Engineering Faculty Document No. 13-23
September 1, 2022

TO: The Faculty of the College of Engineering
FROM: The Division of Environmental and Ecological Engineering
SUBJECT: New Graduate Course, EEE 57000, Solid and Hazardous Waste Management

The Faculty of the Division of Environmental and Ecological Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

EEE 57000: Solid and Hazardous Waste Management
Sem. 2, Lecture 2, Credits 3
Prerequisites: no

Course description:
Students will be introduced to the regulation of solid and hazardous wastes; engineering design, planning and analysis of solid and hazardous waste management facilities. The learning objectives for this course are:

1. Apply knowledge of topics from chemistry such as stoichiometry, kinetics, and equilibrium to gas generation, waste composition, and thermal conversion processes.
2. Solve problems that address engineering issues such as the selection of alternatives for recycling and carbon generation.
3. Understand the role of an engineer involving regulations, ethics, professionalism, engineering practice and registration.
4. Solve basic problems related to gas and leachate generation, risk assessment, waste collection and composition, and thermal conversion processes.
5. Demonstrate an ability to communicate effectively.

This course has been taught periodically has CE 59700/EEE 59500 Spring semesters since 2016.

Reasons: The course has been taught since Spring 2016 and a permanent course number is needed.

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John W. Sutherland, Professor and Fehsenfeld Family Head
Division of Environmental and Ecological Engineering

EEE 57000: Solid and Hazardous Waste Management (EFD 13-23)

Level: Graduate

Course Instructor: Andrew Whelton

Course Description
Students will be introduced to the regulation of solid and hazardous wastes; engineering design, planning and analysis of solid and hazardous waste management facilities.

Learning Outcomes & Learning Objectives

1. Apply knowledge of topics from chemistry such as stoichiometry, kinetics, and equilibrium to gas generation, waste composition, and thermal conversion processes.
2. Solve problems that address engineering issues such as the selection of alternatives for recycling and carbon generation.
3. Understand the role of an engineer involving regulations, ethics, professionalism, engineering practice and registration.
4. Solve basic problems related to gas and leachate generation, risk assessment, waste collection and composition, and thermal conversion processes.
5. Demonstrate an ability to communicate effectively.

Previous Teaching:
This course has been taught as CE 59700/EEE 59500 in the following semesters

Enrollment Spring 2016 = 11
Enrollment Spring 2017 = 20
Enrollment Spring 2018 = 17
Enrollment Spring 2019 = 28
Enrollment Spring 2022 = 21

The syllabus for Spring 2022 follows.

CE 597/EEE 595: Solid and Hazardous Waste Management, Spring 2022

Course Instructors: Prof. Andrew Whelton awhelton@purdue.edu [email best], Office: HAMP 3145D, Telephone: (765) 494-2160
Course Credit: 3 credits
Course Content: Brightspace ("Learning Management System")
Meeting Day and Time: Tuesday/Thursday, 900-1015 EST
Meeting Location: Hampton Hall Room 2102
Prerequisite: Graduate standing or by special permission of the Instructor.
Office hours: Contact the instructor directly.

Course Description

Civilization has been defined by technological advancement, but also waste and disasters. Students will be introduced to recent globally important environmental and public health issues and disasters, the U.S. regulation of wastes; engineering design, planning and analysis of management facilities, and the complexity of responding to and recovering communities from disasters.

Learning Outcomes

It is expected that students taking EEE 690 will achieve the following learning outcomes:

1. Solve basic problems related to pollutant generation, waste collection and composition, recycling, and thermal conversion processes.
2. Apply knowledge of topics from chemistry such as stoichiometry, kinetics, and equilibrium to gas generation, and waste composition.
3. Understand the role of an engineer involving regulations, ethics, professionalism, engineering practice and registration.
4. Demonstrate an ability to communicate effectively.
5. Solve environmental and public health problems associated with man-made and natural-disasters.

Learning Resources, Technology & Texts

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  - Brightspace page: You can access the course via Brightspace. It is strongly suggested that you explore and become familiar not only with the site navigation, but with content and resources available for this course. See the Help tab for resources.
  - ***Required*** **(EREF textbook and online learning)**. **$50.00.** Go here https://solidwastecourse.org/groups/ and select "Instructor Andrew Whelton – Purdue University Spring 2022." Then purchase the online learning bundle for the class. Students will receive access to all 10 modules developed by EREF. This provides access to training webinars, educational videos, textbook, quizzes, and answers.

Course assignments and readings will come from this text and additional readings will be available as handouts or on the course Blackboard Learn site. Course Content: Blackboard Learn Site: https://mycourses.purdue.edu/

Optional Materials **(Textbook FREE online through Purdue University)**

Free, Solid Waste Technology and Management by Thomas Christensen; Publisher: John Wiley & Sons, October 2010, 1056 pgs; LC CALL NUMBER TD791 --.S65 2011eb; DEWEY DECIMAL NUMBER 628/.744; PRINT ISBN 9781405175173; EBOOK ISBN 9780470666968; OCLC NUMBER 769189166

Academic Guidance in the Event a Student is Quarantined/ Isolated

If you become quarantined or isolated at any point in time during the semester, in addition to support from the Protect Purdue Health Center, you will also have access to an Academic Case Manager who can provide you academic support during this time. Your Academic Case Manager

can be reached at acmq@purdue.edu and will provide you with general guidelines/resources around communicating with your instructors, be available for academic support, and offer suggestions for how to be successful when learning remotely. Importantly, if you find yourself too sick to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation. The Office of the Dean of Students (odos@purdue.edu) is also available to support you should this situation occur.

GRADING AND ASSESSMENT

There will be three exams. In class activities may be given at any time; you must be present to receive credit. Homework will be assigned and collected for grading. The overall course grade will be weighted as follows:

Exam 1	35%
No exam 2	
Exam 3	20%
Homework/Quizzes	25%
Project	20%

A	=	93 – 100	B-	=	80 – 82	D+	=	67 – 69
A-	=	90 – 92	C+	=	77 – 79	D	=	60 – 66
B+	=	87 – 89	C	=	73 – 76	F	=	59.4 and
B	=	83 – 86	C-	=	70 – 72	below		

Grades will be rounded to the nearest whole number. For example, and 84.4 would be rounded to 84 whereas 84.5 would be rounded to 85.

Activity A – SOLID WASTE

Watch one of the following and write a 1 page (max) summary and assessment of it. To complete this assignment, you should find supporting articles in scientific journals to cite. Use Google Scholar to search for key words and terms.

- Trash, Inc: Secret Life of Garbage [CNBC]
- The Wasteland [CBS 60 Minutes]
- WALL-E
- The Lorax

Activity B – HAZARDOUS WASTE

Watch one of the following and write a 1 page (max) summary and assessment of it

- A Civil Action
- Erin Brockovich
- Crude
- Dark Waters

There are several EREF educational modules students will need to watch for this course. Students will access https://solidwastecourse.org/groups/ for most of the material. Prior EREF webinars have now been integrated into the EREF online learning experience. Students will be assigned specific Webinars during the course which are not yet posted. The webinars (see homework assignments) will be accessed at: http://www.erefcontinuingeducation.org/. Students must complete an online quiz at the end of each webinar. Students must screen capture the score and upload the score to the Blackboard Course site. See below. There is a password needed to enter these modules. There are quizzes for some of the EREF learning modules students must complete as well. These too need to be screen captured and uploaded to the Blackboard Course site. The password will be provided by EREF.

ACTIVITY C – Technical Papers

The purpose of the technical paper activity is for students to select topics they wish to learn more about and read technical papers. Students must submit 1 page research paper SUMMARIES periodically through the semester (see schedule). The following sites are some places where students can download papers for their final project: *Environmental Science and Technology* by

Am. Chemical Society; *Waste Management* by Elsevier; there are many others. Students can use Google Scholar to find research papers to review for the final project. *Please see the schedule for which SPECIFIC papers students are to read.*

PROJECT

The purpose of the project activity is for students to select ONE topic they wish to learn more about and synthesize their knowledge. Students must submit a 3 page SINGLE SPACED 11 point ARIAL FONT final report on a disaster specific topic WITH references (see schedule). The topic should not be too broad in that the student is unable to focus on a specific topic. The topic should be focused and the submission should demonstrate the student understands, in depth, a single issue pertaining to public health or the environment as it pertains to disasters.

MISSED OR LATE WORK

Late assignments will not be collected. Homework assignments are due at the **start** of each class period. Homework will be turned in online (uploaded) or hardcopy (where requested). Hardcopy should be flat, not folded, and MUST BE stapled in the upper left corner, with your name on each page. Each page should also be numbered. It should be done with a professional looking quality. Writing must be neat and organized, and margins must be observed. Any missed or late work, exams, etc. will not be made up unless an emergency or unavoidable cause can be identified and approved by instructor. If there is a scheduling conflict with the final, a solution will be worked out with the instructor prior to the final.

Attendance Policy during COVID-19

Students should stay home and contact the Protect Purdue Health Center (496-INFO) if they feel ill, have any symptoms associated with COVID-19, or suspect they have been exposed to the virus. In the current context of COVID-19, in-person attendance will not be a factor in the final grades, but the student still needs to inform the instructor of any conflict that can be anticipated and will affect the submission of an assignment or the ability to take an exam. Only the instructor can excuse a student from a course requirement or responsibility. When conflicts can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency conflict, when advance notification to an instructor is not possible, the student should contact the instructor as soon as possible by email, through Brightspace, or by phone. When the student is unable to make direct contact with the instructor and is unable to leave word with the instructor's department because of circumstances beyond the student's control, and in cases of bereavement, quarantine, or isolation, the student or the student's representative should contact the Office of the Dean of Students via email or phone at 765-494-1747. Our course Brightspace includes a link on Attendance and Grief Absence policies under the University Policies menu.

Classroom Guidance Regarding Protect Purdue

The Protect Purdue Plan, which includes the Protect Purdue Pledge, is campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Required behaviors in this class include: staying home and contacting the Protect Purdue Health Center (496-INFO) if you feel ill or know you have been exposed to the virus, properly wearing a mask in classrooms and campus building, at all times (e.g., mask covers nose and mouth, no eating/drinking in the classroom), disinfecting desk/workspace prior to and after use, maintaining appropriate social distancing with peers and instructors (including when entering/exiting classrooms), refraining from moving furniture, avoiding shared use of personal items, maintaining robust hygiene (e.g., handwashing, disposal of tissues) prior to, during and after class, and following all safety directions from the instructor.

Students who are not engaging in these behaviors (e.g., wearing a mask) will be offered the opportunity to comply. If non-compliance continues, possible results include instructors asking the student to leave class and instructors dismissing the whole class. Students who do not comply

with the required health behaviors are violating the University Code of Conduct and will be reported to the Dean of Students Office with sanctions ranging from educational requirements to dismissal from the university.

Any student who has substantial reason to believe that another person in a campus room (e.g., classroom) is threatening the safety of others by not complying (e.g., not wearing a mask) may leave the room without consequence. The student is encouraged to report the behavior to and discuss next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights.

1. *A listing of recommended safe practices for the specific class or laboratory setting (other PPE or safety behavior) can be found at the links below.*
    - Overarching SOP for Classrooms, Instructional Laboratories, and Experiential Courses
    -
2. *References Supporting Protect Purdue Compliance:*
    - Office of the Dean of Students Protect Purdue Compliance Plan: Ask, Offer, Leave, Report
    - Office of the Dean of Students Managing Classroom Behavior and Expectations

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace table of contents, under University Policies.

Academic Dishonesty

The University policy on dishonesty is shown below:

> *"Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a,* Student Regulations*] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]"*

You may also refer to Purdue's student guide for academic integrity:

http://www.purdue.edu/odos/odos/academic-integrity/

Use of Copyrighted Materials

The University's regulations related to copyrighted materials is provided below:

> *Students are expected, within the context of the Regulations Governing Student Conduct and other applicable University policies, to act responsibly and ethically by applying the appropriate exception under the Copyright Act to the use of copyrighted works in their activities and studies. The University does not assume legal responsibility for violations of copyright law by students who are not employees of the University.* A Copyrightable Work may include, but is not limited to: *scholarly publications, journal articles, research bulletins, monographs, books, plays, poems, musical compositions and other works of artistic imagination, and*

works of students created in the course of their education, such as exams, projects, theses or dissertations, papers and articles.

You may also refer to the University Regulations on policies:
http://www.purdue.edu/policies/academic-research-affairs/ia3.html

Violent Behavior Policy

Purdue's policy prohibiting violent behavior is shown below:

Purdue University is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent Behavior impedes such goals. Therefore, Violent Behavior is prohibited in or on any University Facility or while participating in any university activity. See the University's website for additional information:
http://www.purdue.edu/policies/facilities-safety/iva3.html

Emergencies

In the event of a major campus emergency, course requirements, deadlines, and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to the course can then be obtained by contacting the instructor by email or phone. You are expected to read your @purdue.edu email on a frequent basis.
See the University's website for additional information:
https://www.purdue.edu/ehps/emergency_preparedness/

Accessibility and Accommodations

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let the instructor know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Nondiscrimination

Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

Purdue University views, evaluates, and treats all persons in any University related activity or circumstance in which they may be involved, solely as individuals on the basis of their own personal abilities, qualifications, and other relevant characteristics. Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Purdue's Equal Opportunity, Equal Access and Affirmative Action policy which provides specific contractual rights and remedies. Additionally, the University promotes the full realization of equal employment opportunity for women, minorities, persons with disabilities and veterans through its affirmative action program.

Link to Purdue's nondiscrimination statement:
http://www.purdue.edu/purdue/ea_eou_statement.html

Accessibility

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247. More details are available on our course Brightspace under Accessibility Information.

Mental Health Statement

- **If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack.** Sign in and find information and tools at your fingertips, available to you at any time.
- **If you need support and information about options and resources**, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.
- **If you find yourself struggling to find a healthy balance between academics, social life, stress**, etc. sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.
- **If you're struggling and need mental health services**: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

Related Considerations and Guidelines

- If you experience any symptoms of COVID-19 or suspect you may have been exposed to someone with COVID-19 stay home and call the Protect Purdue Health Center at 765-496-INFO.
- Keep your cell phone on to receive a Purdue ALERT text message.
- Log into a Purdue computer connected to the network to receive any Desktop Popup Alerts.
- If you have a "no cell phone" in class policy, allow one or two students who have signed up for Purdue ALERT to keep their phones on to receive any alerts
- A two-page supplement (see Appendix B) at the end of this document provides resources to communicate or engage with your students in case of unexpected emergencies that affect the West Lafayette campus. Emergency notification is vital! Please consider allowing one or more of the options below to ensure you are quickly notified of an emergency.

Tentative Schedule

Other reading and online submission assignments will be issued during the semester.
Students will be advised in advance if changes are to occur.

Dy	Dt	Note # - Topic	Out of Class Activity	Deliverable
January				
T	11	NO CLASS		
Th	13	1,2-Introduction [Syllabus, EREF, critical reviews]; Generation & Characterization [Definitions, MSW]; Technical paper reviews	Before class access the EREF site	-
T	18	Critical review of scientific reports 3- Generation & Characterization [Sampling, Characterization]	Browse through the critical review files	-
Th	20	4- Collection, Processing and Separation [MSW by v/v, % vol, % wt, MC, characterize]	EREF Learning: Intro. to Solid Waste Management Module Parts I, II EREF Learning: Intro. to Solid Waste Management Module Parts III, IV READ Exploring Visitor Attitudes, Values, And Behaviors Regarding Waste In National Parks Executive Summary	*Analysis of technical paper #1*
T	25	5,6- Collection, Processing and Separation [MSW Energy content, Chemical Comp, Collection, Processing and Separation [Calc density, impact on waste comp]		
Th	27	TBD	EREF Learning: Waste Generation and Characteristics Parts I, II	1 EREF LEARNING QUIZ: Intro Solid Waste Management Module We will discuss technical paper #1 in class
February				
T	1	5,6- Collection, Processing and Separation [MSW Energy content, Chemical Comp, Collection, Processing and Separation [Calc density, impact on waste comp]	EREF Learning: Waste Generation and Characteristics Part III	
Th	3	8,10- Collection, Processing and Separation [trucks, routing, MRF, TS, waste sep recovery]	EREF Learning: Material Recovery Facilities (only 1 part to it) EREF Learning: Solid Waste Collection Parts I, II	EREF HW LEARNING QUIZ 2: Waste Generation and Characterization

T	8	**SITE VISIT: Meet at Purdue Waste Management, 844 S. River Rd WL 47907, February 8, 2022 830-945am**	EREF Learning: Solid Waste Collection Parts III, IV	*Analysis of technical paper #2* *HW Problem Set 1*
Th	10	8,10- Collection, Processing and Separation [trucks, routing, MRF, TS, waste sep recovery]		
T	15	8,10- Collection, Processing and Separation [trucks, routing, MRF, TS, waste sep recovery]		EREF LEARNING QUIZ: Solid Waste Collection Listen to: https://www.npr.org/2019/02/07/692259117/toxic-debris-forces-camp-fire-victims-to-stop-camping-on-their-land
Th	17	**Exam #1 handed out** 12- Treatment [WTE, Incineration]	Watch the Incineration videos posted in the course site Ch. 8 Christensen	*Analysis of technical paper #3* 1 pg summary of Activity A (Also = Activity #1) HW Problem Set 2 EREF LEARNING QUIZ: Municipal Solid Waste Landfills
T	22	13- Treatment [Air Pollln Cntrl], 14-Treatment [Bio, Composting]	Analysis of technical paper #5	EREF Webinar: Landfill 101 Part 1 Regulations, Permitting, Siting Conceptual Design Use, https://erefdn.org/continuing-education/online-courses/.
Th	24	15-Landfills [Siting, Ops, Gas] 16,17-Landfills [Gas movement/ transport, Leachate]	Ch. 10 Christensen	***EXAM #1 DUE***
March				
T	1	Landfills		*Analysis of technical paper #4* EREF Webinar: Landfill 101 Part 2: Regulations, Permitting, Siting Conceptual Design Use, https://erefdn.org/continuing-education/online-courses/.
Th	3	Landfills		*Analysis of technical paper #5*
T	8	18,19-Introduction to Haz Materials	Ch. 2 LaGrega, Ch. 3 MacKenzie	
Th	10	18,19-Introduction to Haz Materials		
T	15	**SPRING BREAK**		
Th	17	**SPRING BREAK**		*Analysis of technical paper #6*
T	22	***SITE VISIT: 830 am Heritage Environmental, 7901 Morris Street, Indianapolis, IN***		HW Problem Set 3
Th	24	19-Adsorption		Analysis of technical paper #7
T	29	Treatment technologies		TBD
Th	31	Treatment technologies	TBD	*Analysis of technical paper #8*
April				
T	5	19-Adsorption	Ch. 12 Edzwald	
Th	7	19-ion exchange		1 pg summary of Activity B (Also = Activity #2)
T	12	WE WILL NOT MEET	Ch. 14 Edzwald	Project submission due, see requirements on blackboard

Th	14	**SITE VISIT: Clinton County Landfill,2700 North State Road 39, Frankfort, Indiana**		Final report DUE
T	19	19-Treatment Ion Exchange 20-Treatment: Membranes (If time) **Exam #3 handed out**		STUDENT PPTX PRESENTATIONS ABOUT FINAL REPORT TOPIC - 5 Minutes Each
Th	21	STUDENT PRESENTATIONS		STUDENT PPTX PRESENTATIONS ABOUT FINAL REPORT TOPIC - 5 Minutes Each
T	26	STUDENT PRESENTATIONS		***EXAM #3 DUE***
Th	28	**TBD**		
F	29	NO CLASS- SEMESTER ENDS		

***Homework includes out of class activities such as EREF quizzes, technical paper summaries, activity summaries, and other deliverables as assigned and designated.

Papers

1. Safety and injuries for municipal solid waste workers: https://doi.org/10.1177/0734242X9901700505
2. Wastes generated on Airplanes in Europe https://link.springer.com/article/10.1007/s11356-017-0800-x
3. Food waste management in hospitality operations https://doi.org/10.1016/j.tourman.2018.10.009
4. PDBE flame retardant exposures to e-recycling workers https://insights.ovid.com/crossref?an=00043764-200904000-00006
5. Environmental impacts, pollution sources and pathways of spent lithium-ion batteries https://pubs.rsc.org/en/content/articlehtml/2021/ee/d1ee00691f
6. Monitored Natural Attenuation to Manage PFAS Impacts to Groundwater: Scientific Basis https://doi-org.ezproxy.lib.purdue.edu/10.1111/gwmr.12486
7. Microplastics in Mexican beaches https://www.sciencedirect.com/science/article/pii/S0921344919305397?casa_token=SkAKA2bGJt0AAAAA:7bDfv6F9O1ICl53xtXoGva0K_FA6cQ-VcQd91EBKLhTgweUOUaK_-0gjmEAwPfYmnC2_UZoPTA
8. Will the COVID-19 pandemic change waste generation and composition?: The need for more real-time waste management data and systems thinking https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7365094/