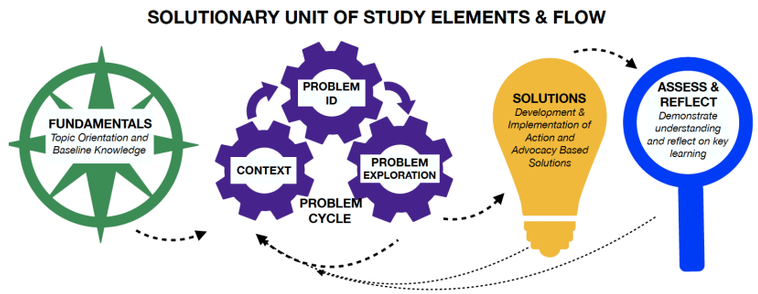
Zero Waste and Sustainable Consumption
K-12 Solutionary PBL Unit of Study Exemplar

Resources developed by SMCOE's Environmental Literacy and Sustainability Initiative (ELSI) • Designed in 2018 - Last updated May 2022

Overview to Content Driven Solutionary PBL: Solutionary Teaching and Learning is a student-centered (but teacher-led) learning experience that provides the opportunity for students to analyze real-world environmental and social justice issues, and develop solutions that seek to mitigate these problems. A Solutionary Unit is built around four elements that take students from understanding basic contextual knowledge about a topic to diving deep into the associated problems and issues, then culminating with designing and implementing solutionary action and advocacy. These units can come in the form of a "mini-unit" or learning sequence that explores one problem within the larger topic and may take 1-2 weeks. Or Solutionary units can be full-length units that explore multiple problems before students move into solutions and action.



Either way, at the conclusion of a solutionary design challenge, students will be invited to pause and reflect. This reflection will center on evaluating impact, reflecting on enduring understandings, and celebrating personal and academic growth. The framework couches this learning process in a larger story-arch, one about a problem that must be solved by the main characters, the students themselves. *To learn more about the Content-Driven Solutionary Unit of Study Framework visit: Solutionary Teaching and Learning Resources.*

Overview of the Waste and Consumption Unit: This document contains a guiding blueprint that includes essential and guiding questions, as well as corresponding concepts that combine to capture the broader "story of waste and consumption." The document also organizes these concepts into a series of standards-aligned solutionary learning segments and activities that teachers can "take-and-teach." However, it must be noted that this is not a fully scripted unit plan - as it is meant to be flexible and customized to meet the local context for each teacher (i.e. local problems and issues, adopted instructional materials, other supplemental resources, field trips, guest speakers, etc.). *It should also be noted that the sample learning segments include activities that are appropriate for both distance and on-site learning.*

The rest of this document provides the architecture for the unit and includes the following:

- **Section A - Waste and Consumption Solutionary Unit Example Blueprint:** The blueprint provides the general storyline of concepts for the four different elements of the unit, with a sample essential question at the top, and sample enduring understanding at the bottom.
- **Section B -** This section provides a high-level overview of the **standards and design considerations for differentiation.**
- **Section C - Concept and Activity Map:** This section provides detail for each concept in the blueprint (i.e. standards, teaching strategies, and activity titles) for each grade band level.

Section A: Zero Waste and Sustainable Consumption Example Blueprint

Essential Question: What are the environmental, social, and economic problems related to the current waste and materials economy systems, and how might we be solutionaries for a zero-waste future?	**Enduring Understanding:** Humans' patterns of consumption and waste are unsustainable; however, it is not too late to make changes that benefit people, the planet, and a thriving economy.

FUNDAMENTALS SEGMENT: *The purpose of this learning segment is to provide a basic understanding of what waste is and why it matters. All concepts are required.*

Driving Question: *What is Waste?*	• Waste is something eliminated or discarded as no longer useful or required after the completion of a process. • The waste system has multiple variables, but can be organized into three general phases: Waste Generation, Waste Sorting, and Waste Processing/Hauling. • The human waste system is complex and has caused an assortment of problems.

PROBLEM SEGMENTS: *The waste system has at least three core problems that could be identified and explored; however, it is only required that a teacher covers one of the problem segments below. The general* ***Driving Question*** for the problem segments is the following: *What are the problems associated with the waste system? How have these problems developed over time (root cause analysis), and what are the impacts?*

Problem Segment: Waste Sorting Humans are not discarding their waste properly.
• While humans have begun to litter less, littering is still a widespread problem • Humans are not accurately sorting their waste into three streams, which means a significant amount of waste does not go to the right place for processing. This has contributed significantly to environmental problems including pollution and global warming. • Population growth and an unsustainable waste system are problematic in the long term.

Problem Segment: Waste Hauling and Processing The system of hauling and processing waste has challenges that have serious environmental, social, and economic impacts.
• Even with the best technology, landfills and incinerators negatively impact humans and the environment, as well as have economic challenges • While recycling has benefits, the system has challenges that need to be solved. • Closed-loop organics recycling is aligned with natural systems and has great environmental, social, and economic benefits

• There are a number of other related waste issues, such as hauling and processing waste after environmental disasters (fires, storms, and floods, etc.), e-waste and hazardous waste, space waste.

Problem Segment: Waste Generation Humans generate too much waste. And even if humans sorted their waste perfectly, because of the way products are designed, there would still be a need for landfills.
• The materials economy is built around a single-use disposable consumer culture that is linear, overuses natural resources, and generates too much waste. This has severe consequences.

SOLUTIONS: *No matter if it is a full-length unit of study or a mini-unit, solutionary teaching and learning must include time for students to design (and ideally implement) solutions that are relevant to their local problems and challenges. The requirement for the solutionary phase is completing one design challenge.*

Driving Question: How can we create a sustainable waste system?	1) Introduction to Solutionaries and solutionary thinking around waste • *Solutionaries* develop solutions that are healthy for people, animals, and the environment. • Solutions for a sustainable waste system are happening at all different scales. 2) Solutionary Design Challenge: Complete one or more solutionary design challenges

REFLECTION: *Reflection and assessment are an integral part of the learning process during and at the completion of a unit. It is required that teachers complete at least one assessment, and at least one reflection process.*

Driving Question: *What did we learn in this unit?*	1) Instructors will integrate formative and summative assessments throughout the unit to check for understanding. 2) Instructors will provide a thoughtful reflection process at the end of the unit for students to identify their enduring understanding, as well as reflect on their growth as a learner. *It is also recommended that students reflect on the extent to which their implemented solution helped remedy the original problem(s).*

Section B: Overview to CA Standards and Differentiation Strategies for Environmental Literacy Integration

Standards Overview: These are the California standards references that can be used for thematic and integrated PBL units, and for entry point connections for integrating the Environmental Principles and Concepts (EP&Cs).

Subject Area	Standards Connections	Reference Resources
Next Generation Science Standards (NGSS)	Although there are many different parts of the CA Next Generation Science Standards (NGSS) that could be referenced, it is recommended to specifically show the connections in the curriculum to the Disciplinary Core Idea (DCI), as these show connections to the content.	San Diego COE NGSS - reference by DCI
CA History Social Studies	The EP&Cs show up in Appendix G of the CA History-Social Studies Framework, which shows specific connections to content and themes. However, when referencing in the curriculum it is recommended to show two specific alignments: • Show connections to specific universal problems, questions, and themes in Appendix B • Show how activities connect directly to Civic Engagement (outlined in Appendix E), which recommends that students have opportunities to participate in civic engagement at every grade level. This includes studying relevant problems and developing solutionary action and advocacy initiatives to solve these problems.	Appendix G - EP&Cs Appendix B - Themes Appendix E - Civic Engagement
CA Health	The health education standards are organized into six health content areas that are recommended for the grade band levels K-5 (different for each grade level), 6-8, 9-12. When developing integrated curriculum it is useful to show connections to show where the curriculum aligns to these content areas.	Health Overarching Standards and Content Areas
CA Common Core Literacy	The literacy standards connections for integrated thematic teaching are generalized across the Common Core Literacy. Based on the teaching strategies students are either reading, writing, listening, and speaking. For each activity or lesson, it is good to be able to reference which of these literacy skills will be covered. If you can get more specific on types of reading (i.e. fiction, non-fiction, etc.) or writing (persuasive, expository, descriptive, etc.) that is useful.	CA Common Core Literacy: Reading, Writing, Speaking and Listening, and Language
CA Common Core Math	Mathematical reasoning is often embedded in a number of activities and lessons. Therefore, it is recommended that the curriculum references the CA Common Core Math Practices. If lessons can point to specific applied math skills then it is recommended to use the *Standards by Domain*.	Common Core Math
CA Visual and Performing Arts	With VAPA, it is often useful to reference how activities connect to the philosophical foundations and goals (creativity, communication, etc.), and/or disciplines (music, art, dance, drama etc).	CA VAPA Framework visual art, music, dance, drama
Career Technical Education (CTE)	Career connections are very common in thematic integrated teaching, and it is recommended to show CTE connections such as specific sectors, and/or connections to Career Ready Standards.	CTE Standards & Practices

Note about differentiation to support ALL learners: In order to ensure high-quality Tier 1 instruction for all students, it is important that teachers make the following considerations for students who are English Learners and students with Special Education needs.

English Learner Considerations

English Learners have a wide range of language strengths and areas to grow - **see overview in ELD standards**. What supports could you provide your English Learner students? Who will you connect with to learn about ways you can support your students?

Determine the level of supports: substantial/moderate/light
Scaffold examples: Language frames, Visuals, Realia, Total Physical Response (TPR), previewing vocabulary, sentence stems, graphic organizers, etc.

Special Education Considerations

Students with IEPs have areas that require specialized planning. Who might you need to connect with to learn more about the students with IEPs in your class? What are some of the needs you might consider? What supports, scaffolds or specific accommodations could you use in order to support the students' learning in your classroom? What assistive technology or tools would you need to support your students with IEPs?

Section C: Zero Waste Solutionary Concept Map with Sample Learning Segment Activities

Overview: This section provides detail for each concept in the Section A Blueprint and Section B Standards, including solutionary teaching strategy recommendations, sample activities and lesson plans for each grade band level (K-2, 3-5, and 6-12), and connections to integrating trauma-informed practices, solutionary thinking, and assessment.

FUNDAMENTALS LEARNING SEGMENT

→ *Quick Guidance for Teachers on Fundamentals: It is highly recommended that any solutionary learning about the waste system begins with attention to the fundamentals on the topic to establish a shared baseline of background knowledge before studying problems and solutions.*
→ *General Resource: 6-12 Fundamentals Slide Deck Example*

Overview: The purpose of this learning segment is to provide a basic understanding of what waste is and why it matters. The learning segment opens with building a shared understanding of the term waste. The unit then moves into making the waste system visible and identifying different phases of waste, as well as identifying different problems associated with the waste and materials economy systems.

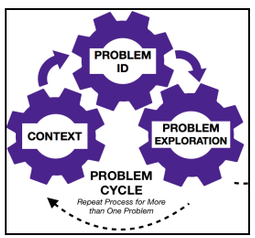
Concept	Standards	Strategies	K-12 Sample Activities	Teacher Adaptations and Notes

Waste is something eliminated or discarded as no longer useful or required after the completion of a process.	• NGSS: ETS1.A, ESS3.A, ESS3.C, PS3.B
	• CA Common Core Literacy: Speaking and Listening
	• CA History Social Studies Themes: Science, Technology, and the Environment
	• California Health Standards: Personal and Community Health
	• CA CTE Standards for Career Ready Practices: #12
		Engage and Explain
		
		Intellectual Rigor
			The unit will begin with an inquiry-based question, “What is waste, and what is the fundamental problem with waste”?
			
			K-12 Recommended Activities and Materials:
			• Students brainstorm a definition for the term “waste,” and compare the definition to the teacher-provided definition.
			• Using pictures or real examples of items and materials (i.e. wrappers, clothes, books, metal can, etc.), students work together to categorize items as waste or not waste. Students are introduced to the vocabulary term “biodegradable”.
			• Students identify how “waste” is processed in a natural ecosystem, and compare that to the human produced waste system.
			
			K-5 Recommended Activities and Materials:
			• Students watch RethinkWaste: “What is Waste” Video & Complete the What is Waste Lesson Plan
			• Students explore materials & their uses with the Office of Sustainability's Activity: Humans Use Natural Resources (Younger students may have difficulty completing this alone.
			  ○ Consider substituting with “What is Biodegradable?” Lesson Plan (page 3)
			  ○ You can also create an online sorting activity using Google Slides, Padlet, or other tech platforms familiar to your students. (You can also substitute a	

			book about waste.)	
The waste system has multiple variables, but can be organized into three general phases: Waste Generation, Waste Sorting, and Waste Processing/Hauling.	• NGSS: ETS1.A, ETS1. B, ETS1.C, ESS3.C, LS2.A • CA Common Core Literacy: Reading, Writing, Speaking and Listening • CA History Social Studies Themes: Haves and Have Nots, Science, Technology, and the Environment • California Health Standards: Personal and Community Health • CA CTE Standards for Career Ready Practices: #4, #5, #12	Engage, Explore, Explain Intellectual Rigor	An important part of understanding the fundamentals of waste is being able to visualize the waste system, and to understand the different "phases" of waste. Students categorize the broader waste system into three phases: Generation, Sorting, Processing and Hauling **K-5 Recommended Activities and Materials:** • Book *Where Does Garbage Go?* By Isaac Asimov (K-2) • Book *What a Waste* by Jess French (better for upper elementary) • Have students draw and label a picture(model) of what happens to waste. They could make a four-panel showing them creating waste, sorting the waste, the truck picking it up, and then the waste being buried in a landfill or made into something new (recycled). **3-12 Recommended Activities and Materials:** • San Mateo County Office of Sustainability's Digital or Paper Packet Version of SMCOOS 4Rs Waste Game • Students model the waste system by playing the San Mateo County Office of Sustainability's 4Rs, "Where does it go?" game. • Students label different variables and elements of the waste system on their own model.	
The human waste system is complex and has caused an assortment of problems.	• NGSS: ETS1.A, ETS1. B, ETS1.C, ESS3.C • CA Common Core Literacy: Speaking and Listening • CA History Social Studies Themes: Haves and Have Nots, Science, Technology, and the Environment • California Health Standards: Personal and	Explore, Elaborate, Explain Intellectual Rigor, Emotional Engagement	Before moving into a more detailed study of the problems associated with waste, students will be given the opportunity to identify all the problems they can identify within the waste system. **K-5 Activities and Materials**: • K-2 Students should try to categorize problems by phases (generating too much waste, not sorting, processing too little, and hauling to filled landfills) using diagrams of the waste system, any drawings or models they have created, and images of landfills. • 3-5 Students use the Graphic Organizer to group waste problems into the different categories **6-12 Activities and Materials:** • Students brainstorm and identify different problems within the waste system. It is useful to have the visual model they created earlier in front of them. • Students group problems into different categories.	

	• Community Health • CA CTE Standards for Career Ready Practices: #2, #5, #9, #10			
Additional Resources and Considerations	By the end of the fundamentals learning segment, students should be able to accurately explain to someone else the fundamental basics of waste. Formative and summative evaluation tools for this learning segment are recommended in the Assess and Reflect section.			

PROBLEM LEARNING SEGMENTS OVERVIEW



Overview: *Any given topic likely has at least 1-5 problems that could be identified and explored. In order to identify something as a problem, students may need additional context from which they can then make observations of social and scientific phenomena, and follow a cycle of inquiry using evidence and systems thinking. This process of context - problem ID - problem exploration, is repeated for each problem. Depending on grade level and time constraints teachers may choose to select only 1-2 problem learning segments to explore with students, and/or teachers may go from problem to solution, and then go back and explore another problem and solution. This phase of learning is meant to be flexible and meet the interests and development level of students.*

Each problem segment below has an additional row at the end of the table that reminds instructors (teachers) to integrate different teaching strategies and tools such as Solutionary PBL Teaching Strategies, Trauma-Informed Practices, Assessment and Reflection, and Solutionary Activities and Resources.

PROBLEM SEGMENT: Waste Sorting

→ *Quick Guidance for Teachers on this problem segment: This problem cycle has a number of complex issues embedded within it, and teachers need to determine which concepts are best to explore with students based on grade level, local context, and time constraints - not all concepts need to be covered It is critical that trauma-informed practices be at the center of lessons, in particular those exploring environmental justice and population growth issues.*

→ *General Resource: 6-12 Waste Sorting Slide Deck Example*

Overview: Humans are not discarding their waste properly.				
Concept	**Standards**	**Strategies**	**K-12 Sample Activities**	**Teacher Adaptations and Notes**
While humans have begun to litter less,	• NGSS: ESS1.C, ETS1.A	Engage, Explore, Explain	The first problem segment focuses on litter, as litter is a primary example of humans not being able to discard their waste properly. Litter also has significant environmental, social, and	

littering is still a wide-spread problem.	• CA Common Core Literacy: Reading, Speaking and Listening • CA History Social Studies Themes: Science, Technology, and the Environment • CC Math: Counting & Cardinality, Measurement & Data, Statistics & Probability • California Health Standards: Personal and Community Health • CA CTE Standards for Career Ready Practices: #7, #8	Intellectual Rigor, Emotional Engagement, Ethical Reflection	economic impacts. All students will develop a definition of the term litter. **K-2 Recommended Activities and Materials:** • Read: *Michael Recycle* and/or *Michael Recycle Meets Litterbug Doug* by Ellie Bethel • Rethink Waste Litter Bingo (optional, best for upper elementary) • Litter Matching Activity (optional, complete with an adult or older buddy) • Students conduct a local litter exploration (take a walk in the area, look for litter but do not pick any up without adult permission and safety equipment like gloves, tongs, etc) • Discuss the types and amount of litter students observed **3-5 Recommended Activities and Materials:** • 3-5 Litter Worksheet • Students will explore litter in their own neighborhoods by playing the Rethink Waste Litter Bingo game **3-12 Recommended Activities and Materials:** • Students will investigate litter statistics from the past 50-100 years and analyze to what extent problems with litter are getting better or worse. The teacher may need to adjust for younger learners. (Slidedeck with littering facts specific to waste sorting problem exploration) • Students will use the app Litterati (optional, requires technology/personal cell phone, adult permission) • Students will explore different anti-littering campaigns, how they have developed over time, and to what extent they are effective **6-12 Recommended Activities and Materials:** • Students will complete the 6-12 Litter Hyperdoc • Students will analyze the TBL impacts of litter (environmental, social, and economic), and discuss issues with peers.	

Humans are not accurately sorting their waste into three-streams, which means a significant amount of waste does not go to the right place for processing. This has contributed significantly to environmental problems including pollution, and global	• NGSS: ESS3.A, ESS3.C
	• CA Common Core Literacy: Speaking and Listening
	• CA History Social Studies Themes: Haves and Have Nots, Worlds of Exchange, Science, Technology, and the Environment
	• CC Math: Counting & Cardinality,
		Explore, Explain, Elaborate
		
		Intellection Rigor, Emotional Engagement, Ethical Reflection
			The next concept to explore is the waste that does make it into a waste receptacle, but may or may not be sorted correctly. During this segment, students will analyze data and identify impacts and problems through online research and inferences.
			
			K-2 Recommended Activities and Materials:
			• RethinkWaste Sorting Video: Episode 2 of The GreenZone (optional for younger learners)
			• Read: Michael Recycle by Ellie Bethel
			• K-2 Waste Streams Activity
			
			3-12 Recommended Activities and Materials:
			• Students will complete a hyperdoc and/or WebQuest
			  ○ 3-5: Waste Streams 3-5 Hyperdoc
			  ○ 6-12: 6-12 Waste Streams Hyperdoc	

warming.	Measurement & Data, Statistics & Probability • California Health Standards: Personal and Community Health • CA CTE Standards for Career Ready Practices: #7, #11, #12		○ 6-12: Waste Streams WebQuest: 6-8 and 9-12 • Students will analyze statistics and data at multiple scales (global, national, local) that demonstrate patterns over time for each waste stream: Landfill, Recycling, Organics. • Students will complete online research to investigate Triple Bottom Line (TBL) impacts (environmental, social, and economic) from each waste stream. • Students will then discuss impacts in a variety of engaging small-group and whole-class discussions.	
Population growth and an unsustainable waste system are problematic in the long-term.	• NGSS: ESS3.C • CA Common Core Literacy: Reading, Writing, Speaking and Listening • HSS: Patterns of Population, Science Technology and the Environment • CC Math: Functions, Modeling • California Health Standards: Personal and Community Health • California Arts Education Framework: Media Arts as Means to Wellbeing	Explore, Explain, Elaborate Intellection Rigor, Emotional Engagement, Ethical Reflection	One critical aspect of the sorting problem is how an exponentially growing human population that chooses not to sort their waste exacerbates and accelerates the urgency of this problem. **K-5 Recommended Activities and Materials:** • Students watch WALL-E and reflect on human population growth impacts • K-5 WALL-E Sample Reflection Prompts (teacher may facilitate this with younger learners) **3-12 Recommended Activities and Materials:** • Students explore the relationship between population growth and consumption using the CalAcademy Interactive Human Migration Map or California Population Changes Since 1901, NOVA World in Balance website and podcast, "Population and Environment: A Global Challenge" to learn more about the impacts of population size, composition, distribution, and consumption. • Students play the Musical Chairs Resource Simulation to apply the concerns over an increased population producing waste in a finite space or resource being overused. In this case the amount of space left on the floor is the finite resource.	
Additional considerations: Teaching Strategies Trauma-Informed Practices, Assessment, and Solutionary Activities.	*As instructors develop and plan this unit, it is critical to integrate different teaching strategies and tools such as:* • *Solutionary PBL Teaching Strategies*: Each learning segment should blend a mix of strategies • *Trauma-Informed Practices*: Especially for content and activities that have emotional engagement and ethical reflection • *Assessment and Reflection*: Learning segments should include and/or end with formative assessment and reflection • *Solutionary Activities and Resources: Often when examining problems, students will naturally want to find ways to solve these problems at the individual or collective scale. Depending on the grade and social and emotional development, it may be appropriate for teachers to spend time examining some aspects of solutions after each problem segment. However, to support solutionary thinking that gets at root causes, it is also recommended that students be exposed to all problem segments that a teacher plans to include in a unit of study (or mini-unit) before completing a solutionary design challenge.*			

PROBLEM SEGMENT: Waste Hauling and Processing

→ Quick Guidance for Teachers on this problem segment: This problem cycle has a number of complex issues embedded within it, and teachers need to determine which concepts are best to explore with students based on grade level, local context, and time constraints.

→ *General Resource: 6-12 Waste Hauling and Processing Slide Deck Example*

Overview: The system of hauling and processing waste has challenges that have serious environmental, social, and economic impacts.				
Concept	**Standards**	**Strategies**	**K-12 Sample Activities**	**Teacher Adaptations and Notes**

Even with the best technology, landfills and incinerators negatively impact humans and the environment, as well as have economic challenges.	• NGSS: ESS3.A, ESS3.C, ETS1.A, ETS1. B, ETS1.C
	• CA Common Core Literacy: Reading, Writing, Speaking and Listening
	• CA History Social Studies Themes: Science, Technology and the Environment
	• CC Math: Measurement & Data, Modeling, Statistics & Probability
	• California Health Standards: Personal and Community Health
	• CA CTE Standards for Career Ready Practices: #4, #5, #11, #12
		Engage, Explore, and Explain
		
		Intellection Rigor, Ethical Reflection, Emotional Engagement
			This segment kicks-off with students examining how landfills and incinerators work, and analyzing to what extent landfills/incinerators are a reasonable solution for hauling and processing waste.
			
			K-2 Recommended Activities and Materials:
			• **Full lesson plan:** K-2 Landfill Lesson Plan & K-2 Landfill Worksheet
			• Read Where Does the Garbage Go? By Paul Showers
			  ○ Discuss with students where their garbage goes
			  ○ Students model a landfill
			
			3-5 Recommended Activities and Materials:
			• **Full lesson plan:** Students research statistics about landfills from the past and the present (global, national, and local) and examine the geography of landfills in the U.S. and locally 3-5 Landfill Lesson Plan & 3-5 Hyperdoc
			• Students will visit a landfill and/or modeling a landfill
			  ○ San Mateo County Office of Sustainability: Modeling a Landfill
			  ○ Virtual field trip: Republic Services Modern Landfill Video Tour Grades 3-5
			
			6-12 Recommended Activities and Materials:
			• **Full lesson plan:** Landfill 5E Lesson Plan
			• Students will research statistics about landfills from the past and the present (global, national, and local) and examine the geography of landfills in the United States and locally using the 6-12 Landfill Hyperdoc
			• Students will visit a landfill and/or modeling a landfill
			  ○ SMCOOS Build a Landfill Lesson Plan
			  ○ Virtual field trip	

While recycling has benefits, the system has challenges that need to be solved.	• NGSS: ESS3.A, ESS3.C, ETS1.A, ETS1. B, ETS1.C • CA Common Core Literacy: Reading, Writing, Speaking and Listening • CA History Social Studies Themes:	**Explore, Elaborate, Explain** Intellection Rigor, Emotional Engagement, Ethical	When it comes to recycling, it is important that students understand that there are a lot of positive benefits to recycling and at the same time our current recycling system has a lot of challenges that make it an incomplete solution to the waste problem. **K-2 Recommended Activities and Materials:** • **Full lesson plan:** K-2 Recycling Lesson Plan • Students will learn where their recyclables go by taking a virtual tour of a Materials Recovery Facility (MRF). ○ RethinkWaste Video: Where does your stuff go?	

	Worlds of Exchange, Science, Technology and the Environment • CC Math: Measurement & Data, Modeling, Statistics & Probability • California Health Standards: Personal and Community Health • CA CTE Standards for Career Ready Practices: #4, #5, #7, #11, #12 • California Arts Education Framework: Visual Arts as Culture, History, and Connectors	Reflection	○ Keep America Beautiful: Virtual Tour of a Materials Recovery Facility (MRF). • Students will use common recyclable items to do a creative reuse project ○ Waste Management Recycling Art Project Ideas and Instructions. **3-5 Recommended Activities and Materials:** • **Full lesson plan:** Students will research statistics about recycling from the past and the present (global, national, and local) 3-5 Recycling Lesson Plan & 3-5 Hyperdoc • Students will take a tour of a Materials Recovery Facility (MRF) GreenZone Episode 1 Video (from 9:16 - 12:43 only) • Students will conduct a recycling experiment ○ Recycling Plastics ○ Purdue's Science Experiment: Reduce, Reuse, Recycle **6-12 Recommended Activities and Materials:** • **Full lesson plan:** Students will research statistics about recycling from the past and the present (global, national, and local) using the 6-12 Recycling 5E Lesson Plan and 6-12 Recycling Hyperdoc • Students will take a tour of a Materials Recovery Facility (MRF) GreenZone Episode 1 Video (from 9:16 - 12:43 only) • Students will compare recycling, downcycling, and upcycling to better understand the properties of a variety of materials and the number of "lives" they each have. • Students will research the recycling crisis. 6-12 Recycling Crisis Webquest	
Closed-loop organics recycling is aligned with natural systems and has great environmental, social and economic benefit.	• NGSS: ESS3.A, LS1.C, LS2.B, PS3.D • CA Common Core Literacy: Reading, Writing, Speaking and Listening • CA History Social Studies Themes: Science, Technology and the Environment • CC Math: Measurement & Data, Modeling, Statistics & Probability	**Explore, Elaborate, Explain** Intellection Rigor	The cycle of organics into compost is one of the most effective processing techniques we have for waste. Students will get familiar with techniques for making this closed loop cycle at a residential scale, and at the commercial scale. **K-2 Recommended Activities and Materials:** • **Full lesson plan:** Students will compare different types of organics, learn how they are processed and composted, and experiment with composting in the K-2 Organics 5E Lesson Plan • Office of Sustainability: A Rot is Happening Here (Need to be a reader to complete) **3-5 Recommended Activities and Materials:** • **Full lesson plan:** Students will research statistics about organics processing in the past and present, compare different types of composting, take a tour of an organics processing facility and experiment with composting in the 3-5 Organics 5E Lesson Plan ○ Introductory Activities to Understand Organic Waste & Composting	

	• California Health Standards: Personal and Community Health • CA CTE Standards for Career Ready Practices: #4, #5, #7, #11, #12		○ Compost in a Bucket Activity • Office of Sustainability: A Rot is Happening Here **6-12 Recommended Activities and Materials:** • **Full lesson plan:** Students research statistics about organics processing in the past and present and compare different types of composting in the 6-12 Organics 5E Lesson Plan. ○ 6-12 Organics Hyperdoc • Students will experiment with composting in the Worm Bin Activity	
There are a number of other related waste issues, such as hauling and processing waste after environmental disasters (fires, storms and floods, etc.), e-waste and hazardous waste, space waste.	• NGSS: ESS3.A, ESS3.C • CA Common Core Literacy: Reading, Speaking and Listening • CA History Social Studies Themes: Haves and Have Nots, Worlds of Exchange • California Health Standards: Personal and Community Health • CA CTE Standards for Career Ready Practices: #4, #5, #7, #11, #12	**Explore, Elaborate, Explain** Intellection Rigor, Emotional Engagement, Ethical Reflection	Students will be exposed to other interesting and important related waste issues such as hauling and processing waste after environmental disasters (fires, storms and floods, etc.), e-waste and hazardous waste, space waste. **6-12 Recommended Activities and Materials:** • 6-12 Hazardous Waste Hyperdoc • 6-12 E-Waste Hyperdoc • Video on space waste • Disaster Clean-Up Case Studies: ○ Camp Fire Clean Up Case Study ○ Guerneville Flood Clean Up Case Study ○ Waste Dumping in East Palo Alto Case Study ○ Bayview Hunter Point Case Study	
Additional considerations: Teaching Strategies Trauma Informed Practices, Assessment, and Solutionary Activities.	*As instructors develop and plan this unit, it is critical to integrate different teaching strategies and tools such as:* • *Solutionary PBL Teaching Strategies*: Each learning segment should blend a mix of strategies • *Trauma Informed Practices*: Especially for content and activities that have emotional engagement and ethical reflection • *Assessment and Reflection*: Learning segments should include and/or end with formative assessment and reflection • *Solutionary Activities and Resources: Often when examining problems, students will naturally want to find ways to solve these problems at the individual or collective scale. Depending on the grade and social and emotional development, it may be appropriate for teachers to spend time examining some aspects of solutions after each problem segment. However, to support solutionary thinking that gets at root causes, it is also recommended that students be exposed to all problem segments that a teacher plans to include in a unit of study (or mini-unit) before completing a solutionary design challenge.*			

PROBLEM SEGMENT: Waste Generation

→ Quick Guidance for Teachers on this problem segment: This problem cycle has a number of complex issues embedded within it, and teachers need to determine which concepts are best to explore with students based on grade level, local context, and time constraints. This problem cycle is best explored at the end of unit, when students have already explored the waste system.

→ General Resource: 6-12 Waste Generation Slide Deck Example

Overview: Humans generate too much waste. And even if humans sorted their waste perfectly, because of the way products are designed, there would still be a need for landfills.				
Concept	**Standards**	**Strategies**	**K-12 Sample Activities**	**Teacher Adaptations and Notes**

The materials economy is built around a single-use disposable consumer culture that is linear, overuses natural resources, and generates too much waste. This has severe consequences.	• NGSS: ESS3.A, ESS3.C, ETS1.A, ETS1. B, ETS1.C
	• CA Common Core Literacy: Reading, Writing, Speaking and Listening
	• CA History Social Studies Themes: Haves and Have Nots, Science, Technology and the Environment
	• CC Math: Measurement & Data, Statistics and Probability, Modeling, Functions
	• California Health Standards: Personal and Community Health
	• CA CTE Standards for Career Ready Practices: #4, #8, #10, #11, #12
		Engage, Explore and Explain
		
		Intellection Rigor, Emotional Engagement Ethical Reflection
			The last learning segment leverages principles of systems thinking to help students identify the importance of eliminating waste at the start of the process, so that humans can move towards a circular (closed-loop or cradle-to-cradle) economy.
			
			K-12 Recommended Activities and Materials:
			• Students will categorize “stuff” into needs and wants (using words, pictures or actual items depending on grade)
			
			K-2 Recommended Activities and Materials:
			• **Full lesson plan:** K-2 Life Cycle Analysis Lesson Plan
			  ○ Background for teachers: Life Cycle Assessment.
			  ○ Video of students working on Life Cycle Mapping.
			• Needs vs Wants Lesson Plan
			• Life Cycle of a T-shirt (upper elementary)
			• Book and online reading: The Great Trash Bash by Loreen Leedy
			
			K-5 Recommended Activities and Materials:
			• RethinkWaste: Waste Detectives For a Day (an at-home, personal waste audit) - younger learners will need help
			
			3-12 Recommended Activities and Materials:
			• **Full lesson plan:** 3-5 Chocolate Company Why Packaging Matters
			• **Full lesson plan:** 3-5 Life Cycle Analysis 5E Lesson Plan
			• **Full lesson plan:** 6-12 Life Cycle Analysis 5E Lesson Plan
			  ○ 6-12 Life Cycle Analysis Hyperdoc
			• Students will watch The Story of Stuff
			• Students will investigate Ecological Footprint of the world, their country, and themselves
			• Students will research and analyze the concept of Earth Overshoot
			• Students will complete a life cycle analysis of a product and research and analyze history and trends of single-use
			  ○ LIFE Magazine
			  ○ BBC Podcast	

			○ SMCOOS Single Use Plastic and Food Packing Lesson Plan & Worksheet **6-12 Recommended Activities and Materials:** ● Woodside High School: APES Personal Solid Waste Audit	
Additional considerations: Teaching Strategies Trauma Informed Practices, Assessment, and Solutionary Activities.	*As instructors develop and plan this unit, it is critical to integrate different teaching strategies and tools such as:* ● *Solutionary PBL Teaching Strategies*: Each learning segment should blend a mix of strategies ● *Trauma Informed Practices*: Especially for content and activities that have emotional engagement and ethical reflection ● *Assessment and Reflection*: Learning segments should include and/or end with formative assessment and reflection ● *Solutionary Activities and Resources: Often when examining problems, students will naturally want to find ways to solve these problems at the individual or collective scale. Depending on the grade and social and emotional development, it may be appropriate for teachers to spend time examining some aspects of solutions after each problem segment. However, to support solutionary thinking that gets at root causes, it is also recommended that students be exposed to all problem segments that a teacher plans to include in a unit of study (or mini-unit) before completing a solutionary design challenge.*			

SOLUTIONS LEARNING SEGMENT: ACTIVITIES, CONTENT, AND RESOURCES

Overview: No matter if it is a full length unit of study, or a mini-unit, solutionary teaching and learning must include time for students to design (and ideally implement) solutions that are relevant to their local problems and challenges. This applied problem solving is called for in multiple subject area standards and frameworks:

- CA NGSS Engineering ETS1.A-C
- CA HSS Civic Engagement
- CA Health
- CA CC Math Practices
- CA CC Literacy
- CA VAPA Framework (Arts Integration)
- CA CTE Standards for Career Ready Practices

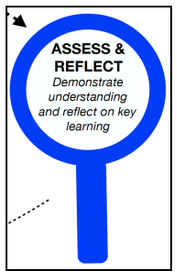
Please note that instructors may choose to integrate solutionary activities at the end of each problem learning segment, and/or teachers may save the majority of solutionary activities (in particular the design challenges) for the end of the unit (or mini-unit).

The table below includes general suggestions for introducing solutionary thinking and general solutionary design challenges, as well as specific content for solutionary teaching and learning regarding the waste system.

Concept	Sample Activities and Resources	Teacher Adaptations and Notes
A Solutionary is someone who is able to identify inhumane and unsustainable systems, then develop solutions that are healthy for people, animals, and the environment.	Introduce students to the concept of a solutionary. Utilize and adapt the following resources for your grade level: ● Introduction to Solutionary Mindset Slide Deck ● Solutionary Books and Videos	
Solutions for waste systems are happening at all different scales.	**Description and Resources:** Introduce students to the types of solutions that are possible for a sustainable waste system. Utilize and adapt the following resources for your grade level and local context - *resources are the same for on-site and remote learning*: ● Waste Solutions Slide Deck Overview **Activities Overview:** ● Provide background and context ● Explore examples and discuss relevance and feasibility in local context	
Humanity cannot wait for students to graduate and get started on doing things that contribute to a better world. We need to give students in every school, at every age, real agency and authentic	Students should complete at least one design challenge at the end of the Solutionary PBL unit. Choose a solutionary design challenge from the Solutionary Design Challenges Overview and Examples - handout and slide deck embedded. → Note that design challenges need to be adapted for your topic, grade level, and local context.	

opportunities to make a difference in this volatile, unpredictable, complex, and ambiguous world. *- David B. Hawley: CIO for IBO Curriculum*		

ASSESS (EVALUATE) & REFLECT:



Overview: Assessment (evaluation) provides students an opportunity to apply their understanding of the standards - both content and practices (see below):

- CA NGSS Science and Engineering Practices
- CA HSS Civic Engagement
- CA Health
- CA CC Math Practices
- CA CC Literacy
- CA VAPA Framework (Arts Integration)
- CA CTE Standards for Career Ready Practices

Assessment also provides opportunities for students to grapple with the California Environmental Principles & Concepts (EP&Cs) that are most relevant. A solutionary unit (or mini-unit) provides many opportunities for assessment (evaluation) and reflection, and it is recommended that instructors integrate formative assessment during and after each learning segment. Many instructors may want to use a rubric for assessing students throughout the solutionary unit, and at the end of the unit during the culminating presentation. A few sample rubrics can be found here:

- *Solutionary Unit of Study Student Outcomes Rubric Example*
- *Zoe Weil @ Institute for Humane Education - Solutionary Rubric*

Assess (Evaluate): *Suggestion for how to complete a formative or summative assessment are below.*	
Formative: By the end of each learning segment, students should have done multiple formative assessments that demonstrate their understanding of each issue that is relevant to this problem.	Examples of formative assessment/evaluation tasks include: • Students can make the problem visible to others through a diagram, chart, picture, etc. This picture or diagram would include the relevant variables that contribute to the problem, and connections between these variables. • If the problem lends itself to argumentative/persuasive reasoning, students could collect credible evidence that is relevant to the problem, and make a claim (C) that they back up with evidence (E) and reasoning (R) - this CER statement can be done in writing or verbally in a video. *If your students are not familiar with C-E-R, consider using KLEWS to prepare the students for CER in future grades. KLEWS 101.* • In a whole class discussion or socratic seminar, students share their intellectual, emotional, and ethical understanding of the problems and issues. • Students can complete a Triple Bottom Line (TBL) analysis, by identifying environmental, economic, and social impacts. This can be done in a graphic organizer, writing, or in a video. • If a case study was included in this problem exploration, students can complete a case study analysis and contribute to each aspect of a case study analysis and can collaborate with peers on developing feasible solutions. • Students can choose which of the California Environmental Principles & Concepts (EP&Cs) they think are most relevant to this problem, and analyze how/why in writing or verbally in a discussion or video.
Summative: A culminating	After studying the fundamentals, problem(s), and completing a solutionary design challenge, students will need to capture their learning by demonstrating their understanding of the content (and skills) during each segment of the unit (or mini-unit). It is recommended that instructors have students complete a culminating presentation that will ideally

summative assessment captures student learning from the entire unit (or mini-unit).	also include a final reflection (see reflection prompts in the reflection section below). Below are some recommended presentation styles: ● Whole-Class Presentations (this should include some sort of visual - poster, slide deck, etc.) ● Showcase and Solutionary Fair Displays - see details HERE for how to host a solutionary fair ● TEDx Style Talk/Video ● Presentation to Industry Experts

Reflection: *Suggestions for integrating reflection are below.*	
Reflection is an integral part of the learning process during and at the completion of a unit..	Instructor supports students to reflect on their learning throughout the unit (mini-unit), and to provide an understanding of their enduring understanding at the end of the unit. Possible outcomes from reflection are the following: ● At the end of a problem segment, students can complete a reflection journal prompt that expresses their sense of urgency regarding the problems and issues they studied so far. ● Students reflect on their overall emotional feelings during and at the end of the unit: fear, hope, outrage, optimism, etc. ● Students articulate an enduring understanding from the unit. ● Students reflect on their personal growth based on their experiences during the project. ● Students reflect on the extent that their implemented solution helped remedy the problem.