.cfm?ItemNumber=1405.

[30] "Definitions of Resins Polystyrene," The Plastics Industry Trade Association, accessed May 25, 2016, http://www.plasticsindustry.org/AboutPlastics/content.cfm?ItemNumber=1406&navItemNumber=1128.

[31] Amanda Willis, "Recycling Mystery: Plastic #7,"(blog), Earth 911, November 30, 2009, http://earth911.com/home-garden/recycling-mystery-plastic-7/.

True biodegradable plastics, plastics that disintegrate into organic substances as the result of natural processes, are largely experimental and have not come into wide use because of their relative high cost. Research by large corporations has made little advance in the last decade. Many are continuing to experiment with bacteria and plants, but thus far, the ultimate biodegradable plastic bag has eluded them.

"Biodegradable plastics are made by fermentation of natural substances such as sugar and other carbohydrates. One firm has produced biodegradable plastic with the help of a vigorous strain of bacteria found in canals. The bacteria are cultivated in vats and fed a sugary diet on which they thrive. In doing so they multiply and produce biological 'plastic' rather like mammals who make fat in their bodies as they grow. The plastic is extracted in fermentation vessels and is then dried and sold as granules. This plastic is readily broken down by algae, fungi, or bacteria in the soil. A bag made from it will disappear within twelve to fifteen months or indeed within only three to four months if it is placed in a compost heap."[32]

The biodegradable label has been used for a number of plastics (particularly shopping bags) that use cornstarch or other organic substances as bonding agents in or in combination with crude-oil plastics. Like photodegradable plastics, these plastics do deteriorate as their organic matter decomposes, but they only degrade into smaller pieces of plastic. They do not degrade.

How are Plastics Recycled?

Plastics must first be sorted by resin type. They can then be baled or shredded for transportation to a remanufacturing plant. Thermoplastics are easily recycled by melting and reforming them into new shapes. Because plastic molecules migrate and can remain contaminated with food particles, most recycled plastic is not used in direct contact with food. It is more often used as a filler layer in food packaging as long as they don't come into direct contact with the food. The quality of recycled plastic depends on how well the scrap is separated prior to recycling. The less control over this process, the poorer the quality of the end product.

Why are Plastics Hard to Recycle?

Several challenges hinder plastic's recyclability. There are hundreds of different kinds of plastics. Each type has a different chemical composition and is carefully engineered for a specific purpose. Layers of different plastics can be used in just one container, each adding a special quality to the design. By sight, these chemical recipes are indistinguishable.

The success of plastics recycling depends in part on the proper identification and separation of plastics. Plastics are masters of impersonation - it is very difficult to distinguish between resin types solely by visual inspection. Companies are developing new plastics that may benefit consumers, but are not readily recyclable. Recyclable plastics can be identified by the coding number on the bottom of the container. (See above). Check with your local recycling center or solid waste district to find out what plastics they are collecting.

Transporting plastics for recycling is expensive because they are lightweight and bulky. While certain secondary plastics have maintained good market prices through the years, the cost of transporting a ton of plastic is much greater than any other recycled material.

What are Household Hazardous Products (HHP)?

Household hazardous products are those products that contain hazardous ingredients. They are a potential danger to humans, pets and the environment. Hazardous products generally fall into five categories: automotive, cleaning and polishing, paint and related solvents, pesticides and miscellaneous items (examples include batteries, fingernail polish remover, some cosmetics and shoe polish). These products are considered hazardous because they can be toxic, flammable, corrosive and/or cause violent chemical reactions.

Corrosive materials destroy metal surfaces and living tissues. They chemically change what they touch. Corrosive substances are acidic or caustic. Some examples of corrosive substances include oven cleaner (sodium hydroxide), bathroom cleaner (phosphoric acid) and pool chemicals (hydrochloric acid).

[32] John Seymour and Herbert Girardet, Blueprint for a Green Planet (Simon & Schuster, 1987).

Reactive materials are very unstable and react with the substances around them. They are explosive and can sometimes create toxic fumes. Examples of reactive materials found in the home or school include picric acid (formerly used in science lab), welding material (calcium carbide) and certain rodenticides (zinc phosphate).

Flammable materials will burst into flames if they come into contact with sparks or flames at certain temperatures. The temperature at which this happens is referred to as the flash point. Flammable liquids have a flashpoint of 140 degrees Fahrenheit. Examples of ignitable materials in the home include nail polish (acetone), paint remover (toluene, xylene) and hair spray (butane). Toxic materials cause immediate or long-term health problems. Exposure to toxic materials may result in injury, illness, or death. Examples of toxic materials found in the home are paint stripper (methylene chloride), pesticides (chlordane) and wood preservatives (pentachlorophenol).

How Much Do We Have in our Homes?

Approximately 20 pounds of household hazardous waste is generated per household each year in the United States. Although the actual amount may seem small, the cumulative amount poses a significant threat to the environment. This waste may enter waste disposal facilities that are not equipped to deal with it. The Environmental Protection Agency estimated in the mid-1980s that over one million tons of HHW were produced in the United States each year, or 21 pounds per person per year. 2012 EPA figures put per capita generation at four pounds, resulting in 530,000 tons nationwide per year.[33]

What are the Problems Associated with Household Hazardous Products (HHPs)?

Household hazardous products cause problems in their use and disposal. They pose health risks during use. If the unwanted portions of these products go down the drain, into the trash, or get burned, they may threaten the environment. The impact of low level, long-term exposure to many chemicals present in our homes and the environment is still unknown; however, children, elderly people and adults with asthma and allergies are known to be most susceptible. It is often difficult to know the true effects of a particular toxic substance because its effects may not appear immediately. A chronic, or long-term health effect usually results from repeated exposure to small amounts or low concentrations of a toxic substance over the years. In contrast, an acute reaction is a short-term effect and usually results from a single exposure to a high dose of a toxic substance. Some researchers warn that very brief exposures to some substances found in many household products may be all that is needed to cause irreversible harm to humans and the environment.

Although HHPs contribute to less than 1% of the municipal waste stream, they have great potential to pollute the environment through improper disposal in landfills, incineration, composting sewage sludge, pouring down drains which empty into waterways, by on-site disposal (e.g., pouring waste oil on the road) and illegal dumping. One of the most serious concerns is groundwater contamination. About 45% of the US population depend on groundwater as its primary drinking water source.

Disposal of HHP in a landfill threatens groundwater. Landfills are not isolated, they are connected to the environment. Rain, snow and other precipitation enter the landfill and mix with the landfill contents, including hazardous waste. This contaminated water (called leachate) trickles down through the layers of trash and can enter the environment if it does not encounter any kind of barrier. Some types of hazardous waste can destroy the synthetic liner, making it ineffective. Overtime, leachate could potentially enter the water cycle by moving through a leaking landfill and into surrounding groundwater. Landfill and leak-detection technology has improved recently, yet to minimize risk, we should strive to use less hazardous substances.

Although incinerators are equipped with pollution control devices, some pollutants found in hazardous waste are difficult to capture. In the 1990s the most efficient technology can only remove 75% to 85% of airborne mercury. Note: Mercury is found in some dry cell batteries, fluorescent light bulbs and old paint. However, due to more recent legislation, the amount of mercury being emitted by medical waste incinerators decreased 98% from 1990 to 2005

[33] "Household Hazardous Waste," United States Environmental Protection Agency, accessed May 25, 2016, https://www.epa.gov/hw/household-hazardous-waste-hhw

and municipal waste incinerators have reduced their emissions by 96% in the same time period. Airborne mercury is soluble in water and finds its way into lakes, streams and groundwater, where it can enter the food chain. Also the leftover ash from incinerator burning may contain concentrated amounts of some hazardous substances.

For some towns, spreading composted sewage sludge onto the land is an attractive alternative to the practice of landfilling. However, if hazardous wastes from industry and homes are not separated out, the end prod uct may be too contaminated to use. For example, two button cell batteries in two pounds of compost can make it unsuitable for general use due to the heavy metal content. If dumped directly on the ground, the first thing the hazardous waste will encounter is soil. The viscosity of the product and the type of soil will determine how quickly the solution moves. It may contaminate the surrounding soil or percolate down and potentially contaminate groundwater. Anything that is poured down the drain either enters a septic system, a wastewater treatment facility, or a waterway and ultimately enters the water cycle.

Should We Use Hazardous Products?

It is best to avoid or reduce the amount of hazardous products in the home. Several low-cost, non-toxic alternatives are available at your local market. Suggested alternatives and recipes for non-toxic cleaners are attached to this curriculum as a separate pamphlet. Many solid waste districts provide additional information. Remember: Reduce, Reuse, Recycle.

If potentially hazardous substances cannot be avoided, make sure to buy only the amount you will need and use. Read the entire label; follow the directions precisely; apply the substance properly (using appropriate safety precautions, including the right gloves and eye protection).

Clean up safely by following directions on the product container. Clearly label the storage container; use the original container or a non-breakable, preferably non-plastic, container (to avoid potential chemical reactions); secure in a tamper proof area (inaccessible to children and animals); and check regularly for any leaks. Also keep the products away from moisture, water and food and never mix one product with another in the same container (to avoid potential chemical reactions). Use leftovers for other similar projects. You can also give the leftovers to a friend, neighbor, community group or business that might need them.

One specific example of state legislation regarding batteries and consumer awareness is in 1990, the Vermont Legislature passed Act 282, the Vermont Household Hazardous Products Reduction Program, commonly called the Shelf Labeling Program. The act requires all stores to identify household hazardous products with shelf labels. Stores must also provide information to consumers regarding the toxicity of HHPs and alternatives to HHPs.

How Should We Dispose of HHP?

Do not dispose of unused products in the trash or down the drain! Bring unwanted HHP to a household hazardous waste collection day or store safely until a disposal option is available. Waste oil should be recycled. (See Waste Oil section below.) It should never be landfilled, nor disposed improperly. Antifreeze, pesticides, herbicides, acids, corrosives and their empty containers, as well as flammables, outdated medicines, paints, paint removers and wood preservers should be stored until there is a scheduled household hazardous waste collection day in your area.

In order to avoid storing hazardous chemicals in your home and being responsible for their ultimate disposal, it is best to use safe alternatives whenever possible. Every spill, leak and mishandling of hazardous materials poses a threat to our health, the environment and future generations. When there is no substitute, use a hazardous product sparingly, for the appropriate task and store the excess until you can dispose of it properly.[34]

[34] "Safer Choice," United States Enivronmental Protection Agency, accessed May 25, 2016, https://www.epa.gov/saferchoice.

HAZARDOUS MATERIALS, ***WASTE OIL***

What is Waste Oil?

Motor oil contains many hazardous substances. To begin with, the petrochemicals and additives in unused motor oil are highly toxic. As motor oil is used, it picks up heavy metal contamination from engine operations. Used oil contains significant levels of heavy metals: lead, arsenic, cadmium and chromium. Waste oil comes from cars, lawnmowers, chainsaws, generators and farm and construction equipment.

The majority of used motor oil disposal methods are environmentally unsound. Direct dumping or sending it to a landfill threatens groundwater quality and is illegal. Burning used motor oil may result in high levels of hazardous emissions into the atmosphere. There are stringent air pollution control requirements governing waste oil burning.

The amount of improperly disposed oil annually in the United States is 17 times the amount of the Exxon Valdez oil spill. If allowed to enter the water used for drinking, the amount of used oil from a single oil change (four quarts) can contaminate a million gallons of water - one year's supply for 37 people. You can taste less than 300 parts per million of oil in fish and smell and taste only five parts per million in water. Just one pint of motor oil can create a slick an acre in size on surface water and will kill floating aquatic organisms such as diatoms and other algae on contact. The whole food chain depends on these organisms. The oil will also encourage the growth of organisms that deplete the dissolved oxygen supply available to fish and other aquatic life. Human health is threatened by waste oil if we drink water contaminated with it, if we eat fish or animals who have ingested it, or if our skin is exposed directly to it for long periods of time.

How is Used Oil Recycled and Reused?

Waste oil can either be reprocessed or re-refined. Both methods remove contamination. Re-refining produces a cleaner product (lubricating oil) and reprocessing produces a lower grade fuel oil. Most used motor oil collected in the United States is reprocessed due to economic constraints. Used oil is also reprocessed for, use as a fuel supplement or to manufacture other petroleum-based products. If used as a fuel, waste oil needs to be properly cleaned to remove the toxins that would pollute the air if left in the oil and burned.

- 200 million gallons of oil are discarded every year. Just two gallons of oil can produce enough energy to power the average home for about 24 hours.
- One gallon of used oil can make two and one-half quarts of lubricating oil, while it takes 42 gallons of crude oil to produce the same amount of lubricating oil.[35]

The re-refining industry was once very healthy, but in the 1950s the Federal Trade Commission began requiring a previously used label on processed used oil. This resulted in a misconception that re-refined oil was inferior to virgin oil and the industry suffered severe market losses. According to CalRecycle, less than 60% of oil consumed in the United States is recycled. Gas stations often burn waste oil in specially designed furnaces or give it away to sugaring operations and for the lubrication of farm equipment. Most of the solid waste districts collect used oil for recycling.[36]

[35] "Managing, Reusing and Recycling Used Oil," Environmental Protection Agency, accessed May 25, 2016 https://www.epa.gov/recycle/managing-reusing-and-recycling-used-oil.

[36] "Used Oil Recycling Program," CalRecycle, accessed May 25, 2016, http://www.calrecycle.ca.gov/usedoil/certcenters/.

HAZARDOUS WASTE, *BATTERIES*

What are Batteries?

Batteries convert chemical energy into electrical energy. The basic battery cell consists of three parts: an anode (negative electrode); a cathode (positive electrode); and an electrolyte or medium through which the electrical current passes. Batteries store electricity in the form of potential chemical bonds between two active ingredients (anode and cathode). Hundreds of electrochemical pairs create this reaction, but few are cost effective. As electricity is drawn from the battery, the chemical composition is changed and discharging takes place. Batteries consist of two main types: primary and secondary. Once primary batteries are discharged, they need to be disposed. Secondary batteries are rechargeable.

The average American discards eight dry cell batteries annually in toys, flashlights, hearing aids, tape recorders, radios, cameras, calculators and other common household items. In addition to smaller amounts of copper, zinc, manganese, nickel and lithium, batteries use 25% of the cadmium, 45% of the mercury and 66% of the lead produced in this country. After the passing of the Mercury-Containing and Rechargeable Battery Management Act, in 1996, many battery manufacturers have phased out mercury from their batteries. In the early 1980s the amount of mercury used in batteries totaled over 1,000 tons, in 1996 this was reduced to one ton. The EPA calculates that Americans discard over three billion batteries each year, resulting in over 125,000 tons of waste. Dry cell batteries use material for the electrolyte that is in a paste form (e.g., in household batteries). Wet cells use liquid electrolytes (e.g., in lead-acid car batteries).

Why are Batteries a Problem?

Many batteries contain hazardous materials and may become hazardous waste if disposed improperly. If landfilled or composted, batteries can break apart, leaching heavy metals into the ground and surface water. If incinerated, metals are either released as particulates into the atmosphere or trapped in the incinerator ash and landfilled, where they contaminate water sources and threaten our health.

Battery Legislation

In the early 1990s several states passed legislation regarding battery recycling and disposal. In addition, the legislation required manufacturers to assume responsibility for setting up a consumer friendly recycling system for these batteries (referred to as take back) and to ensure that rechargeable batteries were easily removable from battery pack. Manufacturers were also obligated to provide consumer education and information. Vermont legislation also banned the sale of batteries containing added mercury.[37] Twelve other states adopted similar legislation requiring labeling and easily removable rechargeables, but only eight required take back programs. These states (including CT, RI, ME, MA, NH, NJ, NY, MN, CA, IL) led the groundswell that initiated Federal legislation.[38]

In 1995, the United States Environmental Protection Agency issued the Universal Waste Rule, which applied to batteries as well as other hazardous wastes. The rule was designed "to reduce the amount of hazardous waste items in the municipal solid waste (MSW) stream, encourage recycling and proper disposal of certain common hazardous wastes and reduce the regulatory burden on businesses that generate these wastes."[39] In response to this ruling, the rechargeable battery industry formed a nonprofit that eventually resulted in the Rechargeable Battery Recycling Corporation (RBRC), now known as Call2Recycle, which promoted Nickel-Cadmium battery recycling nationwide.[40]

Federal Law supporting these measures soon followed. In 1996, Congress passed Public Law 104-142, "to phase out the use of mercury in batteries and provide for the efficient and cost-effective collection and recycling or cost-effective disposal of used nickel cadmium batteries, small sealed lead acid batteries and for other purposes."[41] The maximum

[37] "Recharding Battery Product Stewardship - The Case for Legislation," Call2Recycle, accessed May 25, 2016, http://www.call2recycle.org/recharging-battery-product-stewardship-the-case-for-legislation/.

[38] "Battery Legislation Across the United States," Call2Recycle, accessed May 25, 2016, http://www.call2recycle.org/battery-legislation-across-the-united-states/.

[39] Universal Waste Rule, 60 FR 25492 (May 11, 1995).

[40] "Who is Call2Recycle?" Call2Recycle, accessed May 25, 2016, http://www.call2recycle.org/who-is-call2recycle/.

[41] Mercury-Containing and Rechargeable Battery Management Act, 42 U.S.C. ch. 137 §§ 14301-14307 (1996).

amount of mercury allowed in alkaline magnesium button cells is 25 milligrams. Many states have passed further legislation applying this maximum amount to other types of button cells. In 2000, studies on batteries showed that the mercury content in batteries decreased 90% since the passing of the 1996 legislation four years prior.

How Should We Dispose of Batteries?

Disposal depends on the type of battery. The best solution is source reduction - to buy rechargeable batteries or use fewer products requiring batteries. Some products are now available with solar cells. Nickel-cadmium batteries (Ni-Cads) are a common household battery that can get up to 1,000 charges if used properly. Ni-Cads are banned from landfills and are easily recyclable through Call2Recycle. Most retail outlets that sell rechargeable battery products participate in this program.[42] To find out more, call Call2Recycle at 877-2-RECYCLE or visit http://www.call2recycle.org/. Unsealed lead-acid batteries (most often found in cars and solar homes) have a 98% recycling rate, because most retailers collect them for recycling. It is illegal in most states to dispose of Ni-Cads, lead-acid and mercuric-acid batteries in mixed-solid waste. Mercuric-acid batteries should be taken to a hazardous waste depot.

Because manufacturers have successfully reduced or eliminated the mercury in them, landfilling of alkaline and button-cell batteries is acceptable in some states. Button-cell batteries should NEVER be incinerated since they may contain some mercury. Lithium batteries, a relatively new battery technology (found in electronics, pagers, cameras and hearing aids) can be landfilled. While lithium is a volatile substance, the battery discharge process transforms it into an inert salt.[43] A problem remains with sealed lead-acids, such as the kind used in rechargeable flashlights and laptop computers. These are not recyclable and tend to be landfilled. They should be brought to a local hazardous waste depot for collection. For public and environmental health, many battery recycling programs accept all non-alkaline batteries It's best to contact your local or state solid waste department to verify the battery disposal regulations.

How Can Batteries Be Recycled?

There are safer alternatives to adding batteries to the residential waste stream. Although technologies and markets are limited, some batteries can be recycled. Currently, the most easily recycled are the button cell batteries used in hearing aids and cameras. Other batteries that cannot be recycled should still be separated out of the trash and saved for household hazardous waste collection days.

Mercury is recovered from some batteries by baking them until the compounds break down, the mercury is released as a vapor, trapped and then converted back into a liquid. Another method breaks down silver and mercury batteries through heating, dissolves them in acids, precipitates out the silver and removes the mercury through electrolysis. Other technologies for recovering cadmium and alkaline from batteries have been developed in Europe and Japan but are not available in this country. Car batteries are readily recyclable because they are easily identifiable and have a high lead content. Most automotive stores have a collection system in place for old car batteries. In addition, some stores participate by displaying recycling collection buckets. Laidlaw, a hazardous waste firm from Massachusetts, collected the batteries and separated them for proper disposal.[44]

42"Find Recycling Locations," Call2Recycle, accessed May 25, 2016, http://www.call2recycle.org/locator/.

43 "Mercury in Batteries," United States Environment Protection Agency, accessed May 25, 2106, https://www.epa.gov/mercury/mercury-batteries.

44 "How Do I Recycle: Common Recyclables," United States Environmental Protection Agency, accessed May 25, 2016, https://www.epa.gov/recycle/how-do-i-recycle-common-recyclables#bat.

PACKAGING

What Purpose Does Packaging Serve?

Packaging protects its contents from physical damage and spoilage and may also be used to ensure that contents are sanitary. By reducing spoilage and damage, it reduces the volume of solid waste. Over two-thirds of packaging is used to protect food and drink. In 2012 food waste accounted for 14.5% of total MSW in the United States. Labels on packaging identify contents and provide directions for use. Packaging may help retailers advertise their goods, keep sales records straight and discourage theft. It also makes possible national marketing and distribution of goods. It provides consumer convenience and may reduce waste of its contents by dividing food and beverages into individualized portions.

In What Ways is Packaging a Problem?

Packaging substantially contributes to the volume of solid waste, comprising approximately 23% of the materials reaching landfills.[45] The development of new plastics and combinations of plastics make it increasingly difficult to recycle them.[46] In addition, packaging depletes limited resources, adds to litter and pollution and increases the cost of a product - it accounts for 35% of the price paid for food.[47] Almost all packaging is meant to be disposed of after one use. Plastic accounted for 13.8% of packaging thrown away in 2012; plastic is non-biodegradable and can release toxic materials if incinerated.[48]

What is Excessive Packaging?

Excessive packaging is often in the eye of the beholder. Generally packaging that is related purely to retailer and consumer convenience and marketing, or that is not related to protecting contents from damage or spoilage, may be considered excessive.

What is Harmful Packaging?

Harmful packaging is packaging that through its manufacture or use hurts the health of humans, animals, plants, or the environment. Such packaging rarely remains in use (at least in the United States) once a scientific consensus develops that it is harmful and government action is taken. However, it often takes decades for such a consensus to form; it took at least two decades for consensus to be achieved on the harmful effects chlorofluorocarbons (CFCs) used in polystyrene. Plastics production uses over 25 toxic chemicals, including propylene, phenol, ethylene, polystyrene and benzene.

How Can Excessive or Harmful Packaging Be Reduced?

Use waste reduction measures and consumer pressure to demand less packaging. Choose products with minimum packaging. Reuse plastic bags for produce and bulk items. Avoid single use items and buy in bulk. Many supermarkets have bulk bins. Use and reuse the bags they provide. Use refillables such as pens, pencils, thermos, water bottles. Bring your own cloth bag to the market. Avoid packaging with two or three different materials, such as juice containers made of paper laminated with plastic and foil. Wash and reuse plastic containers whenever possible. In efforts to reduce the amount of plastic shopping bags, municipalities in AK, CA, CO, CT, FL, HI, IA, ME, MD, MA, NM, NY, NC, OR, RI, TX, WA and the District of Columbia have passed legislation either banning plastic bags or charging a fee for bags, paper and plastic, at retailers within these municipalities.

[45] United States Environmental Protection Agency, Reducing Wasted Food & Packaging: A Guide for Food Services and Restaurants, EPA-909-K-14-002 (Washington, D.C. Governmental Printing Office: 2012).

[46] "Why Can't I Recycle All Types of Plastic?" Because You Asked (blog), Recylebank, February 4, 2015,https://livegreen.recyclebank.com/because-you-asked-why-can-t-i-recycle-all-types-of-plastic.

[47] Patrick Canning, "Food Processing Costs Per Food-at-Home Dollar Rose Sharply in 2009 and 2010," Food Dollar Series, AmberWaves, September 20, 2012, http://www.ers.usda.gov/amber-waves/2012-september/food-processing.aspx#.Vz84N2P4jdk.

[48] United States Environmental Protection Agency, Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and-Figures for 2012, EPA-530-F-14-001 (Washington, D.C.: United States Government Printing Office: 2014), 8.

Ask that your grocer not carry overly-packaged items. Conferring with packaging manufacturers and large-scale packages may help by encouraging voluntary packaging reduction and research into new, less harmful or wasteful packaging. Packaging regulation by federal and state governments may help by reducing excess or environmentally harmful packaging and promoting the use of reusable and recyclable packaging. Such regulation can take the form of deposits, taxes, labeling, regulatory review, bans on specific packages, financial incentives (tax breaks or penalties) and packaging standardization.

What Makes a Good Package?

According to the consumer, a good package would be easy to carry, open and reseal; inexpensive; protective; convenient, non-breakable and reusable. According to the manufacturer, a good package would be designed to sell a product; protective; lightweight for inexpensive transportation; non-breakable; and designed for easy handling. According to a retailer, a good package would be difficult to steal or damage; convenient; able to hold up well in storage; and able to maintain an attractive appearance in artificial light. According to a solid waste manager, a good package would be reusable, refillable, recyclable and biodegradable or compostable.

Packaging Facts

In 2012, Americans discarded 75 million tons of packaging, according to EPA. "In the United States, more than one-half of the paper and glass produced and about one-third of the plastics are incorporated in items with a lifespan of under one year. Producing these packaging materials consumes 3% of the national energy budget."[49]

According to a report produced by the World Packaging Organization, in 2009 the packaging and container industry made approximately 150 billion dollars in North America and 563,847 billion dollars globally. 62% of all packaging ends up in the landfill or is incinerated.[50]

[49] Cynthia Pollack "Mining Urban Waste: The Potential for Recycling," Worldwatch Paper no. 76, 1987.

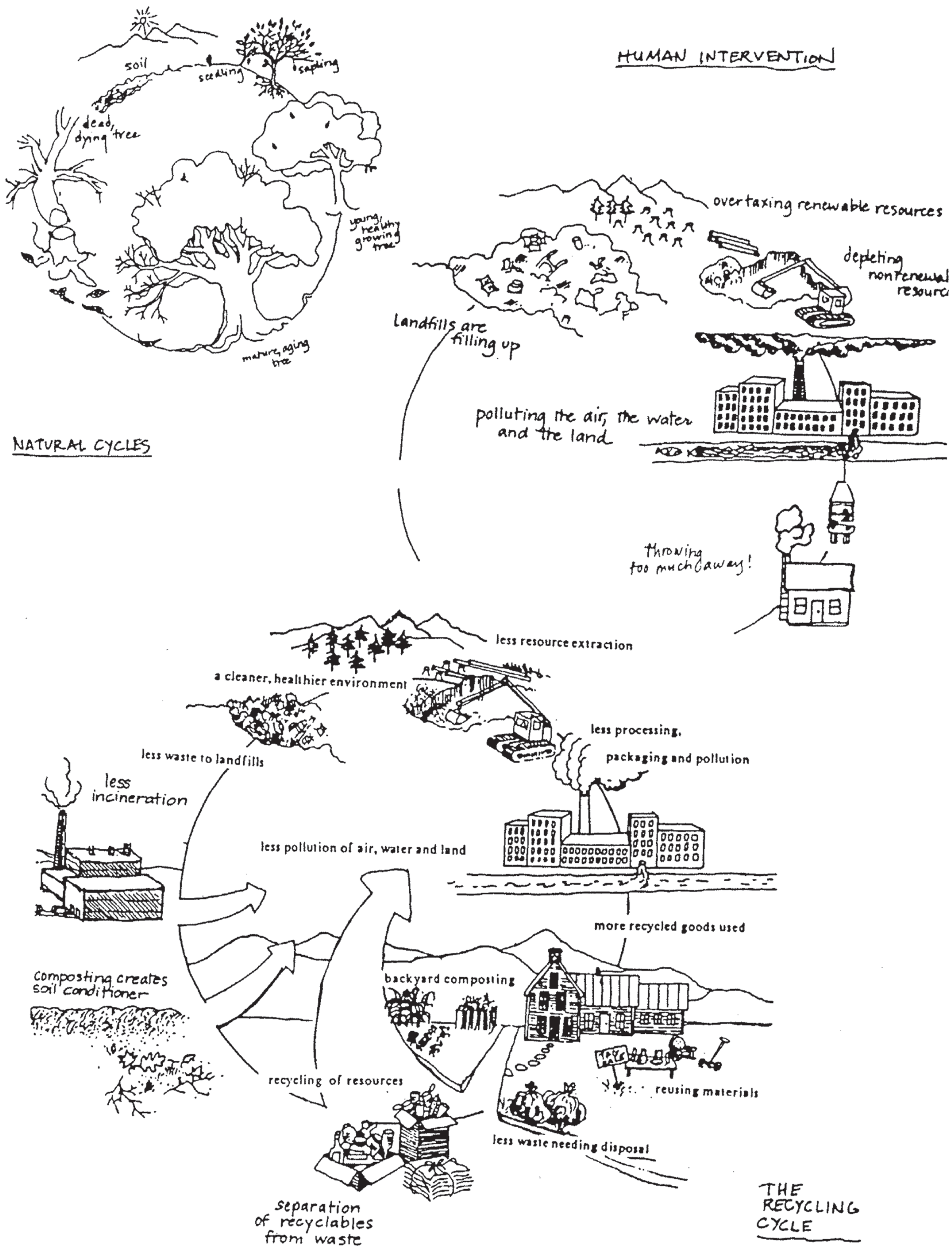
[50] World Packaging Organization, Market Statistics and Future Trends in Global Packaging, accessed May 26, 2016, http://www.worldpackaging.org/i4a/doclibrary/index.cfm?category_id=4.

Waste and Natural Resources

Nonrenewable Resources

Many of the things we use and activities we do everyday utilize nonrenewable resources. Our method of transportation, the goods we buy, the materials we use to build or homes and how we manufacture other goods all rely on minerals and other resources which are extracted from the ground. The United States Geological Survey online at http://www.usgs.gov/energy_minerals/ contains several in-depth and up to date reports on various minerals extract around the world, along with country specific information regaging these industries.

Natural and Human-Made Cycles



A Very Short History of Trash

Some Notes on the History of Solid Waste Management

"About 500 B.C., Athens issued the first known edict against throwing garbage into the streets and organized the first municipal dumps by requiring scavengers to dispose of wastes no less than one mile from the city walls. Like many Greek innovations, the practice of waste removal was lost in medieval Europe. Parisians continued to toss their trash out the window until the fourteenth century. Several hundred years later, as thousands of people thronged to newly industrializing cities to obtain factory jobs, they brought these practices with them and the garbage crisis multiplied. City governments ultimately adopted the responsibility for collecting and disposing of refuse.

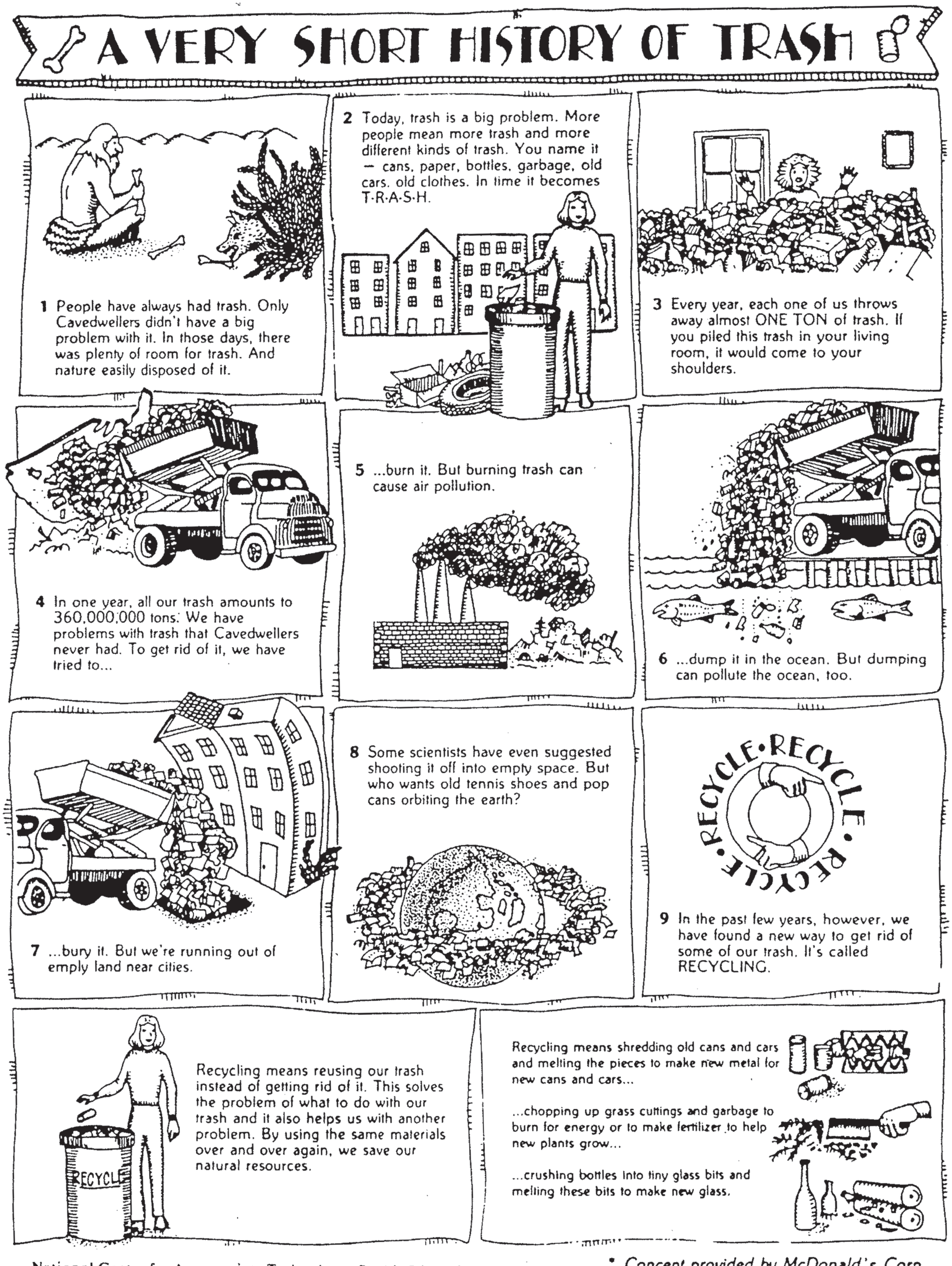
"Once the garbage was transported beyond the city gate, it was commonly dumped on scattered piles in the surrounding countryside. As cities grew, the available countryside shrank and the noxious odors and rat infestations caused by the dumps became intolerable. Free-standing piles gave way to pits dug to confine the waste. In densely populated areas of Europe, even this disposal method was soon regarded as requiring too much space and posing an undue threat to groundwater and a new solution was sought.

"The first systematic incineration of municipal ref use was tested in Nottingham, England, in 1874. Burning reduces waste volumes by some 70 to 90%, depending on the contents, so waste commissioners on both sides of the Atlantic heralded the development. Densely populated and affluent cities soon built experimental incinerators, but many communities could not justify the expense. Large capital outlays for incinerators only made sense where cheap, unregulated waste burial sites were unavailable. Many cities that did hop on the incineration bandwagon soon jumped off when their air quality deteriorated. Waste burial continued as the most widely practiced disposal method.

"In the 1950s the amount of waste began skyrocketing because of new products, new packaging and the type of packaging. Mixed material packaging which forestalls recycling became common and then the volume of the packaging expanded. In fact the expansion of the volume of packaging in the 'SOs led to abandoning the open trash pick up trucks which had facilitated recycling. What came about was a shift to garbage compaction trucks. And that was not enough. So they went to garbage transfer stations where the garbage from compaction trucks was compacted another time and put on trailers that hauled it to a landfill.

"What we had along with this evolution in packaging was increasing capital costs for handling the wastes, resulting in increasing costs for dumping-and also reduced opportunities for recycling anything useful from the compacted trash."

Source: Neil Seldman, interview by, *RE:SOURCES*, summer 1987, 6.



National Center for Appropriate Technology. Sophie Diven, illustrator.

* *Concept provided by McDonald's Corp.*

TRASH TIMELINE

Circa 300 million years ago	Wasps are making paper
Circa 250 million years ago	Swamp precursors to fossil fuels
Circa 2.5 million years ago	First tools made by man
Circa 8,000 B.C.E.	Neolithic period: animals are domesticated, intensive agriculture begins
Circa 7,000-8,000 B.C.E.	Ground and polished stone axes crafted
Circa 6,000-7,000 B.C.E.	First use of native copper
Circa 5,000 B.C.E.	Copper first smelted
Circa 4,000 B.C.E.	First use of meteoric iron
Circa 3,000-4,000 B.C.E.	Bronze age begins
Circa 2,500 B.C.E.	Meteoric Iron used in the pyramids
Circa 2,500 B.C.E.	Written history begins in Sumer (Iraq) and Egypt
Circa 1,500 -1,200 B.C.E.	ron first smelted - Iron age begins, glassblowing begins in Near East
Circa 500 B.C.E.	Athens, Greece issues first known edict against throwing garbage into the streets, orders waste to be dumped no less than one mile beyond city limits
105 C.E.	Paper first made in China
1035	First use of paper as packaging - Cairo, Egypt
Circa 1040	Moveable type invented in China
1620	First iron foundry on American soil
1690	First paper commercially produced in Philadelphia
1709	Abraham Darby making iron using coal instead of charcoal
1739	First successful American glass foundry in Salem, NJ
1769	James Watt invents a more efficient steam engine using coal
1790	Paper first made completely from wood in Vermont
1806	Fourdrinier machine producing a continuous roll of paper patented
1810	First tin-plated iron can patented as food container in England
1818	Tin-plated can introduced in America
1825	Aluminum first isolated from ore
1844	Vulcanization process discovered by Charles Goodyear
1849	Pendulum press patented, can production increases from five or six cans per hour to 50-60
1859	First important discovery of oil by Edwin Drake (lighting fuel)
1869	Lithography label printing process for cans developed
1874	First systematic incineration of municipal refuse tested in Nottingham, England
Circa 1880	Automatic can-making machinery
1886	Charles Martin hall isolates aluminum through electrolysis
1888	First commercial production of primary aluminum

1897	New York City creates a materials recovery facility known as a 'picking yard'
1900	Olds company begins first mass production of autos
1903	Wright brother's first flight
1904	First aluminum recycling business founded
1906	Radio tube invented
1908	Oil discovered in Mideast, first Model T Ford manufactured; electric iron and toaster patented
1897	New York City creates a materials recovery facility known as a 'picking yard'
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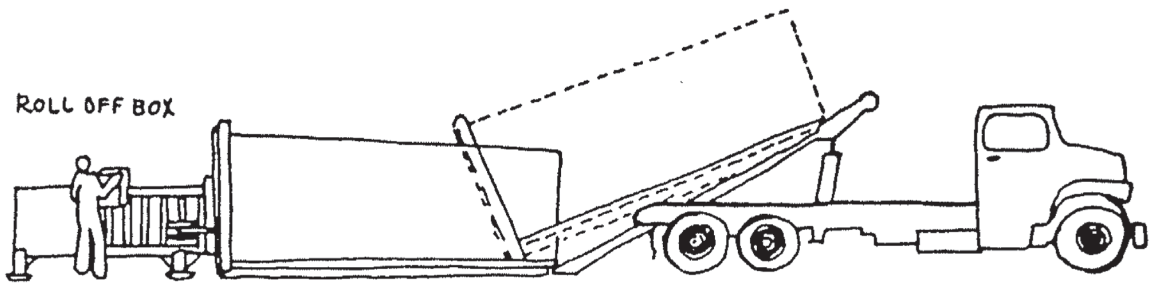
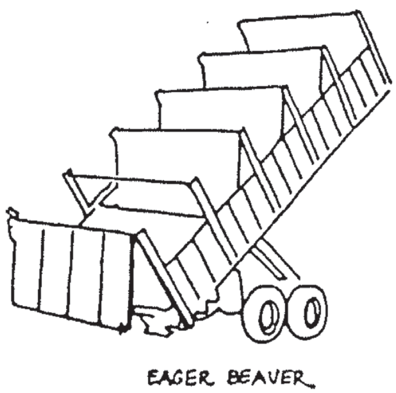
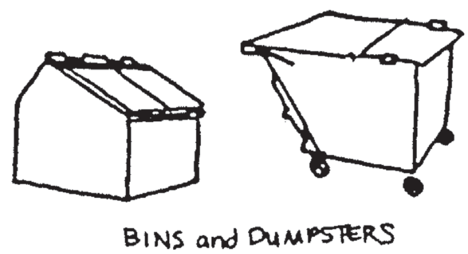
1909	Leo Bakeland invented Bakelite
1910	First commercial production of rayon electric washing machines marketed
1913	Aluminum foil first produced
1914	Celluloid zippers become popular
1915	Activated sludge sewage treatment process developed; first transcontinental phone call
1916	First sanitary landfills open
1918	Rubbing alcohol made from petroleum
1923	Bulldozer invented; Jacob Schick patented the electric razor
1925	Chrome plating is commercialized; electric coffee percolators marketed
1928	First scheduled television broadcasts
1931	Neoprene rubber and fiberglass invented
1934	First major laundry detergent marketed
1938	Nylon first sold as toothbrush bristles; fluorescent lamps marketed; polystyrene plastic marketed; ballpoint pen invented
1939	DDT found to be an insecticide
1940	First regular passenger air service across the Atlantic; nontoxic pigments replace leads in interior paints
1941	Aerosol spray cans introduced (with CFCs)
1943	Polyethylene plastic invented
1944	Silicone resins marketed
1947	Instant photos introduced
1950s	Televisions become a staple of the modern American home. In 1950 3,880,000 homes had a tv, in 1959 43,950,000 homes had a tv
1951	First commercially available computer the Mark 1 (used predominantly at Universities and other research centers)

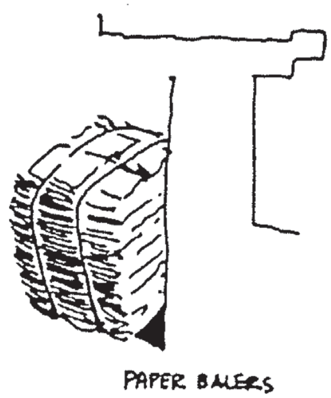
1953	Detroit's first all-fiberglass car body sold, first US-made polyester created
1954	Plastic contact lenses introduced
1954	Plastic contact lenses introduced
1955	Life Magazine publishes article on 'Throwaway Living' - single use materials is modern and ease and convenience are most important when buying goods; first commercial jet transport
1957	First artificial satellite built; first US commercial nuclear power plant; aluminum first used in metal can making
1959	First Xerox machine sold; spandex elastic first sold
1960	OPEC formed; easy-opening cans introduced
1961	Introduction of olefin makes indoor-outdoor carpet possible
1964	Switch to biodegradable detergents
1965	First home videotape recorder; tin-free steel cans developed; Solid Waste Disposal Act created a national office for solid waste
1969	First man on the moon
1970	First Earth Day; peak of US oil production; no-wax vinyl flooring introduced; federal Clean Air Act (CAA) passed
1971	First bottle bill passed (Oregon)
1972	DDT banned in the United States
1973	Oil embargo/Egyptian-Israeli war leads to first oil price shock; federal Clean Water Act passed
1974	University City, MO becomes first community in the United States with curbside recycling
1976	Federal Resource Conservation and Recovery Act passed
1978	Fluorocarbons banned as aerosol propellants
1979	EPA sets criteria for sanitary landfills; second oil price shock
1980	CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) passed
1981	Woodbury, NJ becomes first municipality in the United States to mandate recycling
1991	EPA updates landfill standards - liners required in operating portions of all landfills
2000	EPA confirms link between trash and global warming
2007	Five states require unwanted electronics to be recycled
2015	California enacts statewide ban of plastic bags in grocery and convenience stores
2016	Nine states have paint stewardship programs, more states have pending legislation

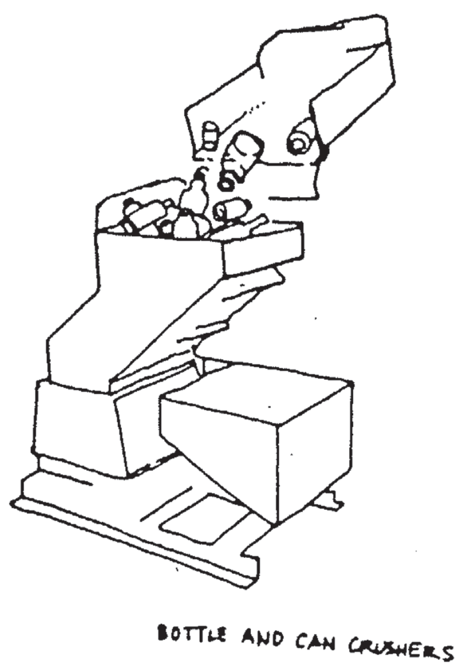
TRASH COLLECTING AND PROCESSING EQUIPMENT











TRANSFER STATIONS

Transfer stations are sites where municipal solid waste is collected (and may be compacted) to be transported elsewhere for incineration or landfilling. Often transfer stations are located at the closed town dump since the use of the site for waste handling is well established (and it would be difficult to establish a new site). The site is open regular hours and is supervised. Individuals and haulers enter the site, pay tipping fees and deposit their waste in large containers (dumpsters and roll-off boxes). Many communities locate a recycling center at their transfer station, allowing persons to reduce their disposal fees by some amount for the waste they separate for recycling.

The main reason why transfer stations exist is to reduce transportation costs of trucks carrying small loads to local facilities, consolidating these loads and bringing them to a larger facility. According to the EPA, transfer stations are cost effective for distances that exceed 35 miles round-trip. Under 35 miles, it is more cost effective for trucks do a direct haul.

LITTER

What is Litter?

Litter is any waste that has been disposed of improperly or has escaped the waste handling system. Most litter escapes from one of the following places: home trash cans, business and commercial trash cans and dumpsters, trucks, construction and demolition sites, loading docks and commercial storage areas, pedestrians and motorists.

Why is Litter a Problem?

While litter is a problem for many reasons, the most obvious is its unsightliness. It spoils the beauty of our natural environment. Once we have covered a roadside or park with litter, we need to clean it up, a task that takes long hours and thousands of dollars. Bottle Bills were passed in an effort to reduce litter. By offering a deposit on beverage containers, it gave people an incentive to return containers to stores instead of tossing them out car windows. Even those containers which were tossed were soon retrieved by entrepreneurs. Bottle Bills worked very well, reducing the number of bottles and cans on highways. In 2003, according to Bottlebill.org, the national redemption rate was approximately 35%, states with Bottle Bills such as Massachusetts, New York and Oregon have much higher redemption rates, around 70%. However, with the increasing popularity of single-serve beverage containers for water, juice and sport drinks, which are generally not included in Bottle Bills and the prevalence of fast-food restaurants and convenience stores, roadside litter is on the rise.

Litter can also hurt people or other animals. For instance, an abandoned bottle could become a trap for an unsuspecting insect or rodent that cannot crawl out on the slippery glass sides. A broken bottle accidentally stepped upon could draw blood from people or animals.

What Special Problems Does Waterborne Litter Cause?

Most litter in our lakes and oceans at one time did not appear to be a problem because metal and glass sank immediately and paper products degraded quickly. Driftwood and seaglass even had aesthetic value. But with the introduction and growth of plastics in the last few decades has come a new problem, one that is highly visible and increasingly noticeable.

Plastic litter comes from ships and from sewage systems and industrial discharges. The fishing industry and pleasure boats discard nets, line, strapping and consumer disposables. In addition, all plastic gadgets we use today, such as plastic bags, tableware, cosmetic cases and brush bristles, are made from very tiny particles of virgin plastic which are melted and formed into any desired shaped. These little pellets or beads of raw plastic are then often lost in waterways during packing or shipping or in some cases are discharged directly into sewage systems and waterways from manufacturing plants.

How Does Plastic Litter Harm Marine Wildlife?

Marine mammals, reptiles and birds can all be hurt by plastic litter in our seas, both from eating it and becoming entangled in it. Seals get discarded strapping bands caught around their necks and strangled. Turtles are often found. with bags in their bellies, which they have presumably mistaken as jellyfish, one of their favorite foods. Little raw plastic nibs have been found in the stomachs of both fish and seabirds. Birds such as pelicans get entangled in fishing gear. Seagulls and fish are easily trapped in discarded six-pack rings.

According to National Geographic there are 5.25 trillion pieces of plastic debris in the world's oceans. Once the piece of plastic decompose, the toxic chemicals contained within the plastic are set free into the water causing just as much harm as the more visible pieces of trash.[51] According to one estimate, plastic trash kills approximately 1,000,000 sea creatures every year.

[51] Brian Clark Howard, "5 Trillion Pieces of Ocean Trash Found, But Fewer Particles Than Expected," *National Geographic*, December 13, 2014, http://news.nationalgeographic.com/news/2014/12/141211-ocean-plastics-garbage-patches-5-gyres-pollution-environment/.

INCINERATORS

The History of Incineration

The first municipal incinerator was designed and built in England more than a century ago. It seemed to be a simple, efficient and sanitary way to dispose of garbage. Burning garbage eliminated the need for transporting waste from cities, saved space in dumps and destroyed many disease-causing microorganisms and viruses. The technology was soon imported to this country and by the 1920s there were more than 300 incinerators in use.

The first incinerators burned trash without worrying about what was coming out of their smokestacks. As concern rose over the quality of our air and legislation was introduced to prevent further air pollution, their use declined, since the cost of pollution control equipment made it cheaper to landfill waste. The development of waste-to-energy technology in the 1970s revived incineration.

Not only do these facilities provide electricity for local homes and businesses, but they also enable the use of pollution control equipment. In such a facility, hot combustion gases convert water to steam, which runs power-generating turbines. Because the temperature of escaping gases in waste-to-energy incinerators is much lower, pollution control equipment can operate effectively.

The waste-to-energy technology lowers the temperature of incinerator exhaust to the point where emission control equipment can operate. Thus this technology makes possible the installation of pollution control equipment in incinerators, while its ability to generate power helps offset some of the high cost of such equipment. With landfills filling up, this new technology, called with varying degrees of precision waste-to energy, energy recovery and resource recovery, led to a renewal of incinerator popularity in the1970s.

Today's waste-to-energy plants can reduce up to 90% of the volume of waste requiring disposal and can be designed to process from 100 to over 3,000 tons of refuse daily. At the same time, they produce steam or electricity that can satisfy a portion of local energy needs. However, the ash remaining from the burn and the exhaust gas can both contain toxic materials.

In the late 1990s, landfills accepted 56.9% of our nation's waste, 27% was recovered for recycling and 16.1% was incinerated. According to the Global Alliance of Incinerator Alternatives, there are 113 waste-to-energy facilities currently operating in 31 states, of these 113 incinerators, only 86 are used to generate electricity. After more than 40 years of operation, there is considerable debate over their usefulness and safety.[52]

How Do Incinerators Work?

Incinerators burn waste to reduce its volume. Incinerators can burn unprocessed waste (mass burn) or processed waste (refuse derived fuel) and can be equipped to generate energy. Incinerators so equipped use the heat from burning garbage to turn water to steam, which is then either fed into a steam-loop or district heating system or used to turn turbines at the incinerator to generate electricity.

Mass-burn facilities are seemingly convenient from a solid waste management perspective. There is no pre-processing of waste and no changes must be made in the way most municipalities presently collect their trash. When trucks enter a waste-to energy facility, their loads are weighed and the trash is delivered to a tipping platform. Front-end loaders and cranes are used to push the waste down a shoot (hopper), from where it is fed into the combustion chamber. The residual ash from the combustion chamber (bottom ash) and that collected by pollution control equipment (fly ash) is deposited into large covered dumpsters which are hauled away to a lined landfill.

Incinerators require a steady flow of refuse and need to maintain a steady temperature in burning. Non-combustibles in the waste stream such as glass and metal inhibit efficient burning as do kitchen wastes, leaves and grass because of their high moisture content (30% to 75%) and low BTU value. Increasing amounts of petroleum-based plastics (with a high BTU value) in the waste stream also affect burning. In order to maintain a consistent temperature, incinerator operators must regulate a changing solid waste composition, the amount of trash fed into the plant, how the system is started up and shutdown and other variables that change burning temperatures.

How Does Incinerator Pollution Control Equipment Work?

The Clean Air Act, passed in 1970, limits the emission into the air of seven major classes of pollutants: particulates, sulfur dioxide, carbon monoxide, ozone, hydrocarbons, nitrogen dioxide and lead. This legislation put an end to incinerators without pollution control devices, as well as routine uncontrolled burning at open dumps. Pollution control devices are now required on incinerators to remove particulates, acid gas and toxic compounds created in burning solid waste.

Pollution control in a state-of-the-art incinerator consists of temperature controls, dry or wet scrubbers and baghouses. To receive an operating license, an incinerator must have all of these controls in place. Temperature controls involve, first and foremost, efficient combustion between 1,500 to 1,800 degrees Fahrenheit of all waste, eliminating most particulate matter. Second, exhaust gases are carefully co aired or cooled to precipitate out any dangerous vaporizing metals, such as lead and mercury. Scrubbers then use reagents (like lime) to neutralize acid gases. Finally a baghouse, essentially a fine mesh filtering system that works something like a vacuum cleaner bag, strains out particulates (including the precipitated metals) from the exhaust gases. Together these controls eliminate most of the particulates and acid gases from incinerator emissions. These emissions are to be continuously tested to see that all particulates and gases are within levels permitted by the United States Environmental Protection Agency and the local state agencies and departments overseeing waste management.

What Happens to Incinerator Ash?

In most cases both bottom ash from the combustion chamber and the generally more toxic fly ash collected by a baghouse are combined for disposal and sent to double lined landfills. In some states the Extraction Procedure, or EP, toxicity leaching test is used before transport of ash to test its potential for leaching heavy metals in mixed solid waste landfills. Fly ash remains a concern as it has been found to contain high levels of toxic contaminants. (Leachate is collected in pipes, located above and between the liners at the bottom of the landfill, which empty into a holding tank, the contents of which are then taken to a wastewater treatment plant for final treatment.)

What are the Benefits of Incinerators?

Incinerating solid waste can reduce the volume of trash going to a landfill by up to 90%, resulting in a 60% to 70% reduction overall in landfill demand. In addition, waste-to-energy facilities generate electricity, lessening our dependence on fossil fuels. The Commerce Refuse to Energy Plant in Los Angeles County, California, burns 360 tons of trash per day and generates enough energy to electrify 20,000 homes.[53]

Incinerators help conserve land and protect water sources from contamination. They destroy potential disease-causing organisms in solid waste and keeping them out of landfills. Highly infectious medical waste is rendered safe when burned. Finally, incineration destroys a number of chemicals and toxic compounds, such as pesticides, that are a major source of contamination at existing landfills.

What is the Debate Over Incinerator Safety?

There is much public debate about the safety of incinerators. The concern centers around their emissions and disposal of their ash. Proponents of incineration maintain that the toxicity of some emissions and ash are well within levels determined safe by state and federal regulations. In addition it is argued that scrubbers and other pollution-control equipment can remove 99% of the Hydrogen Chloride (HCL) and other chlorine-containing compounds and materials.[54]

Advocates also point out that incineration may actually reduce the amount and leachability of toxic substances that would otherwise be landfilled. However, it was found in 2009 that the incinerators in New York state emitted 36% more mercury than coal plants. Incinerators also produce more carbon dioxide per unit of electricity than coal plants.

Opponents of incineration maintain that some potentially dangerous emissions or leachate are not tested for or regulated and many of those that are permitted at levels of exposure that have not been proven safe or are open to question. The EPA admits that 50% of the substances emitted from incinerators remain unidentified. Among the known

[52] "Incinerators: Myths vs. Facts about 'Waste-to-energy'," Global Alliance of Incinerator Alternatives, accessed May 26, 2016, http://www.no-burn.org/downloads/Incinerator_Myths_vs_Facts%20Feb2012.pdf.

substances emitted from incinerators are highly toxic chemicals such as dioxins and heavy metals such as mercury, lead and cadmium. Incinerators disperse these materials into the air and concentrate them in their ash.[55]

Dioxin is a serious concern because it can have severe impacts on human health and the environment. Dioxins result from burning PVC plastic found in electronics, appliances, construction materials, automotive components, consumer goods, packaging and medical products. Dioxin is the most toxic synthetic chemical known. In addition to being a carcinogen, it mimics hormonal function and affects the immune, endocrine, reproductive and developmental systems. It takes minute quantities of this toxin to create adverse effects. According to the EPA, there is no safe level of dioxin, yet it exists in every living organism. Ironically, medical incinerators are one of the greatest contributors to dioxin emissions. Barry Commoner asserts that medical waste incinerators are responsible for 50% of the dioxin in the environment.[56]

Dioxin contaminates food, water and vegetation. It bio-accumulates as it moves through the food chain and concentrates in the fatty tissues of animals. Human exposure is greatest through ingestion of beef, dairy and fish.

Many opponents of incinerators are also skeptical of the notion that incinerators are efficient and effective. The Global Alliance for Incinerator Alternatives points out that over 90% of the material sent to be incinerated is recyclable, not only is it unnecessary to burn these materials, but the incinerators are also destroying valuable resources that could be reused. In addition, recycling these materials would create 10 to 20 times more jobs than the incinerator industry produces.

What are Some Problems of Incinerators?

Incinerators share many of the problems of any waste management facility (such as landfills and recycling centers), including truck traffic and associated noise and litter. However since operations take place within an enclosed structure at an incinerator, problems such as litter, odors and insect and rodent infestation are better controlled than at a landfill.

Incinerators are expensive, capital-intensive systems to invest in, operate and maintain, making it most economical to build large plants so that costs per ton of waste accepted are lower. However, large sums of money must be borrowed to construct an incinerator and whether the plant is running at half or full capacity, the agreed upon schedule of payments must be met. Hence, although larger plants may be more economical, a facility that is oversized can be very expensive and actually can create something of a demand for waste, which is contrary to waste management goals. Facilities are better, perhaps, undersized but designed with the flexibility to add an additional incinerator unit should it be needed.

Although influential groups such as banks and construction companies may strongly support constructing incinerators, once constructed the uncertainties of future government regulation and vocal opposition and legal challenges to any incinerator have the potential to greatly increase the cost to its investors and users. Regulation may affect both the ability of a plant to operate at full capacity (and hence economically) and may increase the cost of disposing of its ash (e.g. if ash were to be classified as hazardous waste, as is sought by some). Although revenues from power generation may in part offset a portion of incinerator costs, these revenues have proved quite variable as utilities have negotiated and public service boards determined the rate that an incinerator receives for its power.

Finally, incinerators can be only as safe as the waste that society produces which is fed into them. Whatever other safety problems there may be, incinerators and their ash will be safest and incineration most cost-effective if nothing toxic (e.g., chemicals, batteries, waste oil), nothing recyclable (metals, plastics, glass, paper) and nothing compostable (food and yard waste) goes into them. An incinerator burning only mixed waste from which these items have been removed as thoroughly as practicable will minimize any potential burning, pollution-control mechanical problems and unnecessary costs of incinerator technology.

An alternative to incinerations is created refused derived energy through a waste converter. Waste converter technology uses pasteurization of organic waste, sterilization of pathogenic or biohazard waste, grinding and pulverization

[53] "Commerce Refuse-to-Energy Facility Refuse Disposal Information," Los Angelos County of Sanitation Disposal, accessed May 26, 2016, http://www.lacsd.org/civicax/filebank/blobdload.aspx?blobid=9974.

[54] "Incineration Q&A," The Plastics Trade Organization, accessed May 26, 2016, https://www.plasticsindustry.org/AboutPlastics/content.cfm?ItemNumber=793&navItemNumber=1124.

of refuse into unrecognizable output, trash compaction and dehydration. These methods can be applied at municipal waste facilities as well as medical facilities, supermarkets, airports and slaughterhouses. The waste can be converted to compost, building materials, biofuel and electricity. It should be noted, however, that once waste is compacted it is sometimes sent to incinerators to be burned for electricity. It is not always a cleaner alternative to incinerators.

Don't Try This at Home: Backyard Trash Burning Can Be Deadly

Open trash burning has been practiced for generations. Many people continue to burn trash in their backyards to avoid tipping fees at the landfill. Their parents and grandparents had a burn barrel, so it became a tradition. Backyard burning is also convenient. What's the matter with burning trash in your backyard?

Household trash has changed considerably over the last 20 years. Items previously packaged in glass or paper may now be packaged in plastic. Even those packaged in paper have changed due to inks. Plastics and inks contain heavy metals such as lead, cadmium and chromium.

When burned, plastics form dioxin. A recent study found that a backyard fire releases 20 times more dioxin than a controlled solid waste incinerator. The leftover ash contains heavy metals, along with dioxins and furans. Lead can affect a child's development. Dioxin and furans have been known to cause cancer and disrupt several body systems, even in very small quantities.

Some effects are more immediate than others. The smoke from your backyard might not bother you, but it could be a serious health threat to your neighbors, especially if any of them have any respiratory illness. Small particulates and pollutants in smoke from burning trash may cause eye, nose and throat irritation, lung irritation and congestion, skin irritations and burns, stomach and intestinal upset, eye damage and headache or memory loss. Repeated exposure may cause developmental problems in children and can increase the risk of getting cancer, asthma, emphysema or chronic bronchitis.

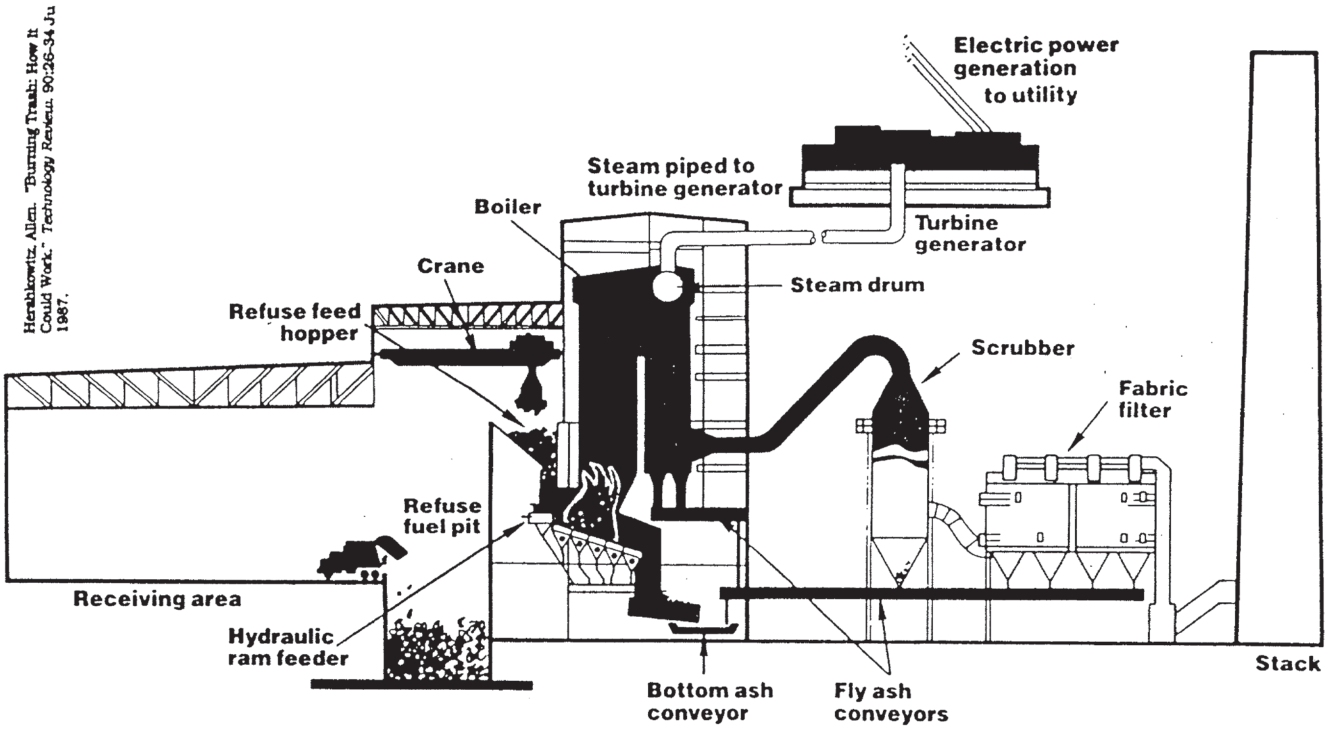
Check with local officials to obtain information about burning permits in your area. Some communities allow brush burning, others forbid any kind of open burning including campfires. If you need to dispose of leaves, weeds, deadwood and brush consider leaving them to decompose, or composting the leaves to make nutrient-rich soil.

[55] "Incinerators," Global Alliance for Incinerator Alternatives, accessed May 26, 2016, http://www.no-burn.org/section.php?id=84.

[56] Ibid.

How a Waste-to-Energy Plant Works

Lime sprayed into the scrubber neutralizes acid gases that would otherwise contribute to acid rain. The scrubber also helps control dioxins and toxic metals emitted during burning. These pollutants are adsorbed onto fly ash-the ash carried out of the furnace by exhaust gases. A fabric filter collects the fly ash, which must be dumped in secure landfills so that it does not contaminate groundwater. The bottom ash, another residue of the burning process, is not as dangerous.



LANDFILLS

The Old Town Dump

"Once upon a time, every community had a dump. The dumps were not very expensive to operate since the only thing they consisted of was a steep bank located near a road, sometimes near a river. The dump was occasionally burned and then covered with soil. That way the bank was extended and the dump, could continue to operate for several years. Rats and other scavengers eliminated the food wastes and people picked a lot of other things that other people threw away. The system of local dumps performed a valuable function. To be sure, smoke, polluted water run-off and noxious odors did cause some health problems, but there were not a great many environmentally-concerned citizens clamoring to improve the situation. Eventually, however, concerns grew about the impact of dumping things like lead-based paints, used motor oil and lead/acid car batteries over the bank and pressures mounted to do something about the dumps."[57]

Landfills of the Past

Prior to EPA guidelines set in the 1970s, landfills were very loosely regulated. Little knowledge existed about the effects of water and air contamination and pollution caused by these facilities. Open burning was quite common.

Landfill Regulations and Legislation

In the late 1960s and early 1970s, several states passed regulations regarding proper waste disposal. These laws heralded the end of the old town dump; the stricter requirements were costly for small communities and resulted in the formation of larger privately-owned and municipal landfills. State legislation was followed by the passage of the

[57] Richard Cate, "Government Versus Garbage," Vermont Affairs, December 1988.

Federal Resource Conservation and Recovery Act (RCRA) in May 1976. All states had to comply with equal or stricter regulations by May 1978.

The legislation established comprehensive, protective standards for managing the nation's solid waste by specifying location provisions and design, operating and closure requirements for landfills. The requirements were as follows: Landfills cannot be located near airports, or be sited in ecologically valuable wetlands or areas subject to natural disasters (flood plains, fault areas, seismic zones and unstable terrain). It should be noted that most legislation regarding bans certain products in landfills is passed at the state level. Please consult https://nerc.org/documents/disposal_bans_mandatory_recycling_united_states.pdf to find information about landfill bans in your state.

Landfill Regulations:

No regulated hazardous waste	Monitor methane gas
Control disease vector populations (e.g.: rodents, flies, mosquitoes, seagulls)	Have monitoring wells to detect groundwater contamination. Contamination clean up is the responsibility of the owner-operator.
Restrict public access	Control stormwater runoff
Protect surface water from pollutants	Keep appropriate records

It became apparent that most of these landfills were sited in places or operated in ways that endangered groundwater (due to seepage of waste-contaminated rainwater through the landfill). Stricter state laws were passed requiring landfills, new and old, be lined. In states with EPA-approved permitting programs, landfills must be designed to ensure that groundwater quality meets drinking water standards. In states without EPA-approved standards, landfills must be designed with a composite liner made of synthetic material covering a two-foot clay liner.[58]

In 1990, Congress passed the Pollution Prevention Act, which mandated source reduction and waste management of all toxic and hazardous substances. Beginning in 1991, all creators of hazardous substances had to report the amount of hazardous or toxic waste produced. In addition, they had to describe whether it was treated, disposed, recycled, recovered, or released. This information was to be reported to the Environmental Protection Agency.

In 1995, the United States Environmental Protection Agency issued the Universal Waste Rule, which applied to batteries as well as other hazardous wastes. The rule was designed "to reduce the amount of hazardous waste items in the municipal solid waste (MSW) stream, encourage recycling and proper disposal of certain common hazardous wastes and reduce the regulatory burden on businesses that generate these wastes."[59]

Universal wastes include nickel-cadmium batteries, small sealed lead-acid batteries, and banned/obsolete/unused pesticides. This rule applies to businesses and industry, but many communities have banned all toxic and hazardous wastes from their landfills.

Federal Law supporting these measures soon followed. In 1996, Congress passed Public Law 104-142, whose purpose is "to phase out the use of mercury in batteries and provide for the efficient and cost-effective collection and recycling or cost-effective disposal of used nickel cadmium batteries, small sealed lead acid batteries and for other purposes."[60]

According to Environmental Information Ltd., a national research firm based in Minneapolis, MN, in 1998 17 states still accepted hazardous waste from small businesses in their landfills. While these conditionally exempt small quantity generators produce less than 220 pounds of waste per month, they are often placed in unlined landfills, potentially leaching into the surrounding environment. Two-thirds of the nation's landfills also lack protective liners while continuing to accept these wastes and many lack leachate collection systems. These states include AL, AK, AR, IN, KS, KY, MS, MT, NV, NE, ND, OR, SD, UT, VA, WA, WI.[61]

[58] Resource Conservation and Recovery Act of 1976, 42 U.S.C. 82 (1976).

[59] Universal Waste Rule, 60 FR 25492 (May 11, 1995).

[60] Mercury-Containing and Rechargeable Battery Management Act of 1996, 42 U.S.C. 6921 (1996).

[61] "17 States allow Hazardous Waste Disposal in Municipal Landfills," Environmental Information Ltd., accessed 4 April 1998, www.envirobiz.com/ homepages/ec/er-NovS.htm (site discontinued).

What is groundwater?

Groundwater is precipitation that has worked its way down from the surface to the water table or aquifer. The water table is the point at which this water saturates the soil or fractured bedrock. The size of any given aquifer varies with the area's geologic conditions. Water can move easily through or saturate sand and gravel, but does not flow through silts and clays as easily. The amount of water in bedrock will depend on the number of cracks and fissures in the rock that will allow the water to flow freely. It is important to consider the geology of an area very carefully when looking for a site for a new landfill. Soils that easily transport water must be avoided.

How is groundwater replenished?

Recharge areas are places where soils absorb rainwater and runoff allowing it to seep down to the aquifer. Once there, the water begins to move slowly through the water table to a discharge area - a stream or swamp, pond or lake, a natural spring or constructed well. Water moves very slowly underground, but it can travel a long way from its recharge area before it is discharged to the surface again. Landfills must be sited away from recharge areas and the natural flow of water must be mapped.

What is Leachate?

Leachate is water that has percolated down through a substance, picking up chemicals or organic matter as it goes. The particles become dissolved in the water and move with it, running off into streams or seeping down to contaminate the aquifer. When it rains on a landfill, the passing water can pick up many of the components of the solid waste. Hazardous wastes such as used motor oil, paint products, cleaners and batteries all contain elements which add to leachate. As other wastes decompose, additional hazardous substances may be produced and picked up by leachate. Fortunately the concentration of hazardous substances in leachate is greatest during the first years after waste is buried and rapidly becomes less and less over time; this is why liners for landfills that do not accept hazardous wastes do not need to last forever.

At a lined landfill, leachate is collected in pipes located above the liners at the bottom of the landfill. The leachate is pumped through the pipes to a holding tank and then pumped out of the tank when it is full. It is then transported to a wastewater treatment plant for final treatment, similar to any discharge from industries that generate water wastes.

How can we protect groundwater?

About 40 to 50% of the US population depends on groundwater as its primary drinking source. Once contaminated, groundwater sources are extremely difficult if not impossible to clean. There are many contaminated sites in the United States, many of them landfills, which must now be cleaned. Many existing landfills are releasing leachate into our environment presently or will do so as time goes on.

Federal, state and community legislation has been passed in an effort to minimize groundwater contamination. These laws attempt to reduce problem-causing materials from entering the waste stream that goes to the landfill. They require landfills to be sited in a suitable hydro-geologic area, to be properly lined and to be equipped with leachate collection devices. All landfills must test, treat, neutralize and/or have the capacity to store the leachate collected. Legislation also calls for careful monitoring systems to make sure that preventative measures are working and that groundwater is not being contaminated. Despite these efforts, groundwater pollution is still a serious issue.

What is Methane and Why is it a Problem?

Another by-product of the decomposition of buried solid waste is methane. Carbon dioxide, methane, ammonia and sulfur gases are all produced as microorganisms break down these wastes. Trapped beneath the landfill surface, these toxic gases are potential health and safety threats. Unexpected explosions and underground fires are common. Methane will also move laterally beneath the surface of the landfill, threatening adjoining land and homes where the flammable gas can resurface, polluting air and threatening additional explosions. To prevent these problems, vents are installed in the landfill to reduce the pressure build-up of the gases and allow their safe escape. In 2011, the EPA estimated that landfill gases were responsible for 17.7% of all methane emissions in the United States.

Can We Use Methane as a Fuel?

Methane is the largest component of natural gas, a commonly used fuel. If the volume of the landfill is at least one million tons, the methane produced can be captured, purified by removing carbon dioxide and water and sold to gas utility supplies. As with recycling, the production of methane may not represent a profit, but it can help subsidize the operating costs of the landfill. As of May 2016, there are 648 operations LFG (landfill gas) locations in the United States and a further 400 that are good candidates for LFG projects.[62]

According the the Environmental and Energy Study Institute, the landfills that produce energy collectively produce approximately 15 billion kilowatt-hours (kWh) of electricity and 100 billion cubic feet of LFG for direct use annually.

Other Problems with Landfills

Landfills, like most waste management facilities, generate a great deal of truck traffic, noise and litter. They also attract rodents, gulls and other pests and have dust and odor problems. Although studies indicate that the value of properties more than one thousand feet from a landfill are unaffected by its presence, nobody wants a landfill anywhere near their home (Not in my backyard!), so new landfills are politically very difficult to site and open. In addition regulations regarding the placement of new landfills have become stricter and with growth and development demands there are even fewer suitable new sites.

However, old landfills are filling up and must be closed to protect the environment. As they fill up, many towns must send their waste farther and farther,away from its source. This costs more and more money; in New York City and Philadelphia disposal costs per ton reached $100 in 2008 and continues to rise. Despite any potential problems, landfills are needed because once we have reduced, reused, recycled and composted as much of the waste stream as we can, there are no other more environmentally sound options for disposing of waste.

Remember: If we don't make it, we won't have to get rid of it. The United States produces far more trash than any other nation in the world. First we need to reduce the waste we produce. In the United States we produce about 251 million tons each year.[63] Too many products are designed to be thrown away soon after purchase. Disposables have been taking over the marketplace and our lives. After careful thinking, what we decide we do need, we should try to reuse as many times as we can before recycling it. We should try to throw out as little as possible.

Source reduction is waste prevention. It is the practice of keeping goods and materials from the waste stream. Reduction is the highest waste management priority. It applies to individuals as well as businesses and requires us to think about how we can avoid recycling or throwing things away in the first place. By doing so, we conserve energy and resources and create less pollution, particularly hazardous waste. Reduction has opportunities for expansion in the economic sector through reuse, repair, redistribution and re-manufacture.

Landfill Facts

In the late 1980s, 90% of the nation's waste was disposed of in landfills. By 1997, approximately 55% of our trash was landfilled.[64] According to the EPA that number fell to 53% in 2012. In 1979, there were approximately 18,000 landfills in the US, by 1990, there were about 6,300 landfills and in 1995, it was estimated that there were only 3,000 landfills left. In just 16 years the number of landfills dropped 84% and during that same time, there was an 80% increase in the amount of trash generated.[65] In 2009 the number of landfills in operation tallied at 1,908. The amount of trash generated, however, continues to rise.

[62] "Energy Projects and Candidate Landfills," United States Environmental Protection Agency, accessed May 26, 2016, https://www3.epa.gov/lmop/projects-candidates/.

[63] United States Environmental Protection Agency, Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2012, EPA-530-F-14-001 (Washington, D.C.: United States Government Printing Office: 2014), 1.

[64] United States Environmental Protection Agency, *Characterization of Municipal Solid Waste in the United States: 1998 Update,* EPA530-S-99-021 (Washington, D.C.: Government Printing Office: 1999), 13.

[65] "Trash Trivia," Cass County Solid Waste Management District, accessed April 21, 1998, http://web.iquest.net/ccrecycle/trivia.htm (site discontinued).

Did You Know?

- Almost 33% of the trash generated in America is packaging.[66]
- An average child uses between 8,000 and 10,000 disposable diapers before being potty trained.[67]
- The average American adult receives 41 pounds of junk mail every year, 44% of that mail is never opened.[68]
- Landfill problems are the worst in the northeast and central states where populations are high and land limited.
- Before 1980, there were no federal regulations on the construction of landfills and little control over what went into them.
- In the late 1960s, 90% of all US landfills were open dumps.

"The Environmental Protection Agency's Office of Solid Waste has estimated that an average land disposal site, 17 acres in size, with an annual infiltration of ten inches of water, can generate 4.6 million gallons of leachate a year." [69]

As part of the Garbage Project in 1987, four landfills were excavated to depth of 90 feet. Trash samples were taken at 10 feet intervals. They analyzed the garbage by weight and volume. These were some of their findings:[70]

- 1980, Fast-food packaging took up less than ¼ of 1% of the volume, not 10% as originally believed.
- 1981, Disposable diapers, estimated to take as much as 5% of landfill volume, averaged 1% of total landfill volume.
- At least 180 of the 888 worst Superfund sites are municipal landfills. (May 11, 1987 US News and World Report)
- Each ton of waste consumes about 50 cubic feet of landfill space.

66 Ibid.

67 Ibid.

68 "Junk Mail Impact,"41pounds.org, accessed March 22, 2016, https://www.41pounds.org/impact/.

69 Michael Brown, *Laying Waste: The Poisoning of America by Toxic Chemicals* (Random House, 1983), 106.

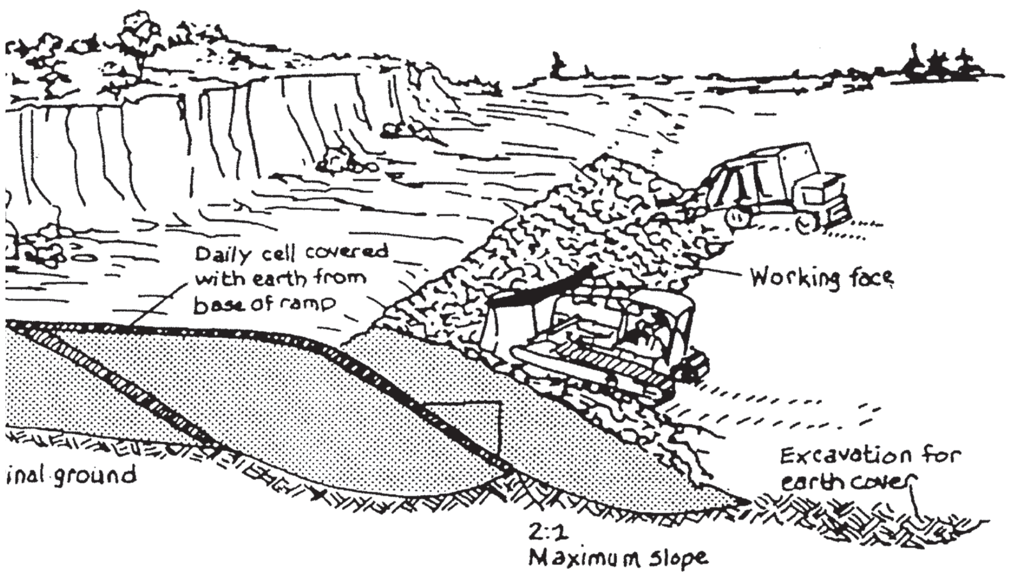
70 "Looking Into Landfills," Academy of Natural Science. Accessed April 4, 1998, www.acnatsci.org/erd/ea/landfills.html (site discontinued).

Organic Material

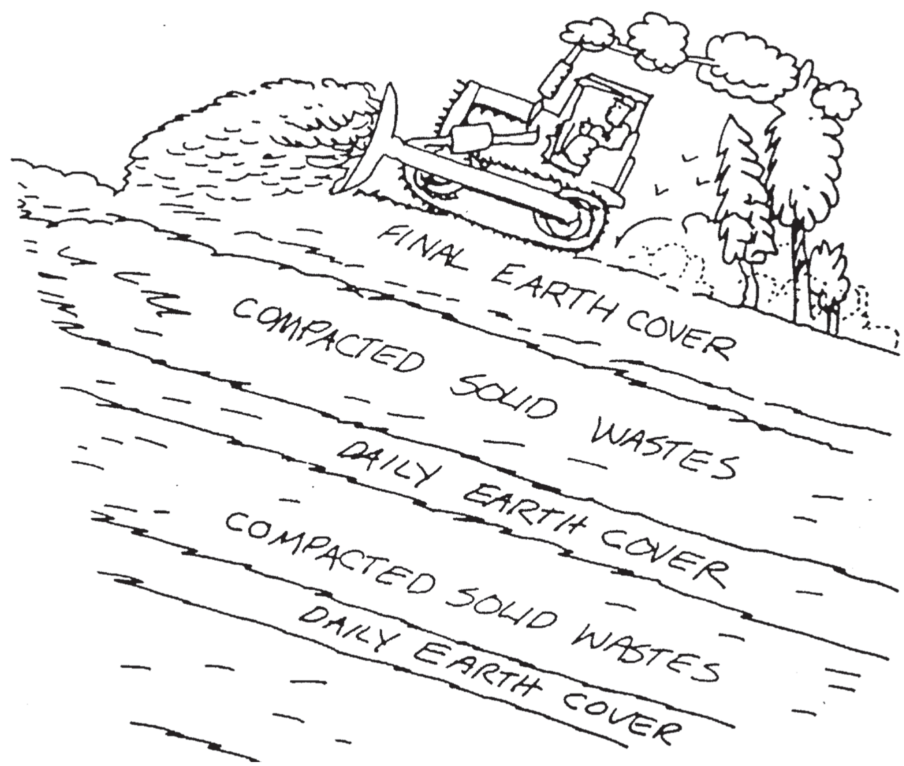
Organic material is still the largest component of solid waste, in 2012 27.4% of total solid waste generated in the United States is paper or cardboard, 28% of total solid waste is yard trimmings and food scraps.[71]

A 2008 survey of landfills found that 82% of the surveyed landfill cells had leaks, 41% of landfills had a leak larger than one square foot.[72]

A Closer Look at a Landfill



The Layers of a Landfill



[71] United States Environmental Protection Agency, Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2012, EPA-530-F-14-001 (Washington, D.C.: United States Government Printing Office: 2014), 1.

[72] "Waste and Recycling Facts," Clean Air Council, accessed May 26, 2016, http://www.cleanair.org/program/waste_and_recycling/recyclenow_philadelphia/waste_and_recycling_facts#_ednref16.

Bottle Bill[73]

Americans, on average, consume 20.36 gallons of beer and 40.57 gallons of soft drinks each year. Long ago, before any deposit laws existed, most soda and beer were packaged in glass bottles and most glass bottles were designed to be returned, refilled and used again. Consumers received a deposit when they returned the bottles. When new one-way bottles and cans entered the marketplace, litter problems increased and legislation to solve the problem was introduced. Vermont passed the nation's first container law in 1953, however the law expired in 1957. Oregon passed the first bottle bill in the nation still in use in 1971, other states followed suit in the 1980s.

Refillable soft drink bottles can make 10 to 15 trips from consumer to bottler and back to the consumer. Unfortunately, the number of refillable bottles that are actually refilled is a small percentage of the total and getting smaller. Nationally, only about 33% of bottles or other recyclable containers are actually returned and recycled, however, states with deposit laws or 'bottle bills' often have a recovery rate of 70% or higher. The following states have bottle bills: CA, CT, HI, IA, ME, MA, MI, NY, OR, VT. Tennessee and Texas have both been unable to pass bottle bills and Delaware's bottle bill was repealed in 2009.

Bottle Bill and Recycling

Clearly, the bottle bills are successful on two fronts: recycling and litter control. Because of the economic benefit to individuals, no other recycling program achieves as great of a return rate. It also results in a comparatively high quality recyclable material. Further, bottle bills have served to introduce Americans to the routine of recycling and has acted as an impetus for the private sector to invest in the United States' recycling infrastructure.

But, bottle bills are not without its controversy. Some groups claim that bottle bills rob curbside recycling programs of valuable revenue and eliminate jobs in the packaging and manufacturing industries. Opponents of these laws also claim they are expensive and inconvenient for the average citizen. In 2014, Massachusetts attempted to expand its bottle bill to cover bottled water and soft drinks. Of the over nine million dollars used in campaign against this legislation, over 80% of it came from beverage companies. It was also found that the statistics used in the anti-bottle bill ads were false.

United States Fact Sheet (2015)

Population	323,476,523 (As of March 23, 2016)
Area	3.8 Million Square Miles
Estimated Tons of Waste Generated (2012)	251 Million
Estimated Tons Recycled (2012)	87 Million
Active Landfills	1,908
Resource Recovery Plants	645
Incinerators	113
Wastewater Treatment Plants	14,780 Publicly Owned Treatment Works
Superfund Sites	1,322

[73] "Bottle Bill Resource Guide," Container Recycling Insitute, accessed May 26, 2016, http://www.bottlebill.org/.

THE ZERO WASTE AGENDA[74]

Introduction

Zero Waste is the next step in the American success story called recycling. Everyday more than 100 million citizens do the right thing by recycling. Now it is time to set our sights higher and start planning for the end to wasting resources and to our reliance on landfills, incinerators and other waste facilities. Zero Waste is necessary and feasible. As human populations and material use increases, the natural systems that sustain us are suffering from accelerated degradation. Over the next few decades, our society will change in almost every way. Zero Waste represents a new planning approach for the 21st Century. The American economic system stands for individual freedom, entrepreneurship and free market capitalism. The GrassRoots Recycling Network (GRRN) adds to that system the principles of conserving resources, minimizing pollution, maximizing employment opportunities and providing the greatest degree of local economic self-reliance. Zero Waste defines the discipline required to create a more sustainable interaction with our natural world.

GRRN's plan is to have hundreds of community organizers across the country promote the Zero Waste message at the grassroots level in the Main Streets and legislative chambers of America.

The following policies and actions will be needed to move us towards Zero Waste:

- **Tax Shifting:** Instead of giving incentives for wasting, we should give tax credits and economic incentives for reducing waste and utilizing recovered materials.
- **Manufacturer Responsibility:** Waste management is an unfunded mandate that falls almost entirely on taxpayers and local governments. Manufacturers and producers must share responsibility for recovering their products and ensuring that they are recycled and not wasted.
- **Minimum-Content Standards:** Manufacturers need to help close the loop by using the materials collected in local recycling programs to manufacture new products.
- **Unit-Pricing for Trash:** Residents and businesses need to be given the incentive to reduce waste and recycle through variable garbage rates. The public must have the opportunity to eliminate their garbage bill if they are to achieve Zero Waste.
- **Full-Cost Accounting and Life-Cycle Analysis:** The benefits of waste prevention and recycling should include a full accounting of the costs of resource depletion, remediation and environmental degradation caused by the alternative: continued reliance on virgin materials and wasting.
- **End Subsidies for the Extraction of Virgin Resources:** The time has come to put an end to subsidiesfor the resource extraction industries.
- **End Cheap Waste Disposal:** Landfills and incinerators waste resources and produce pollution in our air, land and water. The time has come to have strong environmental standards and to account for the true long-term cost of waste disposal facilities.
- **Create Jobs Through Reuse and Recycling:** Waste prevention and recycling provides tremendous opportunity to create jobs and initiate new business ventures.
- **Campaign Finance Reform and National Resource Policy:** Much of the resistance to changing resource policies comes from industries that profit from wasting.
- **Take Consumer Action Against Wasteful Corporations:** The public must put pressure directly on corporations that profit from waste.
- **Consumer Deposit Programs:** Ten states have enacted Bottle Bill programs that have proven to be effective strategies to promote reuse and recycling. Deposit programs on other materials such as tires and batteries have also been proven successful.

[74] "Zero Waste Agenda," Grassroots Recycling Network, accessed May 26, 2016, http://archive.grrn.org/zerowaste/zerowaste.htm.

SOURCE REDUCTION AND REUSE IDEAS

Source Reduction

Source reduction is waste prevention. It is the practice of keeping goods and materials out of the waste stream. Reduction is the highest waste management priority. It applies to individuals as well as businesses and requires us to think about how we can avoid throwing things away in the first place. By doing so, we conserve energy and resources and create less pollution, particularly hazardous waste. Reduction has opportunities for expansion in the economic sector through reuse, repair, redistribution and remanufacture.

Reduction is a higher priority than recycling because recycling still uses energy and creates pollution. For example, while the impact of recycling paper is far less than that of producing paper from pulp, most recycled paper must be de-inked. The de-inking process leaves a toxic sludge that is then landfilled or incinerated. Manufacturing carpets or fleece jackets out of PET bottles takes energy.

In addition there is enormous potential for source reduction by businesses and manufacturers. By encouraging commercial, industrial and institutional waste generators to develop self-sustaining programs, source reduction can become a vital contributor to the economy. Already, these organizations have used waste reduction to their advantage by utilizing refillable printer cartridges, two-way envelopes, waste exchanges and identifying surplus equipment and material to schools and nonprofit agencies.

In addition, there is a profit to be made for entrepreneurs who are willing to provide services within the reduction market. Such innovators have created businesses which repair washing machines for resale, convert old topographic maps into stationary, printers' waste ink, salvage quality used carpet for resale, build furniture, toys and bird feeders from waste wood, rent formal wear and maternity clothes and design reusable shipping materials to name a few.[75]

The advantages of incorporating a source reduction strategy into our daily lives and our economy are numerous. In addition to the advantages mentioned in the opening paragraphs, reduction preserves the so-called embodied energy[76] that was originally used to manufacture an item, reduces the strain on valuable resources such as fuel, forests and water supplies and helps safeguard wildlife habitats. Reduction saves money in purchase and disposal costs, generates new businesses and employment opportunities and creates an affordable supply of high-quality goods. It can bring these goods and services to individuals and organizations that might otherwise be unable to afford them.

Reusing Scrap Materials

Scrap materials are an excellent source for art projects and other creative endeavors. Stores selling leftover odds and ends for craft supplies have sprung up across the country. These materials are appropriate for schools, after school programs and day care centers, camps, scouts and other community groups. The use, or re-use, of these materials inspires ingenuity, can be thought provoking and is an excellent opportunity for a lesson on reduction.

[75] David Goldbeck and Nikki Goldbeck, Choose To Reuse, (Woodstock: Ceres Press, 1995).

[76] Ibid.

Useful Scrap Materials

From Home

- Aluminum pie tins
- Appliances (broken) with moving parts (clocks, radios, fans)
- Appliance boxes or crates
- Baskets
- Boards, bricks and concrete blocks
- Books (especially children's books)
- Boxes
- Bottle caps
- Buttons
- Candles and wax
- Carbon paper
- Cardboard tubes
- Clay
- Clothes (dresses, socks, costumes)
- Coat hangers
- Containers, durable
- Corks
- Corrugated paper and cardboard
- Crayons
- Ditto stencils and paper
- Egg Cartons
- Electronic equipment scraps
- Envelopes and manila folders, used
- Eyeglasses
- Fabric, fabric scraps
- Felt
- Foam rubber
- Furniture (desks, lamps, shelves)
- Games and puzzles
- Greeting cards, used
- Hats
- Jewelry
- Juice cans
- Kitchen utensils
- Magazines, old
- Maps
- Musical instruments
- Nails and screws
- Nylons, used
- Objects (natural and found), eg: flat stones, pine cones, feathers, driftwood
- Orange crates
- Paint
- Paper clips
- Paper/plastic bags
- Paper, poster or cardboard
- Paper products, such as crepe paper, paper cups and plates, tissue paper, contact paper
- Paste and glue
- Pencils and pens
- Pillows and cushions
- Plastic containers (butter, bleach, squeeze bottles)
- Plumbing pipe
- Popsicle sticks
- Record players
- Records
- Rubber band
- Rugs/carpet pieces
- Rulers, yardsticks and tape measures
- Scissors, paper cutter
- Sewing machines
- Sewing patterns
- Spools, ribbon, yarn
- Staplers, staples
- Strawberry container
- Straws
- String, rope
- Styrofoam packing
- Tape
- Tiles
- Tools (hammers, saws, screwdrivers)
- Toothbrushes, used
- Toys
- Trays, meat and produce
- Trinkets
- Typewriters
- Wallpaper books
- Wallpaper leftovers
- Wire screen, chicken wire
- Wood scraps/pieces
- Wrapping paper

From Businesses

- Airlines - plastic cups, packing boxes
- Art Supply Stores and Stationery Stores - leftover or damaged paper; leftover or damaged stock (e.g., paint, pencils, paper clips, staplers, staples, markers, etc.)
- Architects - blueprints and blueprint paper; slide rules and other tools
- Building Supply Companies - wood/lumber, tiles, wallpaper books, color samples
- Bottling Firms - bottle caps, large cardboard tubes
- Churches - old candles
- Container Companies - large cardboard sheets, damaged containers (sturdy and of uniform size)
- Contractors - lumber, pipes and wire, wallpaper, linoleum, tiles, molding wood, wood curls, etc.
- Department Stores - stocking boxes, fabric swatches, rug pieces, corrugated packing cardboard, packing boxes from appliances and pianos, Styrofoam packing material, decorative displays, old posters and business forms (blank on one side), shoe boxes, envelopes
- Dollar Stores - boxes, leftover or damaged packs of crayons, leftover toys, school supplies
- Drug Stores - small plastic bottles, crayons and other school supplies
- Electric Power Companies - wire, large spools, assorted packing materials
- Furniture Stores and Factories - large packing boxes, packing material, fabric scraps and swatches, scrap lumber
- Garment Factories, Clothing Firms - buttons, decorative tape, ribbon, yarn trim, spools, fasteners, fabric scraps
- Gift Shops and Boutiques - candles, boxes, Styrofoam packing material, wrapping paper, ribbon
- Grocery Stores, Food Co-ops, Outdoor Markets - cartons, packing materials, fruit crates, cardboard boxes, materials from displays, discarded display racks, Styrofoam fruit trays, baskets
- Hardware Stores - sample hardware books, sample tile charts, rope, chain, wood, molding strips
- Ice Cream Stores - three gallon ice cream containers
- Interior Designers - fabric, carpet and flooring samples and scraps
- Leather Craft Companies - scrap pieces of leather and lacing
- Lumber Companies - scrap wood, damaged bricks, concrete blocks, doweling, wood curls
- Offices - discontinued business forms and posters (anything blank on one side), pencils and erasers, office furniture, file cabinets, lamps, typewriters, envelopes, manila folders, large brown envelopes
- Paint Stores - leftover paint, samples, sample books, wallpaper books, end rolls of wallpaper, tiles
- Paper and Printing Companies - end cuts and damaged paper and posters
- Phone Companies - colored wires, old telephones, large spools
- Photographers and Framing Shops - empty film containers, scraps from matt board and foam core
- Plastics Companies - trimmings, cuttings, tubing, scrap plastic and Plexiglas
- Plumbers and Plumbing Supply Companies - wires, pipes, tile scraps, linoleum Printmakers and Artists - paper and matt board scraps
- Quiltmakers and Rugmakers - scraps of fabric and batting
- Repair Shops - unclaimed appliances (preferably working, but inoperable as well) - tv's, clocks, fans, lamps, record players, typewriters, sewing machines, radios
- Restaurants - candles, empty food and produce containers, corks, ice cream containers, bottle caps, boxes and cartons
- Rug Companies - any leftovers or scraps, sample swatches, end pieces from carpets
- Textile Companies - color samples, any scraps or pieces
- Tile and Ceramic Companies - leftover or damaged tile
- Toy Stores - leftovers, damaged products, packing materials, boxes
- Upholsterers and Tailors - buttons, scrap material, spools, cord, string

Source reduction can be practiced easily by individuals on a daily basis.

Here are some examples:

Buy products in reusable, refillable or recyclable containers.	Avoid using disposable dishes and utensils.
Buy items that are minimally packaged.	Buy unbleached paper products.
Avoid packaging using mixed materials, e.g: juice boxes.	Buy recycled paper products.
Avoid multi-layered plastic containers. These include squeezable and microwavable products.	Tell your supermarket manager you won't buy over-packaged goods. Write the supermarket chain with the same message.
Buy concentrated products - they use less packaging.	Use cloth, not paper napkins.
Use both sides of the paper.	Use cloth diapers whenever possible.
Use old rags or cloth towels instead of paper towels for cleaning.	Patronize fast-food outlets that use recyclable containers.
Use cloth bags when shopping at the grocery store, or reuse your own plastic or paper bags.	Buy products that are durable and repairable. Avoid use once and throw away products.
Choose fresh produce instead of canned or packaged. Often, chemicals are added to these foods to make them last longer.	Buy fresh produce that is not pre-packaged. Usually the packaging is polystyrene or shrink-wrap. Bring reused paper and plastic bags to package the produce.
Encourage your family to hold a garage sale to recycle old possessions, such as clothes, toys and books. Hold a class garage sale to raise money for cloth lunch bags.	Dispose hazardous wastes (toxic cleaners, pesticides) properly. Call your Solid Waste Management District or Town Clerk for Hazardous Waste Collection days.
Give old clothes to stores that specialize in reuse.	Use a lunch box or cloth bag for lunches.
Return coat hangers to the cleaners.	Reuse glass or plastic containers to store leftovers.
Buy products that are recyclable - and recycle them!	Bring your own coffee mug.
Use a thermos or water bottle instead of multi-layered drink boxes.	Use reusable containers for your sandwich or snack instead of plastic or aluminum foil.
Reuse manila envelopes.	Keep a compost pile.
Share a magazine subscription or a book with a friend.	Use your library instead of buying books/magazines.

World of Recycling

Remember — If we don't make it, we won't have to get rid of it. The United States produces far more trash than any other nation in the world. First we need to reduce the waste we produce which, in the United States, is about 251 million tons each year.[77] Too many products are designed to be thrown away soon after purchase. Disposables have been taking over the marketplace and our lives. After careful thinking, what we decide we do need should be used as long as possible before it is recycled. We should try to throw out as little as possible.

Pre Consumer Recycling

Recycling of materials goes on consistently within industries. What can be saved within the manufacturing process saves money and generates more profit. Small savings repeated over and over do add up to substantial savings for the producer. Most scrap metal, plastic, paper and glass are all recycled in the production of consumer goods.

Recycling on this level is easy because the waste is CLEAN. It has not been contaminated with old banana skins and rotten tomatoes. Itis also in one place, which means it does not have to be collected back from all corners of the earth and the end of every dirt road.

Post Consumer Recycling

Even after we've reduced our usage and reused things as much as we can, we will still produce some waste. But much of our waste stream is readily recyclable or compostable. For instance, bottles can be designed to be reused by industry and then recycled. Many resources that we throw away are potentially valuable and could be reused or converted into other products. Washing a glass bottle and using it again saves all the energy it took to make the bottle, although it also consumes some energy to pump, heat and later treat the water used.

Recycling, since it involves the making of new products, will contribute its own share to our waste and pollution problems. Recycled paper requires use of energy and water and produces much pulp-sludge. De-inking of paper for recycling concentrates potentially toxic ink substances in its waste. Aluminum recycling requires much less energy but produces a similar amount of air pollution potential when it is smelted. Overall, however, recycling saves energy and natural resources, reduces pollution and saves valuable space in landfills.

How Much Can We Really Recycle?

In the early 1980s, EPA estimated that 26% of urban trash can be recycled, in 2012 it was estimated that 75% of waste can be recycled. Yard trimmings and food scraps that could have been composted are approximately 28% of the total waste generated in the United States.

The question for some time has been whether it is really feasible to recover these resources. Several myths about recycling have stood in the way:

- People will not separate their trash.
- Recycling cannot make a serious dent in the waste stream.
- Recycling costs too much.

However, as the cost of waste disposal increases, more and more people are recycling at least some of their waste and this is beginning to make a difference in the amounts of waste requiring disposal.

Beverage Container Deposit Legislation

Bottle bills increase recycling by providing a substantial financial incentive and by providing convenient redemption centers. They make it easier and provide an incentive for consumers to separate recyclable deposit containers from their trash.

[77] United States Environmental Protection Agency, Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2012, EPA-530-F-14-001 (Washington, D.C.: United States Government Printing Office: 2014).

Economic Incentives

Market conditions for recyclable materials are dependent on demand. For example, much of the paper collected by recycling programs is exported and other paper is used by the building trades. When exports or construction are strong, prices for paper are good. To improve the market conditions for recyclables, we need to remove regulatory and policy barriers to the use of recycled materials and increase the specifications for and number of products made with secondary (recycled) materials.

Avoiding the increasing costs of trash disposal provides a real financial incentive to recycle. Because of the demand for landfill space and the rising costs of disposal, over $100 per ton in New York, recycling has become a desirable and economically feasible waste management technique. Recycling is also more successful when user fees are imposed for disposal according to how much trash a person, business or community produces.

When recycling costs less than disposing of their recyclables as trash, people have an economic incentive to recycle. Residences who pay a flat weekly rate regardless of how many bags of trash they produce have no financial incentive to reduce their waste. Whether they put out one bag each week or six, they will pay the same amount. Currently, trash collection costs the average household between $12-$20 per month, much less than other utilities or services. People who pay a tipping fee (pay as you throw) per bag of trash at the local landfill have that incentive; materials separated for recycling are not charged the disposal fee, thereby providing an economic incentive to keep waste to a minimum. In 2006, 7,095 communities across the United States had pay as you throw programs. Pay as you throw encourages personal responsibility for waste production and disposal. There is a need to develop an incentive for haulers to offer unit pricing based on how much trash they collect instead of charging a flat fee. Many municipalities and solid waste districts have negotiated a variable rate system, based on either weight or volume, with handlers operating in their region.

Source Separation: Commingled

Separating glass, paper, metals, plastics and other recyclables before they get mixed in with the trash is called source separation. Once set aside, these materials can be taken to a recycling center or picked up by a waste hauler at curbside.

Source separation requires individual participation and is much less expensive than having the materials separated at a facility after being mixed together. Source separated materials are also often cleaner, command a higher price and may therefore help offset more disposal costs. Mandatory source separation ordinances have been enacted in some communities and have proven to be a successful tool for increasing participation in recycling programs.

Many of the curbside recycling programs and some of the drop-off centers collect recyclables separated into only two categories: paper and containers. The paper group includes newspaper, office paper, magazines, boxboard and cardboard. The containers category includes glass and plastic bottles, aluminum and tin cans.

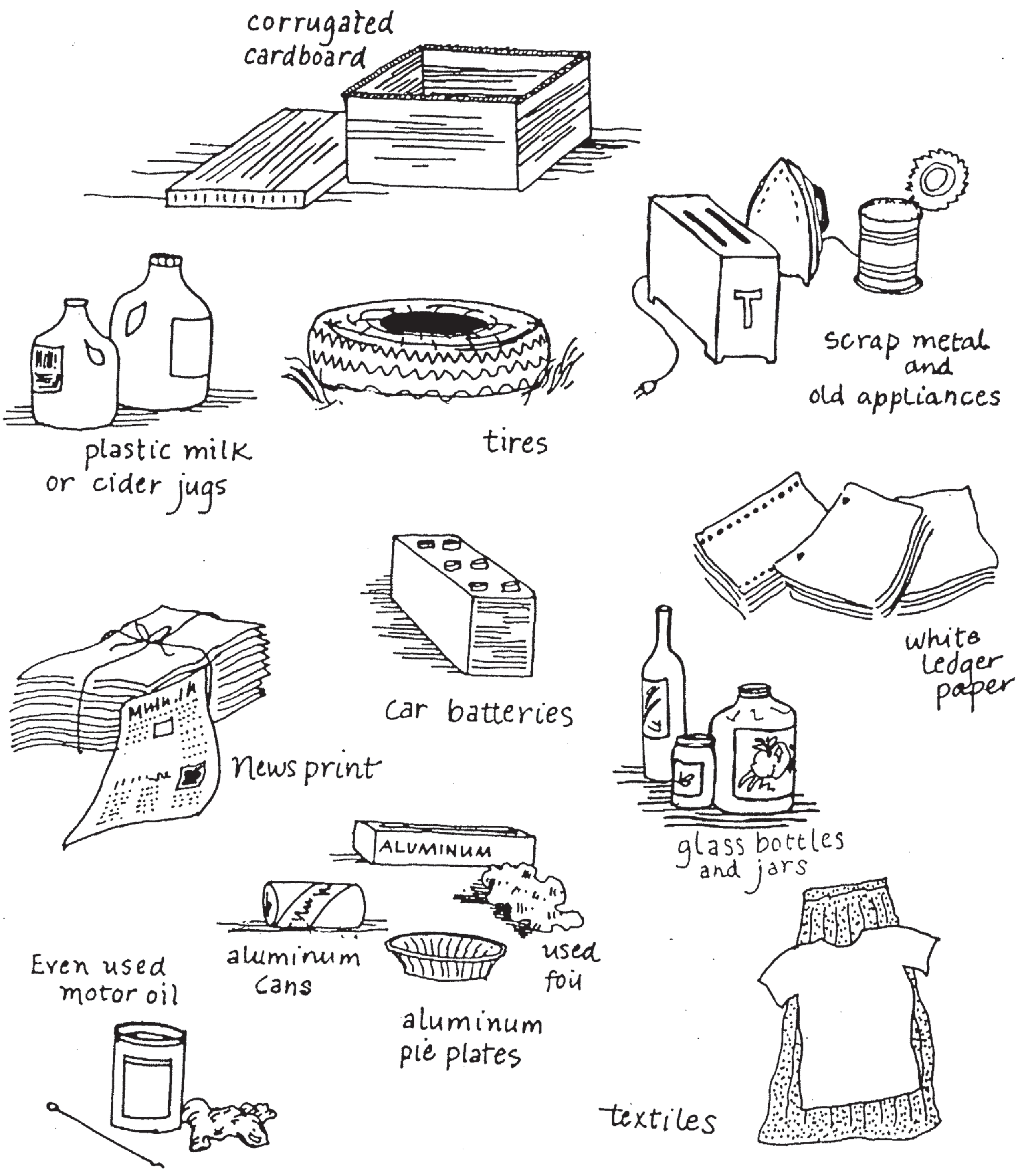
There are many different ways to run a recycling program. Communities must decide which is the best for them according to variables such as geography, population, markets, regional and state government plans and current waste stream composition. Recycling programs can be as simple as running a newspaper drive or as complicated as setting up a full service recycling center or curbside collection program.

The following collection systems are common:

- Drives are one shot collections usually organized for one material. They are popular as fundraising events for schools and community organizations, but can only make a temporary dent in the waste stream.
- Recycling drop-off bins, sheds or roll-off boxes are set up at accessible public locations for the supervised or unsupervised drop off of materials. Drop-off locations require a special trip by the recycler unless they are located in a place where most people already need to go, such as at a school, a grocery store parking lot, or a landfill or transfer station.
- Buy back centers are recycling centers where materials are brought and exchanged for payment. Some centers will pay individuals for small amounts of recyclables; others provide payment only for large amounts. Buyback centers are common in urban areas, particularly in states lacking a bottle bill.

- Reverse vending machines are mini-automated buy-back centers. They are a recent addition to the recyclable collection system in the United States. In states where beverage containers have deposits, they provide automated collection of aluminum, glass and plastic soft drink bottles similar to soda vending machines. Containers are inserted and money is dispensed automatically to the customer. Many larger grocery stores offer these machines.
- In curbside recycling programs each household separates its recyclables from the trash according to guidelines provided by the business or agency providing the recycling service. Some haulers have trucks with separate compartments for trash and recyclables. Others must use two trucks: one for trash and one for recyclables.

Recyclables



Single Stream

Single stream recycling is the 21st century advent for making recycling easier thus potentially collecting more material. An important step toward meeting zero waste goals. Instead of diligently separating recyclables into two separate streams: mixed paper (newspaper, junk mail, etc.) and commingled containers (bottles, cans, etc.), these two streams are put together in one bin. The idea behind a single stream recycling method is to make recycling as simple as using a trash can. For the previously unconverted, there, is no excuse for not recycling. In addition, with all recyclables collected in one can, communities and recycling haulers can plan to use the second can for compostable materials like food scraps and yard waste, making it possible for to recover up to 80% of discards. That leaves little need for that third can, the trash.

Processing Recyclables

At recycling centers, materials are sorted, processed and made ready for shipping to manufacturers. Aluminum and tin-plated steel cans are crushed and baled. Glass is separated by color, crushed into very small pieces called cullet and contaminants such as bottle caps and rings are removed. Newspapers, corrugated cardboard and other grades of paper are also baled for shipping. Plastic is either punctured and baled or shredded. Some five to 20% of incoming collected materials is not recycled due to contamination and becomes waste that is shipped to the landfill. Like all waste management facilities, recycling centers do generate truck traffic and noise and must control litter and dust.

Materials Recovery Facilities (MRFs)

There are several materials recovery facilities (MRFs), clean MFR's are divided into single stream and dual stream. In these facilities all material is mixed together (single stream) or is divide into a glass, plastics and metals container stream and a mixed paper stream. The materials are sorted, baled, crushed and compacted, then sent back out into the market. Dirty MFR's accepts all solid waste, the recyclables are picked out and the rest is dumped in a landfill.

It is more expensive to process single stream recyclables and the material is more contaminated than source separated or dual stream. Broken glass reduces the amount of material recycled and wreaks havoc on the machinery. This decreases the market value for the recyclables. Source separated recyclables are less contaminated thereby they have a higher market value. The rates of "residuals", recyclables that end up in the landfill during the sorting process are higher for single stream recycling systems than for systems that require more sorting earlier on in the process. Those residuals eat away at the gains in initial recycling rates.

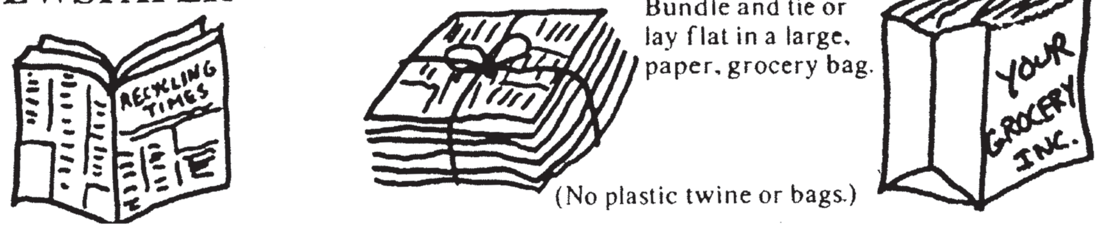
Recycling Fact Sheet

- According to one estimate, making paper from recycled fibers at the factory requires 61% less water, 60-70% less energy and produces 70% fewer pollutants.
- Producing an aluminum can from bauxite ore requires 20 times as much energy as making it from recycled aluminum.
- If you buy beer or a soft drink in an aluminum can, chances are better than 50-50 that your can was made from other cans; the time between its leaving the factory and dropping into the melting furnace once more may be only three months. ("The Fascinating World of Trash," National Geographic)
- Of the 251 million tons of garbage produced 2012, only 87 million tons were recycled.
- If all of the newspapers published in 2005 had been recycled it would have saved about 250,000,000 trees each year.
- Throwing away two aluminum cans per day wastes more energy than is used daily by each of one billion people in poorer countries.
- According to the Environmental Protection Agency, recycling all municipal paper and metal would prevent release of 2000 tons of air pollutants and 700 tons of water pollutants annually in the United States.
- The 0.0015 inch coating of tin on a tin can represents 1/3 of the recycled value of the can while comprising only 0.25 to 0.4% by weight.
- One gallon of used motor oil can be re-refined into two and one half quarts of lubricating oil. The United States could reduce petroleum imports by 25.5 million barrels of oil each year and save 1.3 million barrels of oil each day by re-refining its used motor oil.

HOW TO PREPARE RECYCLABLES

(Contact your local recycler or market for exact specifications.)

NEWSPAPER

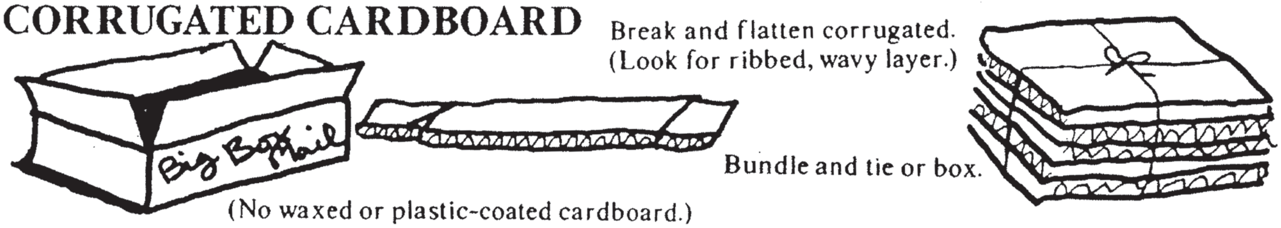


Bundle and tie or lay flat in a large, paper, grocery bag.

(No plastic twine or bags.)

CORRUGATED CARDBOARD

Break and flatten corrugated. (Look for ribbed, wavy layer.)



Bundle and tie or box.

(No waxed or plastic-coated cardboard.)

GLASS

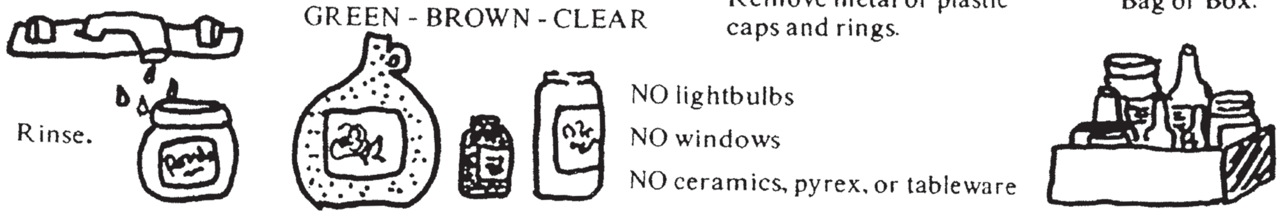
Rinse.

Separate by color.

GREEN - BROWN - CLEAR

Remove metal or plastic caps and rings.

Bag or Box.



NO lightbulbs

NO windows

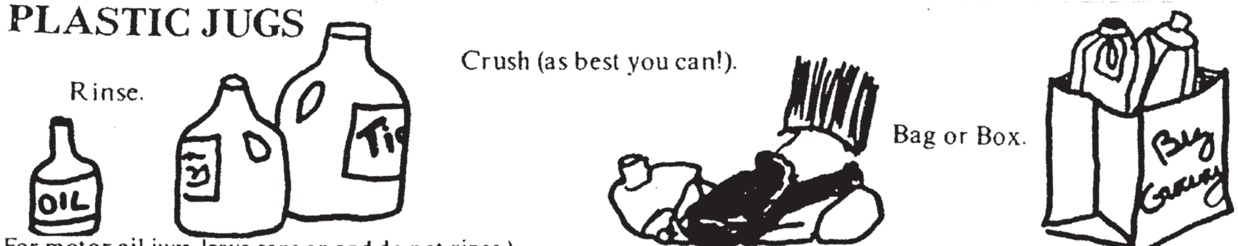
NO ceramics, pyrex, or tableware

PLASTIC JUGS

Rinse.

Crush (as best you can!).

Bag or Box.



For motor oil jugs, leave caps on and do not rinse.)

METAL

Separate aluminum from steel.

(Aluminum is not attracted by a magnet)

Rinse completely. Remove any labels.

Remove ends of cans.

Flatten.

Bag or Box.

PAPER

white ledger

mixed, colored paper.

No paper clips.

Bag or Box.

School Recycling [78]

Implementing a waste reduction or recycling program is an effective way to minimize disposal costs and promote a conservation-consciousness among students. Schools can play an important role in empowering students to understand and participate in resource conservation by becoming informed decision-makers. Involvement in a school waste-reduction program can help students understand how their personal actions can contribute to resource conservation efforts.

Reduction, reuse and recycling minimizes environmental impacts associated with wasting our valuable natural resources. Schools contribute a significant amount of solid waste to landfills and incinerators, a practice that is growing more and more costly. Waste reduction and recycling may decrease school expenditures on trash disposal and conserves valuable landfill space and virgin resources.

Getting Started

Define your goals before starting a program. Some of your goals may be:

- Maximizing reduction and reuse of all waste materials.
- Complying with a local mandatory recycling ordinance.
- Instituting a school-wide or district wide policy to buy supplies with recycled content.

Step One: Analyze the Waste Stream
An excellent way to involve students in the preliminary planning process is to analyze the waste stream. This can be done by either looking in the dumpster or by conducting a school waste analysis. A school waste analysis involves analyzing the type, volume and generation of school waste. See grade 7-8 School Trash Analysis I.A.2 for an activity that outlines this procedure.

Step Two: Identify Opportunities for Reduction
Reduction is a critical step in decreasing your school's waste stream. Your goal is to reduce the purchase and use of material before it enters the school. Schools frequently find that the bulk of their trash is paper, beverage containers, milk cartons, paper towels and cardboard. Some schools encourage their students to use lunch boxes, reusable lunch bags, thermoses and Tupperware instead of disposable bags and packaging. Many schools have successfully switched from milk cartons to milk dispensers in the cafeteria, which reduces the amount of packaging needed for milk.

Step Three: Determine the Type of Materials To Be Recycled
Note: Before establishing a recycling program, contact your hauler and inquire how materials should be separated for collection.

Materials that can be recycled include:

Newspaper	Corrugated cardboard or container board	Tin-plated steel cans
Magazines and catalogs	Boxboard	Glass
Plastics (#1 PETE, #2 HDPE)	Aluminum	Paper: white, colored, glossy, envelopes.

[78] Association of Vermont Recyclers, "The Fourth R," School Recycling Manual.

Choosing a Recycling Vendor

The following is a list of information schools should know before contacting potential haulers:

- Current dumpster size (length, width, height) and number of dumpsters at the school
- Rate of service: how often are the dumpsters emptied? Are they full when emptied?
- Cost of current service

To determine the right hauler for your school, contact your current trash hauler to see if they offer recycling services. Ask what materials they accept, how they must be separated and whether or not they provide collection containers. In addition, be sure to collect a list of guidelines, or material specifications, from the hauler. Confirm changes to contract cost by adding recycling. Try to contract with one hauler that can service recyclables as well as trash, as this should be the least expensive option for the school. The hauler will be able to measure changes due to recycling.

Program Logistics

Equipment you will need to start a recycling program:

1. Each classroom and office will need some type of bin for paper collection. You may need two bins if colored paper is used. The bins can be plastic recycling bins (made with recycled materials), sturdy plastic rectangular boxes (laundry baskets without the slats) or decorated cardboard boxes.
2. Each school will need a storage receptacle into which individual classroom bins are emptied. Rollout carts, discarded drums and drum trolleys, or a wooden boxes serve well for this purpose.
3. Each school will need storage space for recycling receptacles and cardboard. Check with your hauler to determine the most efficient and acceptable storage areas.
4. Check with whomever deals with safety issues at your school to determine if there are specific building code or fire regulations that apply to your school.

Program Planning

The key to a successful program is to plan backwards. Decide how you will remove materials before you collect them. If you will be using a recycling hauler, collect only hauler-accepted materials. The way that the program is introduced is an important component of success, therefore it is necessary to educate all program players about the particulars.

The following ideas will assist schools in the planning and implementation process:

1. **Organize a Staff Meeting.** Meet with school administrators, custodians, teachers and key school board members to discuss the benefits of a recycling program and gain their commitment for a full year in order to measure benefits and determine future actions. During this meeting you should select a recycling program best suited for the school, designate a contact person, identify the number of bins needed and identify a storage/collection area.
2. **Organize a schedule of materials pickup between custodian and hauler.** Establish a contact person for the recycling hauler. These communications serve to update on material specifications and other important changes regarding recyclables. This person should know the recycling pickup schedule and material specifications and should be kept informed by the recycling hauler about important changes.
3. **Organize a student green team to collect, monitor and keep track of recyclables.** Most importantly, green team members ensure that recyclables are collected from classrooms and transported to common storage area.
4. **Acquire bins for each classroom and acquire a rollout cart or storage bin that can be serviced by the hauler.**

Ensuring Student-Teacher Participation

Success depends on all program players. It is necessary to define participant roles and to create an air of excitement throughout the school.

Ideas for success include:

1. **Host a kick-off assembly or event to initiate the program.** Invite an education conservation group to lead a recycling assembly at your school, or hold an informal assembly where the principal, key faculty and school board members introduce the program. A ribbon-cutting ceremony is another way to celebrate the first use of the school's recycling bins. Educational videos or guest presenters are a helpful way to inform student about school recycling.
2. **Publicize the program by writing a press release for the local newspaper and/ or an article for the school district newsletter.** Students can record a public service announcement at your local radio station. Send flyers home with students to notify families about the school program. Include information on the location of local recycling depots so students can assist their families with recycling at home.
3. **Finally, evaluate the success of your program.** Evaluate the quality of collected materials at the end of the first month. Reinforce positive behavior and challenge people to correct mistakes, for example, use a report card to provide feedback to individual classrooms regarding their recycling efforts.
4. **Three months into the program, hold another Staff Meeting** to discuss concerns and program evaluations.
5. **At the end of six months, compare initial disposal costs to present disposal costs.** Note current savings or estimate savings that are necessary to recover any start up costs. Take this time to brainstorm strategies that will make the program more effective. If statistics are readily available from the hauler or monthly invoice, a class could track the quantities of waste and recyclables generated by the school.

Composting

COMPOST OVERVIEW
School, Home and Citywide Composting

Composting can significantly curb the amount of waste that is disposed in landfills. Yard trimmings and food scraps comprise approximately 27% of what goes into a landfill. Dumping food scraps and yard trimmings wastes resources that are the basic ingredients of nutrient-rich humus - the dark part of soil that is derived from decayed material. School is an excellent place to compost because a considerable amount of food is thrown away each lunch hour. The compost pile is also a prime source for biology and chemistry projects, especially if undertaken in conjunction with a garden.

You can reduce the amount of waste and conduct a fascinating science experiment at the same time!

Composting provides an opportunity for students and teachers to interact with the natural world. It teaches how soil, the basis for life on earth, is created. Composting demonstrates the processes involved in the nutrient cycle. Given the right conditions (a balance of air, water, carbon and nitrogen) decomposer organisms break down food scraps and yard waste into fresh, fertile humus that can be used to grow plants on school grounds. The cycle of life is completed when these plants are added to the compost pile in the fall.

Wet (green/nitrogen) materials are mixed with dry (brown/carbon) materials in a ratio of one green: three browns. Nitrogen and carbon provide essential elements for the decomposer organisms to grow. These organisms also need air and water, which is why the pile must be turned and watered once a week. Adding humus from an old compost pile, manure, or a heap of wet leaves and duff from the forest floor ensures that the pile has a healthy population of decomposer organisms.

Many compost manuals instruct you to fill a bin to at least 3′x3′ before you begin to compost. While large piles heat up (temperatures can reach 140 degrees Farenheit, killing weed seeds) and produce compost quickly (within three to four weeks), you do not need to make a 3′x 3′ pile to be a successful composter. If you provide the correct balance of carbon and nitrogen, air and water, decomposition will begin, but the process will be much slower.

Finished compost is uniform in texture and odorless. Well-screened compost can be used in a fertilizer spreader, side-dressed, or used in potting mixtures. Composting concentrates organic matter so you won't have as much material to spread. Nutrients are stabilized against leaching and are slowly available to crops- during the entire growing season.

You can add mineral fertilizers and micronutrients to compost to ensure a more balanced distribution of nutrients. It is not necessary to do this, however. The heat generated during composting destroys most weed seeds, perennial roots and pathogens. Beneficial microorganisms and soil fauna multiply in the composting environment. Substances that enhance plant health, such as antibiotics, are produced.

One of the most fascinating aspects of the compost pile is the biology of decomposition. Numerous microorganisms and macroorganisms work to break down the organic material into humus. Bacteria, actinomycetes and fungi are known as chemical decomposers. The populations of these microorganisms can be astronomical. A half teaspoon of soil can contain a billion bacteria, millions of actinomycetes and fungi and thousands of tiny animals such as protozoa, rotifers and nematodes. The macroorganisms (worms, insects, slugs and others) are considered physical decomposers because they eat the contents of the compost pile. Each of these creatures has its own ecology and all of them work in concert, creating a web of life within the compost pile. A food web is a complex food chain; it describes the intricate relationships of who eats whom. The function of the web is population control. The organisms in each level of the food chain keep the populations of the next lower level in check. Refer to Daniel Dindal's diagram, Food Web of the Compost Pile for a graphic of the compost pile's food web. Below is a brief description of the major players you may find in your background or school compost pile.

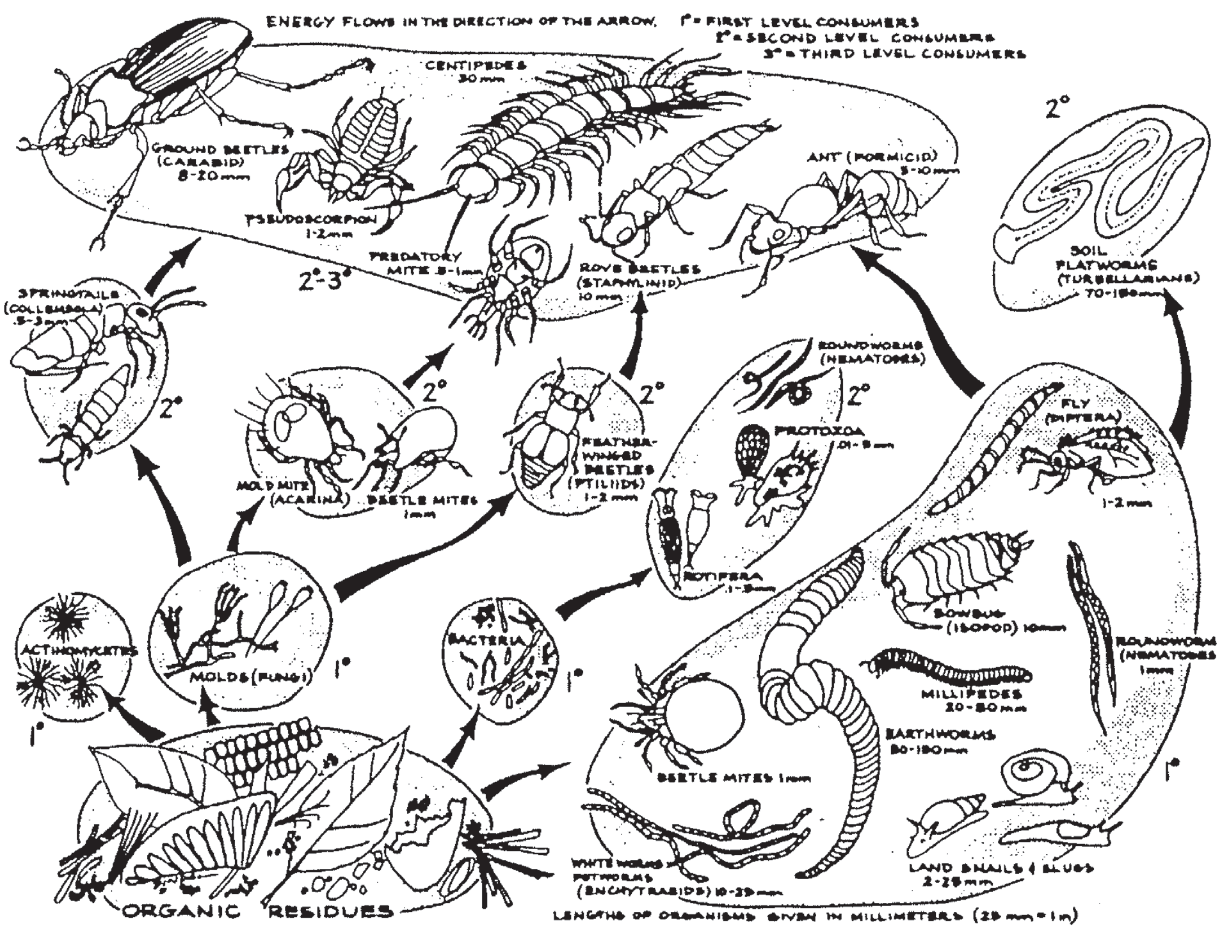
Compost Pile Food Pyramid

Centipedes,
predatory mites, spiders
rove beetles, ants, pseudoscorpions
springtails, mites, feather-winged beetles,
nematodes, protozoa, rotifera, soil flatworms
bacteria, fungi, actinomycetes, earthworms, nematodes,
mites, snails, slugs, millipedes, sowbugs, white worms

Decomposing Organisms of the Compost Pile

- **Bacteria** The species of bacteria in the compost pile will be the type which specialize in anaerobic decomposition. If you have a large pile that heats up, you will also have thermophilic (heat-loving) bacteria. Bacterial populations will differ according to the specific conditions of the pile, such as the raw materials of the compost, temperature of the pile, amount of air available and moisture level. Bacteria break the compost down so it can easily be digested by actinomycetes and fungi.
- **Actinomycetes** Related to fungi and molds, they form the greyish cobwebby filaments you find in an active compost pile and are responsible for the earthy smell of fresh humus. These organisms generally work deep within the soil structure. In the process of decomposition, actinomycetes free carbon, nitrogen and ammonia, making them available to plants.
- **Fung**i Primitive plants that lack chlorophyll. Most of them are saprophytic, meaning they obtain energy by breaking down organic matter in dead plants or animals.
- **Millipedes** Many students are familiar with the many-legged millipede. Millipedes feed directly on plant material. The eggs are laid in the cool, spring soil and soon hatch into worms that must molt several times before obtaining all their legs.
- **Sow Bugs** Feed on plant matter and can become quite numerous as the female can lay many eggs at one time. The eggs hatch into tiny versions of the adult.
- **Snails and slugs** While slugs are well-known for the damage they do to living plants, they also contribute to decomposition by feeding on fresh garbage and plant debris in the compost pile. Both snails and slugs are mollusks with muscular "feet" that enable them to creep through the soil.

FOOD WEB OF THE COMPOST PILE



Reproduced by permission from Daniel Dindal, *The Ecology of Compost* (State University of New York, 1972)

- **Springtails** Feed on decomposing plants, pollen, grains and fungi. They are tiny, blue-gray to silvery-black and have a specialized structure on their undersides which enables them to jump. Springtails are best known for congregating in shallow depressions in late-winter snow, where they feed on fallen debris.
- **Feather-winged Beetles** Feed on fungal spores. Like all beetles, its immature form is a grub that feeds on vegetable matter during the summer. It spends the winter in a pupal stage and emerges as an adult in the spring.
- **Earthworms** Plow, till and enrich the soil, they perform the same functions in the cool parts of the compost pile. Their tunnels allow air and water to penetrate the heap. The organic matter they ingest passes through their gut and is released as rich, fertile humus. Earthworms have a nervous system, blood similar to humans and a complex digestive system. They must stay moist because they breathe through their skin. They sense light through an organ in their heads and as ultraviolet light is deadly to them, they move away from light. Their eggs, known as cocoons, will become dormant if placed in dry conditions, but will begin to develop when suitable conditions return.
- **Predatory Mites** Mites that feed on nematodes, eggs, insect larvae, other mites and springtails.
- **Ground Beetle** Along with the centipede and pseudoscorpion, the ground beetle is king of the compost pile. While ground beetle grubs feed on vegetable matter, the adult form is a predator of insects (including springtails, mites and feather-winged beetles), small animals such as earthworms, roundworms, snails, slugs and millipedes.
- **Centipedes** Arthropods that have at least 15 pairs of legs - one pair per segment Centipedes feed on small animal such as earthworms, insects and spiders.
- **Pseudoscorpions** Predators that seize victims with their visible front claws, then inject poison from glands located at the tops to the claws. Their prey include minute nematode worms, mites, larvae and small earthworms.
- **Spiders** Feed on insects and small invertebrates.
- **Ants** The compost pile is a haven for ants. There is not only plenty of food available (fungi, seeds, food scraps, insects larvae, earthworm eggs and other first - level consumers in the pile), but also excellent shelter for nests and hills. Ants are active only when the pile is cool. They benefit the pile by moving minerals, fungi and other organisms from one part of the pile to another.

Municipal Leaf Composting

Each fall, we are confronted with tons of leaves falling from trees on our lawns. Adding leaves to landfills wastes rich organic matter and adds to leachate, methane and space problems. While the character of rural communities reduces the need for leaf and yard waste disposal, opportunities for recycling suburban and urban areas are increasing.

Several municipalities throughout the country have active leaf composting programs, where leaves are collected and then composted. Many of these programs are in the northern part of the country. In Burlington, Vermont, the Intervale Foundation spearheads the city's leaf-composting program. Many restaurants, hotels, hospitals, grocery stores, schools and other businesses and institutions deliver their food waste to the Intervale Compost Project (ICP) or contract with a food waste hauler. The food waste is then mixed with yard waste, manure and ice cream residue to produce a nutrient rich soil amendment. The compost is used to restore the soil in the Interval and is available for sale to landscapers, nurseries and home gardeners.[79]

In New York City, leaves are collected from Brooklyn neighborhoods. The leaves are taken to a tract of damaged land in Ferry Point Park, a former landfill site. A private sanitation contractor processes the leaves into mulch and compost. It is hoped that this pilot project will expand in the future to include other New York City neighborhoods.[80]

Sewage

Although water disposal of organic waste through sewage systems has many health and cost benefits, it also has notable drawbacks. Water, which we consider a renewable natural resource, is becoming less and less pure and hence less usable, in part because of sewage. Pumped out of septic systems and municipal sewage plants, 25 billion gallons of sludge is produced daily in the United States. According to one study, 60% of this is used as fertilizer, the rest is discarded or burned.

There are problems with composting sewage sludge. Human waste with household chemicals and detergents is flushed into septic or municipal systems, thereby mixing biodegradable materials with potentially hazardous elements. Industries also contribute chemical waste to sewage being processed, contaminating it with hazardous substances, such as solvents and heavy metals, such as cadmium and mercury. Any resulting soil conditioner also may be contaminated. This potential contamination increases the costs of using it as a soil conditioner (since it must be tested for contamination), limits where it can be applied and may lead to public opposition to its application.

Composting toilets hold out some promise for allowing water-less disposal of human and kitchen wastes in homes. Contraptions like the Clivus Mulstrom are large fiberglass containers into which kitchen garbage and human wastes are dumped. The wastes work their way slowly down to the bottom of the container while air circulates through them and the bacteria slowly decompose and transform the waste into soil conditioner over a one to two year period. The volume of waste can be reduced by 90%. However, these devices are not in many respects fully perfected (particularly in their ability to remove water from the wastes).

BACKYARD COMPOSTING
The Basics of Composting

Microorganisms and soil fauna break down organic matter. To accelerate the composting process, you need to provide the best possible environment for these beneficial organisms to do their work. When a gardener puts materials together that match the requirements of these decay organisms, the process works very rapidly - as short a time as two weeks.

Decay organisms require a combination of carbohydrates and protein. A carbon to nitrogen ratio of 30:1 is the perfect balance to speed the composting process. Carbohydrates (carbon) are usually dry, tough, fibrous plant materials, including fall leaves, straw, sawdust, shredded paper and corn stalks. Protein (nitrogen) includes green vegetation and animal by-products including grass clippings, kelp meal, kitchen garbage (non-meat), manure and urine, blood meal and freshly cut weeds.

Any kind of organic material is good for the compost pile, but it needs to be added in the proper proportions. Materials should not be too coarse; bulky items should be shredded for quicker decomposition.

Adding micro-nutrients, seaweeds, rock powders, or other materials may not feed the decay organisms but will produce a richer compost. A compost inoculant (powdered beneficial microorganisms) may be added to encourage rapid breakdown of the organic matter. Layering the materials helps to distribute micro-organisms evenly through the pile and will also help you gauge the proportions of the carbon to nitrogen. You may wish to add some topsoil to the nitrogen layer. This will introduce beneficial soil organisms and bacteria.

Moisture
In dry weather or when incorporating dry materials like fall leaves, it may be necessary to add water to the compost pile. If the pile is usually uncovered, covering it with a plastic tarp while the pile is heating up will help retain moisture.

The compost pile should be consistently damp, but not wet. The material should feel like a well wrung sponge (not too dry but not soggy.) Decay organisms function best in an aerobic (air filled) environment. Too much moisture will force out air and suffocate beneficial organisms. In rainy weather a tarp will also keep excessive moisture out of the pile. Closed backyard units usually maintain an ideal moisture level, but they should be checked once in awhile for moisture content.

Air
The aerobic digestion process requires a lot of oxygen. A fast-acting pile will run low on air in about three days. Turning or mixing the compost not only aerates the material but also encourages temperatures to rise quickly to hasten the decomposition process.

If speed is not important, the pile will need little manipulation, but turning it even once will cut decomposition time in

[79] "Intervale Composting," Chittenden Solid Waste District Home Pages, accessed April 28, 1998, http://homepages.together.net/cswd/ ficp.htm (site discontinued).

[80] "New York City Parks: Citywide Leaf Composting," City of New York Parks and Recreation, accessed April 28, 1998, www.ci.nyc.ny.us/nyclind.html/dpr/html/newscomposting.html (site discontinued).

half. The more the pile is turned, the quicker the compost will be finished and the sooner another batch can begin.

Heat
If you have provided the correct carbon to nitrogen ratio, the pile should heat up to about 110 degrees Fahrenheit within 24 hours after it is put together. At this point, the pile should be turned with a pitchfork. There will be few visible changes in the material, but after turning, the temperature will rise further.

In a few days, the pile should be turned or aerated again. At this point the material will be evenly moist and gray fungus growth should be evident. The temperature should continue to rise. Turn the pile a third time after a few more days have passed. Material in the pile should now be even-textured and after turning, the temperature should reach 150-160 degrees Fahrenheit. At this temperature the organic material will be pasteurized, killing most weed seeds and pathogens. If the pile does not get hot enough, you will need to add more nitrogen, such as blood meal or manure. If there is a strong ammonia smell, there's insufficient oxygen. Turning the pile will incorporate more air, but the pile may also be too wet. Adding more carbohydrates like wood chips or sawdust will help to absorb excess moisture.

Once the temperature has reached the 150 degrees Fahrenheit range, it will drop to approximately 110 degrees Fahrenheit. Decomposition will continue at this lower temperature more slowly. Eventually the temperature will stabilize and the compost will be ready for the garden. The carbon to nitrogen ratio will be approximately 10:1, about the same as naturally occurring humus. Once the compost is ready, it may be spread over the entire garden, used as a side dressing or placed in planting holes.

Compost Size and Containers
A pile 3′ x 3′ x 3′ is the minimum size for good composting action. The organic material needs to be piled on top of itself to generate and retain heat. The location of the compost pile, its size and the amount of material you're adding will determine the type of compost bin used. There are many different designs, but all have the same objectives: to retain heat and moisture, to provide good bottom drainage, to make aeration easy and to keep animals out.

Do not to be flustered by complicated instructions and advice about composting. Just begin, do what you can and watch closely. Compost making is a simple, natural process because decay is an inevitable law of nature. Even if you do nothing at all, a pile of organic matter will eventually decompose. By composting, you are just improving upon and speeding up this natural process. Whatever you do, nature is with you and you can't go wrong!

Junk Yards

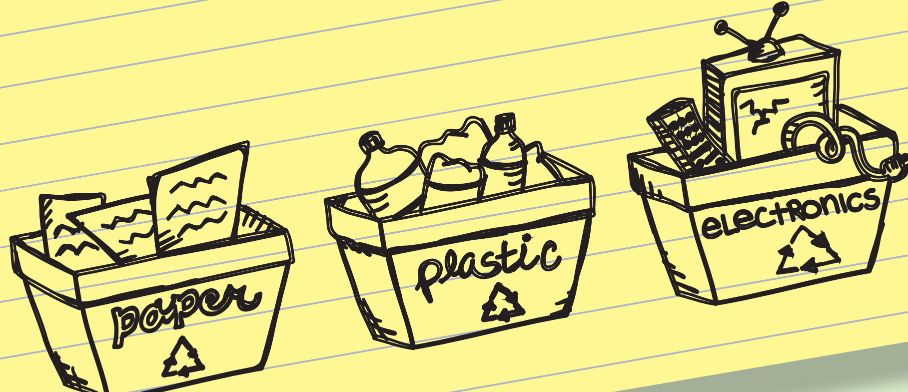
Junkyards include automobile recyclers, scrap metal recyclers, used parts dealers, automobile mechanics/ rebuilders, salvage pools and household scrap collectors. Junkyards provide a critical role in recycling used materials, in fact, in 1997 the Automotive Recyclers Association estimated that they recycle enough steel for 13 million new cars per year. It should be noted, however, that statistics relating to junkyards can be unreliable or incomplete, due to many junkyards operating unofficially. However, it is known for certain that the potential for environmental problems is high given the hazardous nature of many of the items with which they deal (e.g., automobile fluids and batteries, capacitors). Indeed, one study estimates that 10% of all junkyards need extensive cleanup and another 25% need a combination of spot cleanup. Nearly all junkyards have some level of soil contamination.

Most of the regulation and oversight of junkyards happens at the local level. The EPA has a policy of self-audit in order to provide incentives for junkyard and salvage yard operators to report any pollutants or potential environmental risks. The California Auto Dismantlers Association (SCADA) is an example of this. The organization has created the Partners in the Solution program which ensures that its 200 members follow their environmental, safety, business and licensing standards.

3R's of the Common Core

REDUCE REUSE RECYCLE

Glossary Section



Advertising Making known or praising publicly, usually in order to sell something.

Aerate To supply with air or expose to the circulation of air.

Aerobic Decomposition Decomposition of organic wastes occurring in the presence of oxygen, making possible conversion of material to compost.

Alloy A metallic solid or liquid that is composed of a homogeneous mixture of two or more metals or of metals and nonmetal or metalloid elements, usually for the purpose of imparting or increasing specific characteristics or properties.

Alumina Aluminum An oxide of aluminum, A1203, obtained from bauxite and used to make aluminum.

Aluminum A light silvery-white metal made from bauxite ore that can be easily bent or crushed.

Anaerobic Decomposition Decomposition of organic wastes occurring in the absence of oxygen, by bacteria that breathe an inorganic oxidant. Causes production and release of methane gas.

Attenuate To reduce in force, value, amount, or degree; weaken.

Baghouse Baling A fabric filter used in incinerators to remove air particulates from smokestack emissions. A volume reduction technique where a baler compacts mixed solid waste or recyclables into cubes or bricks, usually using wire or steel straps to hold it in place.

Bauxite The principle source of aluminum, containing alumina and impurities.

Bill A proposed law offered to a legislative body.

Biodegradable Capable of being broken down naturally by microorganisms into simple, stable compounds such as carbon dioxide and water. Most organic wastes are biodegradable.

Bottom Ash Residue from burning which collects at the bottom of the incineration chamber.

BTU British thermal unit, a unit of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near 39.2 degrees Fahrenheit.

Buy-back The buying back of goods by the original seller, a popular way to manage waste.

Cellulose Inert substance constituting the chief part of the cell walls of plants; also the major component of paper.

Classify To arrange or sort materials into uniform categories.

Collection Picking up waste materials or recyclables from homes, businesses or industrial sites and hauling them to a facility for further processing, transfer or disposal.

Combustibles Various materials in the waste stream which are burnable.

Commercial Waste	Waste material which originates in wholesale, retail or service establishments, such as office buildings, stores, markets, theaters, hotels and warehouses.
Compactor	Any power-driven mechanical equipment designed to compress and thereby reduce the volume of waste materials.
Compactor Truck	A common refuse collection vehicle with an enclosed body having special power-driven equipment for loading and compressing trash.
Composite Packaging, Conglomerate Packaging	Packaging consisting of an outer packaging and an inner receptacle constructed so that the inner receptacle and the outer packaging form one integral packaging.
Composting	The natural conversion of most organic materials to humus by microorganism activity and an effective solid waste management technique for reducing the organic portion of waste.
Conservation	The planned management of a natural resource to prevent exploitation, loss, destruction, neglect or waste.
Construction waste	Waste materials produced in the construction of homes, office buildings, dams, industrial plants, schools. Usually includes used lumber, sheetrock, miscellaneous metal parts, packaging materials, cans, boxes, wire, excess sheet metal, etc.
Consumer	A person who buys goods or services for his own needs and not for resale or for production of other goods for resale: as opposed to producer.
Container	A thing in which material is held or carried; receptacle. something that holds something else – a box, a trash can, an eggshell, a bottle, a garbage truck.
Contamination	Process by which something is made impure.
Convenience	Being suited or favorable to one's comfort, purpose, or needs; increases comfort or makes work less difficult.
Conversion	The process of changing solid waste, through chemical or physical process, into some other material like energy or soil. Composting and burning waste are both conversion processes.
Cover material	A backfill, usually earth, free of organic material, used to cover compacted waste in a sanitary landfill.
Crusher	Mechanical device used to compress waste materials or recyclables into smaller sized pieces.
Cullet	Scrap glass broken up into small (dime-size), uniform pieces.
Cycle	Circle, return, occur again.
Decompose	To break down, come apart, change form, to break down into basic elements; to rot.

Decomposition The breakdown of organic waste materials by bacteria, either by aerobic or anaerobic process, into carbon dioxide, water and inorganic solids.

De-Inking A process in which most of the ink, filler and other extraneous material is removed from reclaimed paper, prior to the recycling of the fiber into new paper.

Deposit Money paid by consumer to retailer (in the purchase price) for returnable beverage containers and refunded to consumer when container is returned to store.

Dewatering A process of removing water by filtration, centrifugation, pressing, open-air drying or other methods, to prepare sewage sludge (or paper pulp) for disposal by burning or landfilling.

Dioxin Any of several carcinogenic, mutagenic, and teratogenic polychlorinated heterocyclic aromatic hydrocarbons that can occur as impurities in petroleum-derived herbicides and as byproducts of manufacturing chemicals and burning fuels and waste.

Dispose To get rid of, to remove; to get rid of waste properly, by putting it into a proper container for collection and final processing by burying, burning or recovery of its resources.

Disposal The final disposition of wastes usually by burying it on land.

Disposable Designed to be thrown away after use.

Dump (n) An open, unmanaged disposal site used prior to sanitary landfills where waste materials were burned, left to decompose, rust, or simply remain.
(v) to throw away garbage or solid waste in a place set apart for that purpose.

Dumpster Large refuse container to keep waste until it is collected by a trash hauler, usually used by stores, restaurants, apartment buildings, etc.

Ecology The scientific study of the relations of living things to one another and to their environment. From Greek oikos - house (home); knowledge of our home - the earth, air and water.

Ecosystem A system made up of a community of living things and the physical and chemical environment with which they interact.

Emission A substance discharged into the air, especially by an internal combustion engine.

End-use The ultimate application for which a product has been designed.

Groundwater Water within the earth that supplies wells and springs.

Habit An action a person does repeatedly and routinely without thinking about it.

Hazardous Waste Waste materials which are dangerous to living things or the environment because they have one or more of the following characteristics:
(a) poisonous, (b) explosive, (c) corrosive, (d) readily burnable with or without a flame, (e) carriers of diseases, or (f) radioactive.

Heavy Metals A metal with a specific gravity greater than about 5.0, especially one that is poisonous, such as lead or mercury.

Household Hazardous Waste (HHW) Waste materials commonly used in small quantities in the home which have some or all of the characteristics of hazardous waste and should not be disposed of in the same manner as solid waste.

Human-made Anything made by people or machines, such as clothes, books, cakes, milk cartons, desks.

Humus A brown or black organic substance consisting of partially or wholly decayed vegetable or animal matter that provides nutrients for plants and increases the ability of soil to retain water.

Hydrogen An active gaseous element which has the simplest atom of any element: one proton and one electron, hydrogen is the most plentiful element in the universe.

Hygiene The science of health and the prevention of disease.

Illegal Dumping The illegal disposal of solid waste in any place not authorized to accept waste material; usually done to avoid tipping fees at landfills.

Incinerate To burn waste and thereby reduce the amount of waste requiring landfilling.

Incinerator A facility designed to reduce waste volume by burning.

Inorganic Designating or composed of matter that is not animal or vegetable; not having the organized structure of living things; most inorganic compounds do not contain carbon and are derived from mineral sources.

Land application Method of reusing treated wastewater as organic fertilizer.

Landfill A large outdoor site for the burial of solid waste.

Leach To remove soluble or other constituents from by the action of a percolating liquid

Leachate A liquid that has percolated through solid waste and/or been generated by solid waste decomposition and has extracted, dissolved, or suspended materials in it; a liquid containing decomposed waste, bacteria and other poisonous materials which drains from landfills and must be collected and treated to prevent it from contaminating ground and surface water supplies.

Ledger Paper Office grade white paper including stationery, copy and computer paper.

Lime Mineral or industrial form of calcium oxide; a base; used in the production of glass, in pollution control devices in incinerators and to control acidity in composting.

Litter Waste materials that are carelessly discarded in an inappropriate place or which accidentally escape waste handling systems.

Littering Improperly and illegally disposing of waste by allowing it to escape appropriate waste-handling systems.

Manufacture To make products, especially on a large scale and with machines.

Materials Recovery Manual and/or mechanical separation of recyclables or compostables from mixed solid waste.

Methane A colorless, odorless, flammable gaseous hydrocarbon (CH4) present in natural gas and formed by the decomposition of vegetable matter; usable as a fuel.

Microbes A minute life form; a microorganism, especially a bacterium that causes disease.

Microorganisms A microscopic organism, including bacteria, protozoans, yeast, viruses, and algae.

Mixed Paper Waste paper of various kinds and quality, including manila folders and colored copier paper, construction paper, newspaper, etc.

Natural Anything in our world not made by people or machines, such as eggs, rocks, trees, turtles, flowers, water, etc.

Natural Resources Naturally-occurring items such as plants, animals, people, minerals, water and air which are used by people to help make things used by people, such as food, energy, clothes, buildings.

Neutralization In chemistry, a reaction between an acid and a base, usually yielding a salt and water.

Newsprint An inexpensive paper made from wood pulp or recycled paper, used primarily for newspapers.

Nitrogen Cycle The continuous cyclic progression of chemical reactions in which atmospheric nitrogen is compounded, dissolved in rain, deposited in the soil, assimilated and metabolized by bacteria and plants to the atmosphere by organic decomposition.

Nonferrous Metal Metals which contain no iron, such as aluminum, copper and brass.

Nonrenewable Resources Natural materials which, because of their scarcity, the great length of time required to form them and their rapid depletion, are considered finite, including natural gas, oil and minerals.

Obsolescence Being in the process of passing out of use or usefulness; becoming obsolete.

Ocean Dumping The dumping of raw or treated wastes in the sea beyond the continental shelf.

Open Burning The illegal burning of waste materials in the open or in a dump (sometimes accidental, sometimes intentional to reduce volume), which can produce smoke, odor and other toxic pollutants.

Organic Derived from living organisms; pertaining to any chemical compound containing carbon.

Organic Refuse Waste material made from substances composed of chemical compounds of carbon in combination with other chemical elements, primarily hydrogen and generally manufactured in the life processes of plants and animals. including paper, food waste, plastic and yard wastes; once living material, or products of a living thing, such as egg shells, dead flowers, coffee grounds, etc.

Packaging The wrappings, container or sealing used to protect, identify and advertise a product.

Particulates Very small particles of matter.

Percolate To cause (liquid, for example) to pass through a porous substance or small holes; filter.

Petroleum A thick, flammable, yellow-to-black mixture of gaseous, liquid, and solid hydrocarbons that occurs naturally beneath the earth's surface, can be separated into fractions including natural gas, gasoline, naphtha, kerosene, fuel and lubricating oils, paraffin wax, and asphalt and is used as raw material for a wide variety of derivative products.

Phosphate A salt, ester, or anion of phosphoric acid, derived by removal or replacement of one, two, or especially all three of the hydrogens of phosphoric acid; a fertilizer containing phosphorus compounds.

Photodegradable Capable of being broken down by ultraviolet light.

Planned Obsolescence A marketing concept developed to increase production and sales by creating products that must be replaced frequently (either because they have gone out of style or are designed to break easily or be disposable).

Plastic A human-made material consisting wholly or in part of a combination of carbon with hydrogen, oxygen, nitrogen and other organic and inorganic elements that are produced by polymerization and that can be molded, extruded, or cast into various shapes and films or drawn into filaments and used as textile fibers.

Pollution Harmful substances deposited in the air, water or on land, leading to a state of dirtiness, impurity or poor health.

Polymerization Linking together small, single chemical units called monomers in repetition to build one large molecule called a polymer.

Pre-consumer Waste Any waste generated in the manufacturing and production of food prior to the item being sold in grocery stores or served in restaurants.

Processing A series of operations performed in the making or treatment of a product.

Pulp A cellulose fiber and water combination used to make paper; can be made from virgin wood, recycled paper, or other cellulose-based plants.

Pyrolysis The process of chemically decomposing an organic substance by heating it in an oxygen-deficient atmosphere. High heat is usually applied to the material in a closed chamber evaporating all moisture and breaking down materials into various hydrocarbon gases and carbon like residue. The residue may be further processed into useful materials, such as carbon, sand and grit, or can be landfilled.

Reclamation The restoration to usefulness or productivity of materials found in the waste stream.

Recycle To put or pass through a cycle again; to collect and reprocess manufactured materials for reuse either in the same form or as part of a different product.

Recycling Center A site where manufactured materials are collected and resold for reprocessing.

Redesign To change one's habits and actions; to improve an object or policy's quality or usefulness by incorporating a new design element.

Reduce To lessen in extent, amount, number or other quantity.

Refillable An energy-saving glass beverage container designed not only to be returned for deposit but washed and refilled with beverage for resale.

Refuse A general term for solid waste materials.

Refuse-derived-fuel Fuel that is made from waste materials.

Renewable Resource A naturally occurring raw material or form of energy derived from an endless or cyclical source, such as the sun, wind, falling water (hydroelectric), biofuels, plants and animals.

Reserve Base The amount of a particular resource that is available and retrievable.

Resources A supply of something that can be used or drawn upon. something that can be used to make something else: wood into paper, iron ore into steel, bauxite ore into aluminum, sand into glass, old cans into new ones, old bottles into new ones, old newspapers into cardboard.

Resource Base The amount of a particular resource that is in existence.

Resource Recovery Burning of mixed solid waste to produce energy; processing of mixed solid waste to make refuse-derived fuel; the extraction and utilization of materials or energy from the waste stream; production of compost using solid waste as a medium; taking usable materials out of solid waste, usually through high-technology processes.

Returnable A beverage container able to be returned to a vendor, usually with a deposit payable to the consumer upon return.

Reused To extend the life of an item by repairing or modifying it or by creating new uses for it.

Revise To change our attitudes and improve our knowledge of solid waste in order to realize both the scope of the problem and our responsibility for its solution through careful buying and responsible waste disposal. Change buying habits to include reduction of solid waste through recycling, reuse and reduced consumption.

Sand Worn or broken rocks, larger than dust and smaller than gravel.

Sanitary landfill A specially located and engineered site for the land disposal of solid waste, designed to minimize public health and safety threats and to prevent litter, rodents, open burning, pollution of ground and surface water. Wastes are compacted and covered daily with several inches of soil.

Scrap Waste with some value, especially materials leftover from construction or manufacturing suitable for reprocessing.

Secondary Recycled Materials Materials that are modified and re-used without any chemical process. Using 'trash' for another purpose.

Sewage Liquid and solid wastes carried off with water in sewers and drains.

Siting To situate or locate on a site.

Sludge Any heavy waste deposit, sediment, or mass that precipitates in a sewage system tank.

Slurry A thin mixture of a liquid, especially water, and any of several finely divided substances.

Soda Ash Crude sodium carbonate; used in the manufacture of glass.

Solid Waste All solid and semisolid wastes, including garbage, rubbish, ashes, industrial wastes, swill, demolition and construction wastes and household discards such as appliances, furniture and equipment; all useless, unused, unwanted or discarded material, such as refuse, trash, garbage, debris, etc.

Solid Waste Management The controlling, handling, processing and disposal of all refuse; everything that has to be done to get rid of all the waste that is produced in the community.

Solubility The amount of a substance that can be dissolved in a given amount of solvent.

Source Separation The sorting out of recyclable materials at home and in school; sorting recyclable materials into specific types, such as paper, corrugated cardboard, aluminum and glass, by the person who last uses the materials at the place they are generated.

Static Use A rate of use which stays consistent over time.

Styrofoam A trademark for a light, resilient polystyrene plastic.

Steel A tough and widely used metal composed of a mixture of iron, carbon and sometimes other metals.

Thermoplastic Plastics Composed of long polymer molecules that are not jointed chemically and so may be softened by heat and formed into any shape.

Thermoset plastics Plastics composed of polymer molecules which have been chemically linked to other polymer molecules and which cannot be remelted into new forms.

Thermosetting Permanently hardening or solidifying on being heated. Used of certain synthetic resins.

Tipping Fee Disposal fee paid to a landfill or incinerator.

Toxic Capable of causing injury or death, especially by chemical means; poisonous.

Transfer Station A place where solid waste is taken in smaller vehicles, sometimes processed or compacted and reloaded into large trucks for more cost-efficient transportation to landfills, recycling dealers and resource recovery sites.

Trash Another word for solid waste.

Trash Composition The ratios and proportions of materials in a sample of trash or waste.

Virgin Material Any basic material for industrial processes which has not previously been used; e.g., wood pulp trees, iron ore, silica, crude oil and bauxite.

Waste (n) Anything that cannot be used anymore or that has no value.

Waste (v) To treat a resource as disposable excess.

Wastebasket Small container, usually used indoors, for disposing of small waste items.

Waste Processing Doing something to discarded materials so they can be handled more easily, or so resources can be recovered from them.

Waste Stream All the waste material output of an area, location or facility. All materials being thrown away, including resources.

Waste-to-Energy Plants Facilities which employ burning techniques to produce salable energy from solid waste.

Windrow A form of compost pile, arranged in long rows and turned regularly to aid aerobic decomposition.

Zone of Influence Area that is affected, or could potentially be affected by a specific amount of a particular pollutant.

Resources Introduction

When we produced the 1st and 2nd editions of this Resource Guide, the Internet was not available to the general public like it is today. The World Wide Web offers a tremendous volume of information for teachers and students. In our efforts to shift away from paper use, we are going to give you the names and web addresses of some key organizations and governmental agencies necessary to find materials on the Internet rather than reprint what you can find yourselves. Further, new information is constantly being added to this media, and by using the addresses we provide you can remain up-to-date on the latest environmental innovations, facts, curricula, books, publications and videos.

This Resource Guide is divided into several categories to make your search for information a little easier. However, it is important to remember that environmental issues are interdisciplinary and a holistic approach to an issue is often the best research method. The Resource Guide is by no means a complete or comprehensive list of all of the resources available. There are thousands of groups dedicated to various environmental issues, the information listed in the following pages is only a starting point for your own environmental research.

Our hope in providing this Resource Guide is that you will seek out complementary materials and information to present more in-depth lessons to your students as well as have students engage themselves in research projects of their own.

Brought to you by

Northeast Resource Recovery Association
2101 Dover Rd | Epsom, NH 03234
www.nrra.net | info@nrra.net
800-223-0150

NRRA School CLUB
www.schoolrecycling.net
theclub@nrra.net

USDA Rural Development
Committed to the future of rural communities.

Table of Content

Keyword

Searching the Internet, educational databases or book publishers (e.g. Amazon.com, Borders.com) can be overwhelming at times if you do not have the right keywords to use in your search. The main point to remember is to be creative.

If you want information on "recycling," remember to try many different variations: recycle, recycling, recyclable, reuse, secondhand, secondary materials, used. To limit the amount of information retrieved by a search, be as specific as possible. Do not use the keyword "waste." Instead, search for toxic waste, hazardous waste, or solid waste.

Here is a list of keywords that will be helpful to you and your students:

Agriculture
Air Pollution
Alternative Energy
Alternative Fuel
Alternative Transportation
Biodiversity
Biological Diversity
Brownfields
Cancer
Cancer Cluster
Carcinogens
Carrying Capacity
Chlorine-Free
Climate Control
Closed-Loop System
Community Action
Community Right to Know
Compost
Conservation
Consumerism
Contamination
Development
Dioxin
Earth
Ecological Diversity
Ecology
Economic Development
Ecosystem
Ecosystem Management
Electric Vehicles
Emergency Planning
Endangered Species
Energy
Environmental Education
Environmental Ethics
Environmental Hazards
Environmental Health
Environmental Justice
Environmental Law
Environmental Policy
Environmental Protection Agency
Environmental Studies
Fair Trade
Free Trade
Frugality
Garbage
Geographic Information Systems
Global Warming
Green Procurement
Green Products
Ground H20 Contamination
Growth Centers
Growth Management
Habitat Restoration
Hazardous Waste
Hormone Disrupters
Household Hazardous Waste
Hybrid Vehicles
Incineration
Land Preservation
Land Use Planning
Municipal Solid Waste
Natural Resource Planning
Natural Resources
Nature
Organic Food
Overconsumption
Overpopulation
Ozone Depletion
PCBs
Pollutants
Pollution
Prevention
Population Growth
Preservation
Racial Justice
Recycle
Reduce
Resource Conservation
Resource Depletion
Resource
Recovery
Reuse
Secondary Materials
Sense of Place
Simple Living
Solid Waste
Solid Waste Management
Source Reduction
Sprawl
Sustainable Agriculture
Sustainable Development
Sustainable Economy
Sustainable Forestry
Sustainable Growth
Sustainable Living
Toxic Pollution
Toxic Use Reduction
Voluntary Simplicity
Waste Recycling
Waste Reduction
Water Reuse
Water Pollution
Zero Population Growth
Zoning

Resources by Industry

General Search Engines and Directories

Amazing Environmental Organization Web Directory
Earth's biggest environmental search engine.
www.webdirectorv.com

EnviroLink
An online environmental community dedicated to providing the most comprehensive, up-to-date environmental resources available.
www.envirolink.org

EnviroSource
An environmental research tool to find information on a full range of issues, including hazardous waste, land use planning, air and water quality, pollution prevention, recycling, toxic substances, alternative energy, US EPA, environmental law and more.
www.envirosource.com

Air and Climate

Climate Action Network (US)
Promotes government and individual action to limit human-induced climate change to ecologically sustainable levels.
1200 New York Avenue, NW, Suite 400
Washington, DC 20005
Phone: (202) 289-2401 // Fax: (202) 289-1060
www.climatenetwork.org

Global Alliance for Incinerator Alternatives (GAIA)
Provides information on the environmental and health impact of incinerators as well as information on zero waste initiatives.
1958 University Avenue, Berkeley, CA 94704 USA
Phone: (510) 883-9490 // Fax: (510) 883-9493
http://www.no-burn.org/index.php

Alternative Energy

American Solar Energy Society
Dedicated to advancing use of solar energy for the benefit of US citizens and the global environment.
2400 Central Avenue, G-1, Boulder, CO 80301
Phone: (303) 443-3130 // Fax: (303) 443-3212
Email: ases@ases.org // www.ases.org

American Wind Energy Association
Advocates for the development of wind energy as a reliable, environmentally superior energy alternative in the US and around the world.
122 C Street, NW, 4th floor Washington, DC 20001
Phone: (202) 383-2500 // Fax: (202) 383-2505
www.awea.org

Center for Energy Efficiency and Renewable Technologies (CEERT)
Unique collaboration of major environmental organizations, public interest groups, and clean technology companies working to achieve a more sustainable energy future.
1100 Eleventh Street, Suite 311, Sacramento, CA 95814,
Phone: (916) 442-7785 // Fax: (916) 447-2940
http://ceert.org

Northeast Sustainable Energy Association
Fosters the use of renewable and sustainable energy, the responsible use of non renewable forms of energy, and conveys the value of these practices for the preservation of the environment.
50 Miles Street, Greenfield, MA 01301
Phone (413) 774-6051 // Fax: (413) 774-6053
Email: nesea@nesea.org // www.nesea.org

Rocky Mountain Institute
Fosters efficient and sustainable use of resources as a path to global security.
1739 Snowmass Creek Road, Snowmass, CO 81654
Phone: (970) 927-3851 // Fax: (970) 927-3420
www.rmi.org

Biodiversity & Wildlife

Audubon Society
Conserves and restores natural ecosystems, focusing on birds and other wildlife for the benefit of humanity and the Earth's biological diversity.
700 Broadway, New York, NY 10003
Phone: (212) 979-3000 // Fax: (212) 979-3188
www.audubon.org

Defenders of Wildlife
Dedicated to the protection of all native wild animals and plants in their natural communities.
110 114th Street, NW, #1400, Washington, DC 20005
Phone: (202) 682-9400 // www.defenders.org

National Wildlife Federation
Focuses its work on specific core area environmental issues: endangered habitats, wetlands, sustainable communities, land stewardship, water quality, and international. It works to educate, inspire and assist people to conserve natural resources.
8925 Leesburg Pike, Vienna, VA 22184
Phone: (703) 790-4000 // www.nwf.org

Rainforest Action Network
Dedicated to protecting the world's forests and their inhabitants.
221 Pine Street, Suite 500, San Francisco, CA 94104
Phone: (415) 398-4404 // Fax: (415) 398-2732
Email: ran@ran.org // www.ran.org

Sierra Club
Promotes conservation of the natural environment by influencing public policy decisions.
85 Second Street, 2nd Floor, San Francisco, CA 94105
Phone: (415) 977-5500 // Fax: (415) 977-5799
Email: information@sierraclub.org // www.sierraclub.org

The Wildlands Project
Drafts a blueprint for an interconnected, continental-scale system of protected wildlands.
1402 3rd Avenue, Suite 1019, Seattle, WA 98101
Phone: (206) 538-5363 // Fax: (877) 554-5234
Email: info@wildlandsnetwork.org
www.wildlandsnetwork.org

Wild Earth
Wild Earth and The Wildlands Project are closely allied but independent organizations dedicated to the restoration and protection of wilderness and biodiversity. Wild Earth is a quarterly journal melding conservation biology and wildlands activism.
PO Box 455, Richmond, VT 05477
Phone: (802) 434-4077 // Fax: (802) 434-5980
Email: info@ wild-earth.org
www.wildearth.org

World Wildlife Fund
Protects nature and the biological diversity that we all need to survive.
1250 24th Street, NW, Washington, DC 20037
Phone: (800) CALL-WWF
www.worldwildlife.org

Environmental Education and Educational Resources

Discovery Education
Companion website to the Discovery Channel. Provides digital media and lesson plans for classroom use.
www.discoveryeducation.com

The GLOBE Program: Global Learning and Observations to Benefit the Environment
Government sponsored organization that provides activities and projects geared towards data collection and engaging in the scientific process.
Phone: (800) 858-9947
Email: help@globe.go // www.globe.gov

Green Teacher
Non-profit organization that creates educational resources and ideas for teachers in and out of the classroom. Their materials cover ages 6-19.
PO Box 452, Niagara Falls, NY 14304-0452
Phone: (888) 804-1486 // Fax: (416) 925-3474
Email: info@ greenteacher.com
www.greenteacher.com

National Environmental Trust
Functions as the resource for several major public education campaigns about environmental issues.
Phone: (202) 887-8800
Email: pclapp@environet.org //www.undueinfluence.com

National Geographic
Companion website to the popular magazine. Provides information and educational resources on wildlife, climate and human populations in addition to other scientific research.
1145 17th Street NW., Washington, DC 20036.
Phone: (202) 862-8638 // www.nationalgeographic.com/

North American Association for Environmental Education (NAAEE)
Network of professional and students working in the field of environmental education.
410 Tarvin Road, Rock Spring, GA 30739
Phone: (706) 764-2926 // Fax: (706) 764-2094
www.naaee.org

Project WET
Facilitates and promotes awareness, appreciation, knowledge and stewardship of water resources through the development and dissemination of classroom-ready teaching aids and through the establishment of state and internationally sponsored by *Project WET* programs.
201 Culbertson Hall Montana State University
Bozeman, MT 59717
www.projectwet.org

Project Learning Tree
Interdisciplinary environmental education program for educators working with students in Pre-K through Grade 12 that helps students gain awareness and knowledge of the natural and built environment, their place within it, as well as their responsibility for it.
c/o American Forest Foundation
2000 M Street, NW, Suite 550, Wash, D.C. 20036
Phone: (202) 765-3641 // Fax: (202) 827-7924
www.plt.org

Project WILD
Widely used conservation and environmental education program for K-12. The program emphasizes wildlife - because of its intrinsic and ecological values, as well as its importance as a basis for teaching how ecosystems function. Email: info@ projectwild.org // www.projectwild.org

Public Broadcasting Systems
Companion website for PBS. Offers a wide variety PreK-12 digital content for free.
www.pbslearningmedia.org // www.pbs.org/wgbh/nova
ww.pbs.org/teachers/stem

The Video Project
Offers media for a safe and sustainable world.
200 Estates Drive
Ben Lomond, CA 95005
Phone: (800) 4-PLANET // Fax: (831) 336-2168
Email: videoproject@videopro ject.org
www.videoproject.com

Environmental Justice, Advocacy and Policy

Alternatives for Community and Environment (ACE)
Provides community-based educational legal, technical and organizing services under-served communities throughout New England and works with residents to help solve their environmental problems and to·develop local environmental leadership.
2343 Washington Street, 2nd floor
Roxbury, MA 02119
Phone: (617) 442-3343 // Fax: (617) 442-2425
http://www.ace-ej.org

Corporate Accountability International
Corporate watchdog whose purpose is to stop life-threatening abuses by transnational corporations and increase their accountability' to people around the world.
10 Milk Street, Suite 610, Boston, MA 02108
Phone: (617) 695-2525
Email: Info@StopCorporateAbuse.org
www.stopcorporateabuse.org

Environmental Defense Fund
Dedicated to protecting the environmental rights of all people, including future generations. Among these rights are clean air; clean water; healthy, nourishing food; and a flourishing ecosystem.
257 Park Avenue South, New York, NY 10010
Phone: (800) 684-3322 // Email: Contact-EDF@edf.org
www.edf.org

Environmental Justice Resource Center
Seeks to assist, support, train and educate people of color professionals and grassroots community leaders with the goal of facilitating their inclusion into the mainstream of environmental decision making.
James P. Brawley Drive Fair Street, SW
Atlanta, GA 30314
Phone: (404) 880-6911 // Fax: (404) 880-6909
Email: ejrc@cau.edu

Environmental Research and Education Foundation
Organizations that funds and directs scientific research and educational initiatives for waste management practices to benefit industry participants and the communities they serve.
3301 Benson Drive, Suite 101
Raleigh, North Carolina 27609
Phone: (919) 861-6876 // Fax: (919) 861-6878
Email: foundation@erefdn.org // http://erefdn.org

Environmental Working Group
Leading content provider for public interest groups and concerned citizens who are campaigning to protect the environment. The Group also maintains an extensive, award-winning site on the Internet that features most of the organizations publications and numerous searchable databases.
Email: info@ewg.org // www.ewg.org

Greenpeace
Dedicated to the protection of the environment by peaceful means.
1436 U Street, NW, Washington, DC 20009
Phone: (202) 462-1177 // Fax: (202) 462-4507
Email: info@wdc.greenpeace.org
www.greenpeace.org/usa

Interreligious Eco-Justice Network
Promotes discussion between different faiths and looks to protecting the environment as a means of bringing people from different religious backgrounds together.
PO Box 270147, West Hartford, CT 06127
Phone: (860) 595-2321 // Email: info@irejn.org
https://irejn.org/

League of Conservation Voters Education Fund
As the bipartisan political arm of the national environmental movement the League works to elect a pro-environment majority to Congress. Its Education Fund is dedicated to strengthening participatory democracy as the fundamental means for promoting responsible environmental leadership and policy in America.
1707 L Street, NW, #750, Washington, DC 20036
Phone: (202) 785-0730 // Fax: (202) 835-0491
www.lcv.org

League of Women Voters
Encourages the informed and active participation of citizens in government and to influence public policy through education and advocacy. ·
1730 M Street, NW, Washington, DC 20036-4508
Phone: (800) 249-VOTE // Email: lwv@lwv.org
www.lwv.org

National Association for the Advancement of Colored People (NAACP)
Ensures the political, educational, social and economic equality of minority group citizens of the U.S.
1025 Vermont Avenue, NW, Suite 1120
Washington, DC 20005
Phone: (202) 638-2269 // www.naacp.org

Natural Resources Defense Council
Protects the planet's wildlife and wild places and to ensure a safe and healthy environment for all living things.
40 West 20th Street, New York, NY 10011
Phone: (212) 727-2700
Email: nrdcinfo@nrdc.org // www.nrdc.org

Resources for the Future
Conducts independent research - rooted primarily in economic and other social sciences - on environmental and natural resource issues.
1616 P Street, NW, Washington, DC 20036
Phone: (202) 328-5000, Fax: (202) 939-3460
www.rff.org

Union of Concerned Scientists
Citizens and scientists working together for a common goal: a healthy environment and a safe world, for today and for the next century. Issues include: agriculture, arms control, energy, global resources, global warming, and transportation.
2 Brattle Square, Cambridge, MA 02238
Phone: (617) 547-5552 // Fax:(617) 864-9405
Email: ucs@ucsusa.org // www.ucsusa.org

United Nations
The go-to source for reports on virtually everything from environmental and climate issues to human rights abuses. The UN also sets guidelines and goals to resolve these various issues.
405 East 42nd Street, New York, NY, 10017, USA
Phone: (212) 963-9999 // www.un.org/en/index.html

U.S. Public Interest Research Group
Dedicated to serving as a watchdog for the nation's citizens and environment.
218 D Street, SE, Washington, DC 20003-1900
Phone: (202) 546-9707 // Fax: (202) 546-2461
Email: uspirg@pirg.org // www.usprig.org

The World Health Organization (WHO)
The world's leading resource for health, the environment and human rights. WHO carries out extensive scientific research and sets targets and guidelines for combating various problems affecting the globe.
Regional Office for the Americas of the World Health Organization
525 Twenty-third Street, N.W., Washington, D.C. 20037
Phone: (202) 974-3000 // Fax: (202) 974-3663
www.who.int/en/

Right To Know Network
A network providing free access to numerous databases, text files and conferences on the environment, housing, and sustainable development. A project of the Center for Effective Government.
2040 S Street, N.W. · Second Floor ·
Washington, D.C. 20009
Phone: (202) 234-8494 // Fax: (202) 234-8584
www.rtknet.org

Student Environmental Action Coalition
A student-run and student-led national network of progressive organizations and individuals whose aim is to uproot environmental injustices through action and education.
PO Box 31909, Philadelphia, PA 19104
Phone: (215) 222-4711
Email: seac@seac.org
www.energyactioncoalition.org/partners/student-environmental-action-coalition

World Watch Institute
Public policy research organization dedicated to informing policymakers and the public about emerging global problems and trends and the complex links between the world economy and its environmental support systems.
1776 Massachusetts Avenue, NW
Washington, DC 20036-1904
Phone: (202) 452-1999 // Fax: (202) 296-7365
Email: worldwatch@worldwatch.org
www.worldwatch.org

World Resources Institute
An independent center for policy research and technical assistance on global environmental and development issues.
1709 New York Avenue, NW
Washington, DC 20006
Phone: (202) 638-6300 // Fax: (202) 638-0036
www.wri.org

Green Consumption, Consumerism & Sustainable Development

California Integrated Waste Management Board's Recycled-Content Product Database
The RCP database has information on RCPs as well as manufacturers, distributors, reprocessors, mills and converters who procure or produce these products or the recycled materials needed to make them. Searches of the over 10,000 materials, products, and businesses can be limited by product type, location, and percentage of recycled content.
www.calrecycle.ca.gov/RCPM

Center for Livable Communities
Promotes good land-use and resource efficient transportation planning by promoting the benefits of healthy and life-sustaining food choices.
c/o Local Government Commission
1414 K Street, Suite 250, Sacramento, CA 95814
Phone: (800) 290-8202 // Fax: (916) 448-8246
Email: lgc@lgc.org // www.lgc.org

Center for a New American Dream
Dedicated to reducing and shifting North American consumption while fostering opportunities for people to lead more secure and fulfilling lives.
6930 Carroll Avenue, Ste 900, Takoma Park, MD 20912
Phone: (301) 891-ENUF // Fax: (301) 891-3684
www.newdream.org

The Cygnus Group
Helps businesses and organizations integrate environmental concepts into their strategic planning, marketing and communications activities. They also maintain a website with information regarding the most efficient and effective ways to reduce waste and conserve resources. The Group's Use Less Stuff (ULS) Report can be found online.
1019 Berkshire Road, Ann Arbor, MI 48104
Phone: (734) 668-1690 // Fax: (734) 930-0506
Email: info@cygnus-group.com
http://cygnus-group.com

EarthSave International
The only international organization dedicated to educating people about the powerful connections between our food, ou1 health, and the environment, with the mission of helping to create a better world.
20555 Devonshire St., Ste. 105,
Chatsworth, CA 91311
Email: info@earthsave.org // www.earthsave.org

Eco-Mall
EcoMall is your link to eco-friendly ideas and products.
www.ecomall.com

Green American
Leading force in educating and empowering people and businesses to make significant improvements through the economic system.
1612 K Street, NW, Suite 600, Washington, DC 20006
Phone: (202) 872-5307 // Fax: (202) 331-8166
www.greenamerica.org

Green Seal
Awards a "Green Seal of Approval" to products that cause less harm to the environment than other similar products. Publishes various reports on products.
1400 16th Street, NW, Ste 300, Washington, DC 20036
Phone: (202) 588-8400 // Fax: (202) 588-8465
www.greenseal.org

Institute for Local Self-Reliance
Provides technical assistance and information on environmentally sound economic development strategies.
2425 18th Street, NW, Washington, DC 20009-2096
Phone: (202) 232-4108 // Fax: (202) 332-0463
www.ilsr.org

The Media Foundation
Redirects our existing commercial media culture towards ecological and social awareness.
6107 SW Murray Blvd. #127, Beaverton OR 97008
Phone: (503) 649-0134 // Email: info@nlfo.org
www.newlivesforold.org

National Green Pages Green America
A directory of products and services for people and the planet.
1612 K Street, NW, #600, Washington, DC 20006
Phone: (800) 762-7325 // www.greenpages.org

Northwest Earth Institute
Motivating people to examine and transform personal values and habits, to accept responsibility for the Earth, and to act on that commitment.
921 SW Morrison, Suite 532, Portland, OR 97205
Phone: (503) 227-2807 // Fax: (503) 227-2917
Email: contact@nwei.org // www.nwei.org

Sustainable America
Works in a range of disciplines including worker's rights, environmental sustainability, "high-road" business development and community design.
700 Canal St., Stamford, CT 06902
Phone: (203) 803-1250
Email: info@sustainableamerica.org
www.sustainableamerica.org

Hazardous & Toxic Wastes

Children's Environmental Health Network
National project dedicated to children's environmental health.
1515 Clay Street, 17th floor
Oakland, CA 94612
Phone: (510) 622-4440 // Fax: (510) 622-4505
Email: cehn@cehn.org // www.cehn.org

Environmental Health Coalition
Dedicated to the prevention and cleanup of toxic pollution threatening our health, our communities, and our environment.
2727 Hoover Ave., Suite 202
National City, CA 91950
Phone: (619) 474-0220 // Fax: (619) 474-1210
www.environmentalhealth.org

National Coalition Against the Misuse of Pesticides
Serves as a national network committed to pesticide safety and the adoption of alternative pest management strategies which reduce or eliminate a dependency on toxic chemicals.
701 E Street, SE, #200
Washington, DC 20003
Phone: (202) 543-5450 // Fax: (202) 543-4791
Email: info@beyondpesticides.org
www.beyondpesticides.org

Pesticide Action Network (North America)
Campaigns to replace pesticides with ecologically sound alternatives.
49 Powell Street, Suite 500
San Francisco, CA 94102
Phone: (415) 981-1771 // Fax: (415) 981-1991
Email: panna@panna.org // www.panna.org

Rachel Carson Council
Clearinghouse and library with information at both scientific and layperson levels on pesticide-related issues.
8940 Jones Mill Road
Chevy Chase, MD 20815
Phone: (301) 652-1877
www.rachelcarsoncouncil.org

Major Media and Science News

Al Jazeera
http://america.aljazeera.com/topics/topic/categories/environment.html

The Atlantic Monthly
www.theatlantic.com/science/

BBC
www.bbc.com/news/science_and_environment
www.bbc.com/earth/world

CNN Interactive News: The Environment
http://travel.cnn.com/tags/environmental-issues/
www.cnn.com/specials/us/energy-and-environmentwww.cnn.com/specials/world/goinggreen

E: The Environmental Magazine
www.emagazine.com

Earth Times
http://www.earthtimes.org

Environmental News Network
www.enn.com

Grist
http://grist.org/

Live Science
www.livescience.com/environment/

National Science Foundation
www.nsf.gov/news/index.jsp?prio_area=6

Nature
www.nature.com

NPR
www.npr.org/sections/science/

New York Times
www.nytimes.com/section/science/earth

Planet Ark: World Environmental News
http://planetark.org/enviro-news/

Scientific American
www.scientificamerican.com/

VICE
www.vice.com/tag/environment

Pulp and Paper

Chlorine Free Products Association
Dedicated to promoting products 100% chlorine free.
102 North Hubbard Street, Algonquin, IL 60102
Phone: (847) 658-6104
www.chlorinefreeproducts.org

Conservatree
Dedicated to provide the latest, no nonsense, in-depth, insider information about environmentally sound papers and market development.
100 Second Avenue, San Francisco, CA 94118
Phone: (415) 883-6264 // paper@conservatree.org
www.conservatree.org

The Clark Fork Coalition
Works to help heal and protect the vital waters of the Clark Fork basin. A chlorine-free paper resource.
http://clarkfork.org/

Millwatch
Focuses on consumer education about paper and pulp mill monitoring.
Reach for Unbleached!
Box 39,
Whaletown, BC Canada VOP lZO
Phone: (250) 935-6992
Email: info@rfu.org // http://millwatch.ca/

Rainforest Alliance
A forest management certification program that provides independent, objective evaluation of forest management practices, forest products, timber sources and companies, enabling the public to identify products and practices that do not destroy forests.
233 Broadway, 28th Floor
New York, NY 10279 USA
Phone: (212) 677-1900 // Fax: (212) 677-2187
Email: info@ra.org // www.rainforest-alliance.org

Population

Amnesty International
Works to promote all the human rights in the Universal Declaration of Human Rights and other international standards.
600 Pennsylvania Ave. SE, 5th Floor
Washington, D.C. 20003
Phone: (202) 544-0200 // Fax: (202) 546-7142
Email: aimember@aiusa.org
www.amnesty.org

Population Connection
National population membership organization that educates, advocates and brings media attention to population and environmental issues. Fact sheets, newsletter, K-12 curricula.
1400 16th Street, NW, Suite 320
Washington, DC 20036
Phone: (202) 332-2200
www.populationconnection.org

Population Reference Bureau
A private scientific and educational organization which gathers, interprets, and disseminates facts related to population. Publishes reports and teaching materials. It has a population-environment film library.
1875 Connecticut Ave., NW, Suite 520
Washington, DC 20036
Phone: (800) 877-9881 // www.prb.org

U.S. Census Bureau
Provides in-depth information and educational resources regarding the people and geography of the United States.
4600 Silver Hill Road
Washington, DC 20233
Phone: (301) 763-4636
www.census.gov/en.html

Solid Waste and Recycling

Biocycle: The Organics Recycling Authority
Long-running magazine dedicated to educating people on composting, recycling and sustainability and renewable energy.
419 State Ave, Emmaus, PA 18049
Phone: (610) 967-4135 // www.biocycle.net/

Earth 911
The nation's official 24-hour public service resource for geographically specific environmental and recycling information. It provides information on the environment including reducing, reusing, and recycling; your nearest recycling center location; how to buy recycled products; how to handles household hazardous waste; an interactive kid's section; and more.
www.earth911.com

Global Recycling Network
A free-access public site dedicated to recycling-related information with an excellent reference library.
www.grn.com

GrassRoots Recycling Network
Dedicated to environmental stewardship and achieving a sustainable economy by eliminating waste and reusing, recycling, and composting resources which will support community economic growth, create jobs, save wilderness, reduce pollution, and conserve natural resources.
PO Box 49783
Athens, GA 30604-9283
Phone: (706) 613-7121 // Fax: (706) 613-7123
Email: zerowaste@grrn.org // www.grrn.org

Keep America Beautiful
Dedicated to preserving the natural beauty and environment in American communities and improving waste handling practices at the community level.
1010 Washington Boulevard, Stamford, CT 06901
Phone: (203) 323-8987 // Fax: (203) 325-9199
Email: keepamerbe@aol.com
www.kab.org

National Recycling Coalition
Dedicated to the advancement and improvement of recycling, source reduction, composting and reuse by providing technical information, education, training, outreach and advocacy services to its members in order to conserve resources and benefit the environment.
1727 King Street, Suite 105, Alexandria, VA 22314
Phone: (703) 683-9025 // Fax: (703) 683-9026
www.nrcrecycles.org

Northeast Recycling Coalition
Ensures the long-term viability of recycling in the Northeast while maximizing its full environmental and economic benefits.
139 Main Street, Suite 401, Brattleboro, VT 05301
Phone: (802) 254-3636 // Fax: (802) 254-5870
Email: info@NERC.org // www.nerc.org

Northeast Resource Recycling Association (NRRA)
New England based organization providing educational and networking opportunities for recycling, also sponsors grassroots campaigns for recycling.
2101 Dover Road (NH Rt.4), Epsom, NH 03234
Phone: (603) 736-4401 // Fax: (603) 736-4402
Email: info@nrra.net // www.nrra.net

Resource Recycling
Online and print magazine dedicated to information regarding recycling of plastics, electronics and other materials.
PO Box 42270, Portland, OR 97242-0270
Phone: (503) 233-1305 // Fax: (503) 233-1356
info@resource-recycling.com
http://www.resource-recycling.com/

San Francisco Recycling Program
Informative website detailing the whats and hows of recycling.
1145 Market Street, Suite 401
San Francisco, CA 94103
Phone: (415) 554-3400
sfrecycles.org

Solid Waste Association of North America (SWANA)
Public and private sector professionals working towards advancing and educating about solid waste. Organization is also involved in advocacy and research.
1100 Wayne Avenue Suite 650
Silver Spring, MD 20910
Phone: (800) 467-9262 // Fax: (301) 589-7068
https://swana.org/default.aspx

Zero Waste America
An Internet-based information resource and advocate for zero waste, recycling, and associated environmental, health, legal and consumer issues.
1006 Harvard Drive, Yardley, PA 19067
Phone: (215) 493-1070
Email: lynnlandes@earthlink.net
www.zerowasteamerica.org

Transportation

Electric Drive Transportation Association
The trade association promoting various electric drive technologies and infrastructure through education and advocacy.
1250 Eye Street NW, Suite 902
Washington, DC 20005
Phone: (202) 408-0774
Email: info@electricdrive.org
http://electricdrive.org/

Electric Auto Association
Non-profit organization that promotes the advancement and the adoption of electric vehicles.
www.electricauto.org

Institute for Transportation and Development Policy
Promotes environmentally sustainable and equitable transportation policies and projects worldwide.
115 West 30th Street, Suite 1205
New York, NY 10001
Phone: (212) 629-8001 // Fax: (212) 629-8033
Email: mobility@itdp.org
www.itdp.org

Water

Clean Water Network
Alliance of over 1000 organizations working to protect our nation's water resources.
Phone:(202) 289-2395
Email: kwilliams@environmentamerica.org
http://clean-water-network.org/

Surfrider Foundation
Dedicated to protecting the coastal environment.
122 S. El Camino Real #67, San Clemente, CA 92672
Phone: (949) 492-8170 // Fax: (949) 492-8142
Email: info@surfrid er.org
www.surfrider.org

Earth Island Institute
Develops and supports projects that counteract threats to the biological and cultural diversity that sustain the environment. Through education and activism, these projects promote conservation, preservation, and restoration of the Earth. 300 Broadway, Suite 28, San Francisco, CA 94965
Phone: (415) 788-3666 // Fax: (415) 788-7324
www.earthisland.org

Federal Agencies

Center for Disease Control
CDC houses the National Institute for Occupational Safety and Health and the National Center for Environmental Health.
1600 Clifton Road, NE, Atlanta, GA 30333
www.cdc.gov

Consumer Product Safety Commission
Washington, DC 20207
Phone: (800) 638-2772 // www.cpsc.gov

Council on Environmental Quality
Old Executive Office Bldg., Room 360
Washington, DC 20502
Phone: (202) 456-6224 // Fax: (202) 456-2710
www.whitehouse.gov/CEQ

Department of Agriculture
The Natural Resources Conservation Service and Forest Service are housed within USDA.
14th and Independence Avenue, SW
Washington, DC 20250
Phone: (202) 720-2791 // www.usda.gov

Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Phone: (202) 586-6210 // Fax: (202) 586-4403
www.energy.gov

Dept. of Health and Human Services
200 Independence Avenue, SW
Washington, DC 20201
Phone: (877) 696-6775 // Email: hhsmail@os.dhhs.gov
www.hhs.gov

Department of Interior
The following are part of DOI: Bureau of Land Management, Bureau of Reclamation, Minerals Management Service, National Park Service, Bureau of Indian Affairs, Office of Surface Mining, US Fish & Wildlife Service, and US Geological Survey.
1849 C Street, NW, Washington, DC 20240
Phone: (802) 208-3100 // www.doi.gov

Environmental Protection Agency
401 M Street, SW, Washington, DC 20460
Phone: (202) 260-2090
www.epa.gov

Government Publishing Office
www.access.gpo.gov

National Institute of Environmental Health Sciences
PO Box 12233, Research Triangle Park, NC 27709
Phone: (919) 541-3345 // www.niehs.nih.gov

National Institutes of Health
Bethesda, MD 20892
Phone: (301) 496-4000
Email: NIHinfo@OD.NIH.GOV
www.nih.gov

Occupational Safety and Health Administration (OSHA)
Department of Labor
200 Constitution Avenue, NW
Washington, DC 20210
Phone: (202) 693-2000
www.osha.gov

Office of Science and Technology Policy
1600 Pennsylvania Avenue, NW
Washington, DC 20502
Phone: (202) 456-6072
Email: Information@ostp.eop.gov
www.whitehouse.gov/OSTP

Library of Congress
101 Independence Avenue, SE
Washington, DC 20540
Email: lcweb@loc.gov // www.loc.gov

President's Council on Sustainable Development
730 Jackson Place, NW, Washington, DC 20503
Phone: (202) 408-5296 // Fax: (202) 408-6839
Email: infopcsd@aol.com
www.whitehouse.gov/PCSD

U.S. House of Representatives
Washington, DC 20515
Phone: (202) 224-3121
www.house.gov

U.S. Senate
Washington, DC 20510
Phone: (202) 224-3121
www.senate.gov

Waste Management Agencies, By State

While all 50 states must comply with federal guidelines regarding waste management, each state delegates waste management responsibilities differently. Below are the main state agencies involved in waste management in each state. In some cases there is no central state agency that is responsible for the entire state, in those cases there are county or 'regional' offices that oversee a specific locale. It is recommended that you check with your local governments to learn more about waste management in your area.

In addition to government agencies, there may be many non-profit or private organizations in your area dedicated to recycling, reusing waste, sustainability, green business, ecotourism and environmental protection and conservation. We suggest you use the keyword search list at the beginning of the Resource Chapter to help you find organizations in your area.

ALABAMA

Alabama Department of Environmental Management
ADEM Montgomery Office
1400 Coliseum Boulevard
Montgomery, AL 36110-2400
Telephone: (334) 271-7700
https://adem.alabama.gov/default.cnt

ALASKA

Alaska Department of Environmental Conservation
PO Box 111800
410 Willoughby Ave., Ste. 303, Juneau, AK 99811-1800
Telephone: (907)-465-5066
https://dec.alaska.gov/

ARIZONA

Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, Arizona 85007
Telephone: (602) 771-2300

ARKANSAS

Arkansas Department of Environmental Quality
5301 Northshore Drive
North Little Rock, AR 72118-5317
Telephone: (501) 682-0744
https://www.adeq.state.ar.us/p://www.azdeq.gov/index.html

CALIFORNIA

California Environmental Protection Agency
1001 I Street
PO Box 2815
Sacramento, CA 95812-2815
Telephone: (916) 323-2514
http://www.calepa.ca.gov/

California Department of Resources Recycling and Recovery
1001 I Street–PO Box 4025
Sacramento, CA 95812-4025
Telephone: (916) 322-4027
Public Affairs Office: opa@calrecycle.ca.gov
Telephone: (916) 341-6300
http://www.calrecycle.ca.gov/

COLORADO

Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver, CO 80246
Telephone: (303) 692-2000
https://www.colorado.gov/cdphe

CONNECTICUT

Connecticut Department of Energy and Environmental Protection
79 Elm Street
Hartford, CT 06106-5127
Telephone: (860) 424-3000
deep.webmaster@ct.gov
http://www.ct.gov/deep/site/default.asp

DELAWARE

Delaware Division of Waste and Hazardous Substances
89 Kings Highway
Dover, DE 19901
Telephone: (302) 739-9400
www.dnrec.delaware.gov/dwhs/Pages/default.aspx

Delaware Division of Energy and Climate
100 W. Water Street
Dover, DE 19904
Telephone: (302) 735-3480
www.dnrec.delaware.gov/energy/Pages/portal.aspx

FLORIDA

Florida Department of Environmental Protection
3900 Commonwealth Boulevard M.S. 49
Tallahassee, Florida 32399
Telephone: (850) 245-2118
http://www.dep.state.fl.us/mainpage/default.htm

GEORGIA

Georgia Department of Community Affairs
Planning and Environmental Management
60 Executive Park South, NE
Atlanta, GA 30329
Telephone: (404) 679-4940
www.dca.ga.gov

HAWAII

Hawaii Department of Health, Environmental Health Administration Solid and Hazardous Waste Branch
919 Ala Moana Boulevard #212
Honolulu, Hawai'i 96814
Telephone: (808) 586-4226
http://health.hawaii.gov/shwb/

IDAHO

Idaho Department of Environmental Quality
DEQ Boise Regional Office
1445 N. Orchard St.
Boise, ID 83706
Telephone: (208) 373-0550
http://www.deq.idaho.gov

ILLINOIS

Illinois Pollution Control Board
Telephone: (312) 814-3629
http://www.ipcb.state.il.us/

Illinois Counties Solid Waste Management Association
PO Box 112, Murphysboro IL 62966
http://www.ilcswma.org/

Illinois Environmental Protection Agency
1021 North Grand Ave. East
PO Box 19276
Springfield, IL 62794-9276
Telephone: (217) 782-3397
http://www.epa.illinois.gov/

INDIANA

Indiana Department of Environmental Management
Indiana Government Center North
100 North Senate Avenue, Indianapolis, IN 46204
Telephone: (317) 232-8603
http://www.in.gov/idem/

IOWA

Iowa Department of Natural Resources
Wallace State Office Building
502 East 9th Street, 4th Floor
Des Moines, IA 50319-0034
Telephone: (515) 725-8307
http://www.iowadnr.gov/

KANSAS

Kansas Department of Health and Environment
Bureau of Waste Management
1000 SW Jackson, Suite 320
Topeka, KS 66612-1366
Telephone: (785) 296-1600
http://www.kdheks.gov/waste/

KENTUCKY

Kentucky Energy and Environment Cabinet
500 Mero Street
5th Fl., Capital Plaza Tower
Frankfort, KY 40601
Telephone: (502) 564-5525
http://eec.ky.gov/Pages/default.aspx

MISSISSIPPI

Mississippi Department of Environmental Quality
Office of Pollution Control
PO Box 2261, Jackson, MS 39225
Telephone: (601) 961-5171
http://www.deq.state.ms.us/

MISSOURI

Missouri Department of Natural Resources
PO Box 176; 1101 Riverside Drive
Jefferson City, MO 65102-0176
Telephone: (800) 361-4827 or (573) 751-3443
contact@dnr.mo.gov
http://dnr.mo.gov/

MONTANA

Montana Department of Environmental Quality
Lee Metcalf Building, Main Office
1520 E. 6th Avenue, PO Box 200901
Helena, MT 59620-0901
Telephone: (406) 444-2544
http://deq.mt.gov/

MASSACHUSETTS

Massachusetts Department of Environmental Protection
1 Winter Street
Boston, Massachusetts 02108
Telephone: (617) 292-5500
http://www.mass.gov/eea/agencies/massdep/

MICHIGAN

Michigan Department of Environmental Quality
Constitution Hall
525 West Allegan Street, PO Box 30473
Lansing, MI 48913-7973
Telephone: (800) 662-9278
http://www.michigan.gov/deq/

MINNESOTA

Minnesota Pollution Control Agency
St. Paul Office, 520 Lafayette Road N
St. Paul, MN 55155-4194
Telephone: (651) 296-6300
https://www.pca.state.mn.us/

NEBRASKA

Nebraska Department of Environmental Quality
1200 "N" Street, Suite 400
PO Box 98922
Lincoln, NE 68509
Telephone: (402) 471-2186
http://deq.ne.gov/

NEVADA

Nevada Division of Environmental Protection
Carson City Office
901 South Stewart Street, Suite 4001
Carson City, Nevada 89701–5249
Telephone: (775) 687-4670
http://ndep.nv.gov/index.htm

NEW HAMPSHIRE

New Hampshire Department of Environmental Services
29 Hazen Drive, PO Box 95, Concord, NH 03302-0095
Telephone: (603) 271-3503
http://des.nh.gov/

NEW JERSEY

State of NJ Department of Environmental Protection
PO Box 420
Trenton, NJ 08625-0420
Telephone: 1 (866) DEP-KNOW
http://www.nj.gov/dep/

The State Environmental Education Directory
http://www.nj.gov/dep/seeds/projects.htm

NEW MEXICO

New Mexico Environment Department
Harold L. Runnels Building
1190 St. Francis Drive, Suite N4050
Santa Fe, New Mexico 87505
Telephone: (800) 219-6157 // (505) 827-2855
https://www.env.nm.gov/

OHIO

Organization of Solid Waste Districts of Ohio
c/o Portage County Solid Waste District
3588 Mogadore Road
Kent, Ohio 44240
Telephone: (330) 678-8808
http://www.oswdo.org/

Association of Ohio Recyclers
PO Box 14737, Columbus, OH 43214-0737
http://ohiorecycles.org/
Ohio Environmental Protection Agency
50 West Town Street, Suite 700, PO Box 1049
Columbus, OH 43216-1049
Telephone (614) 644-3020
http://www.epa.ohio.gov/

NEW YORK

NY State Department of Environmental Conservation
625 Broadway, Albany, New York 12233-0001
Telephone: (518) 402-8044
contact@dec.ny.gov // public@dec.ny.gov
http://www.dec.ny.gov/index.html

NORTH CAROLINA

North Carolina Department of Environmental Quality
217 West Jones Street
Raleigh, NC 27603
Telephone (877) 623-6748
http://deq.nc.gov/

NORTH DAKOTA

North Dakota Department of Health
Division of Waste Management
918 East Divide Avenue, 3rd Floor
Bismarck, ND 58501-1947
Telephone: (701) 328-5166
http://www.ndhealth.gov/wm/

OKLAHOMA

Oklahoma Department of Environmental Quality
707 N Robinson, PO Box 1677
Oklahoma City, OK 73101-1677
Telephone (405) 702-0100

OREGON

Oregon Department of Environmental Quality
811 SW 6th Avenue
Portland, OR 97204-1390
Telephone: (503) 229-5696
deq.info@deq.state.or.us
http://www.oregon.gov/DEQ/Pages/index.aspx

PENNSYLVANIA

Department of Environmental Protection
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17101
Telephone: (717) 783-2300
www.dep.pa.gov/Pages/default.aspx#.VtcCU-b-t_k

RHODE ISLAND

RI Department of Environmental Management
235 Promenade St.
Providence, RI 02908-5767
Telephone: (401) 222-6800
http://www.dem.ri.gov/

SOUTH CAROLINA

South Carolina Department of Health and Environmental Control
2600 Bull Street, Columbia, SC 29201
Telephone: (803) 898-3432
info@dhec.sc.gov
http://www.scdhec.gov/index.htm

SOUTH DAKOTA

South Dakota Department of Environment and Natural Resources
Joe Foss Building, 523 E Capitol, Pierre, SD 57501
Telephone: (605) 773-5559
http://denr.sd.gov/#

TENNESSEE

Tennessee Department of Environment and Conservation
312 Rosa L. Parks Ave, Nashville, TN 37243
Telephone: (888) 891-8332
ask.tdec@tn.gov
https://www.tn.gov/environment/

TEXAS

Texas Commission on Environmental Quality
12100 Park 35 Circle, PO Box 13087
Austin, TX 78711-3087
Telephone (512) 239-1000
ac@tceq.texas.gov
https://www.tceq.texas.gov/

UTAH

Utah Department of Environmental Quality
195 North 1950 West
Salt Lake City, UT 84114
Telephone: (801) 536-4400 // (800) 458-0145
http://www.deq.utah.gov/

VERMONT

Vermont Department of Environmental Conservation
1 National Life Drive, Main 2
Montpelier, Vermont 05620-3520
Telephone: (802) 828-1556
http://www.anr.state.vt.us/dec/dec.htm

VIRGINIA

Virginia Department of Environmental Quality
PO Box 1105
Richmond, VA 23218
Telephone: (804) 698-4000
http://www.deq.virginia.gov/

WASHINGTON

Washington State Department of Ecology
Office: 300 Desmond Drive SE, Lacey, WA 98503
Mailing: PO Box 47600, Olympia, WA 98504-7600
Telephone: (360) 407-6000
http://www.ecy.wa.gov/ecyhome.html

WEST VIRGINIA

West Virginia Department of Environmental Protection
601 57th Street SE
Charleston, WV 25304
Telephone: (304) 926-0440
http://www.dep.wv.gov/Pages/default.aspx

WISCONSIN

Wisconsin Department of Natural Resources
101 S. Webster Street . PO Box 7921
Madison, Wisconsin 53707-7921
Telephone: (888) 936-7463
http://dnr.wi.gov/

WYOMING

Wyoming Department of Environmental Quality
200 West 17th Street
Cheyenne, WY 82002
Telephone: (307) 777-7937
http://deq.wyoming.gov/

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@school.recycling

REDUCE REUSE RECYCLE

Notes