TOWN BOARD MINUTES
PUBLIC HEARING
September 29, 2021

To view a recording of the full meeting, please visit Town Hall Streams link below:
https://townhallstreams.com/stream.php?location_id=119&id=40256

The following is a summary of the Town Board Meeting as recorded by the Town Clerk.

Call to Order **6:00 PM**
Pledge of Allegiance
Town Board Meeting:

Members of Town Board

Present	Absent	
☒	☐	Supervisor J. Conway
☒	☐	Councilor T. Tierney
☒	☐	Councilor H. Kennedy
☒	☐	Councilor R. Matters
☒	☐	Councilor B. Fritz

PLEASE TAKE NOTICE that the East Greenbush Town Board has scheduled a Public Hearing for Wednesday, September 29, 2021 at 6:00 pm at the East Greenbush Town Hall, 225 Columbia Tpk. Rensselaer, NY 12144 to consider public opinion on the Dunn Landfill's application for an Enhanced Renewal Operating Permit. The Dunn Landfill is located at 315 Partition Street, Rensselaer, NY. Its current operating permit expires in July 2022, and the Dunn Landfill must apply for an Enhanced Renewal Operating Permit from the Department of Environmental Conservation (DEC). This is an opportunity for residents to learn about the Dunn Landfill and have the chance to comment about their experiences with the landfill while also expanding public awareness that DEC is in the process of reviewing the application for an Enhanced Renewal Operating Permit for the Dunn Landfill.

By Orders of the Town Board, Ellen Pangburn, East Greenbush Town Clerk

Presentations by:

Dr. David O. Carpenter, University at Albany, SUNY – Director of the Institute for Health and the Environment, and professor of Environmental Health Sciences. See attached information discussed beginning with Journal of Environmental Management.

Christine Kielb, Co-Chair of Rensselaer Environmental Coalition (REC), and retired from NYS Department of Health as an environmental epidemiologist. See attached for presentation on Dunn Truck Route Community Survey.

Open Comments:

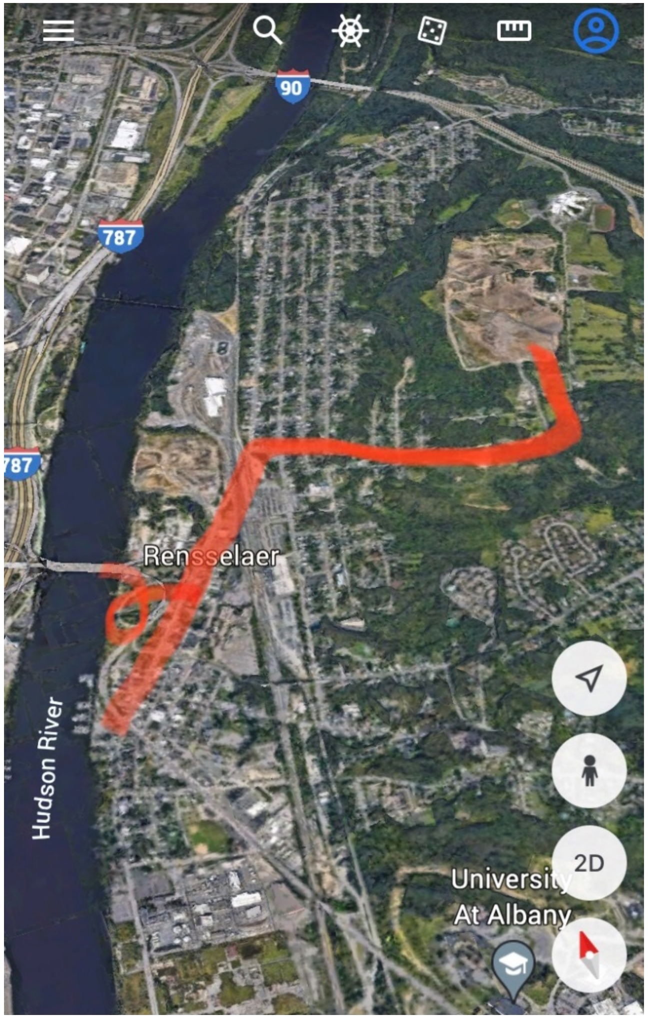
Elected Officials who addressed their respective comments to the Town Board – John McDonald, Assemblyman; Mike Stammel, City of Rensselaer Mayor; Steve McLaughlin, Rensselaer County Executive; Sam Fine, Albany County Executive; and Tom Grant, Rensselaer County Legislator.

Public Comments/Residents of East Greenbush and Rensselaer addressed their respective comments to the Town Board: Bob Welton, REC Treasurer; Victor Batorsky, Rensselaer City Historian; Maria Pollock, Roseann Quinn, Rich Mooney, Lou Sebesta, Gwen Wright, Sarah Hudson, Tom Ellis, REC Secretary; John DeFrancesca, Sean O'Neill, Pam Van Wie, Brittany Vogel, John Flack, Ginny O'Brien, Brian Stall, Andrew Kretzschmar, Lisa Stiles-Ray, Sally Lauletta, Bob Poitras, and Leighton Cookson, among a few others.

ADJOURNMENT – 8:26 PM

Motion to adjourn was duly moved by Supervisor Conway and seconded by Councilor Tierney and brought to a vote resulting as follows:

Supervisor J. Conway	VOTED: YES
Councilor T. Tierney	VOTED: YES
Councilor H. Kennedy	VOTED: YES
Councilor R. Matters	VOTED: YES
Councilor B. Fritz	VOTED: YES



Dunn Truck Route Community Survey

Rensselaer Environmental Coalition

Partition Street

Broadway looking south

Partition Street

Trucks idling in residential area on Partition Street first thing in morning waiting to get inside dump

Dust control on Partition St

Background

- Trucks began running in early 2015
- Up to 100 trucks permitted per day
- 6:30 AM - late afternoon on weekdays

Purpose: to get a sense of the impact of Dunn landfill truck traffic on the residents along the truck route.

Study Methods

Between June 5 and July 18, 2021, three people went door to door along the Dunn Landfill truck route of Partition Street and Broadway:

- We handed residents who were home an envelope containing the survey, a Dunn Landfill information sheet, and a stamped return envelope.
- A total of 57 survey packets were handed out directly to residents and 84 were mailed to residents who did not answer their door.
- Of the 138 surveys hand-delivered or successfully mailed, we received 44 completed surveys for a participation rate of 32%.

Survey Contents

- On what part of truck route residents live;
- Number of years they have lived there;
- How often they are bothered by impacts from the trucks;
- The time of day the trucks are most bothersome to them;
- Negative impacts to their daily activities and enjoyment of their property;
- Self-reported health effects
- Quality of life before vs after the landfill began operating;
- Other local environmental burdens
- Comments

Location and Years Lived

32 (74%) live on/near Partition St
11 (26%) live on Broadway

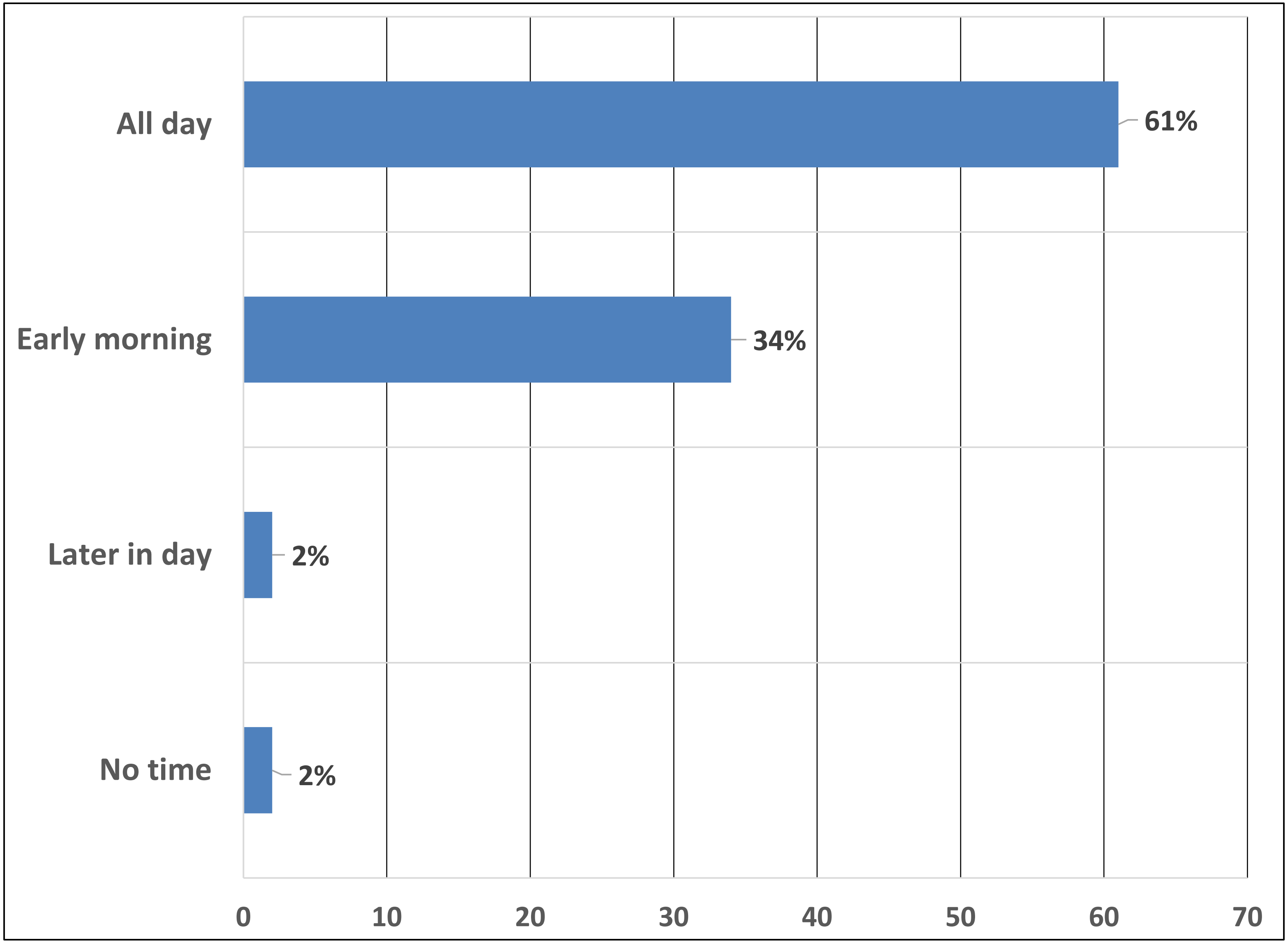
Average time lived at current residence: 15.6 years
(Range: 1-63 years)

How often are you/your family bothered by the following due to the landfill trucks?

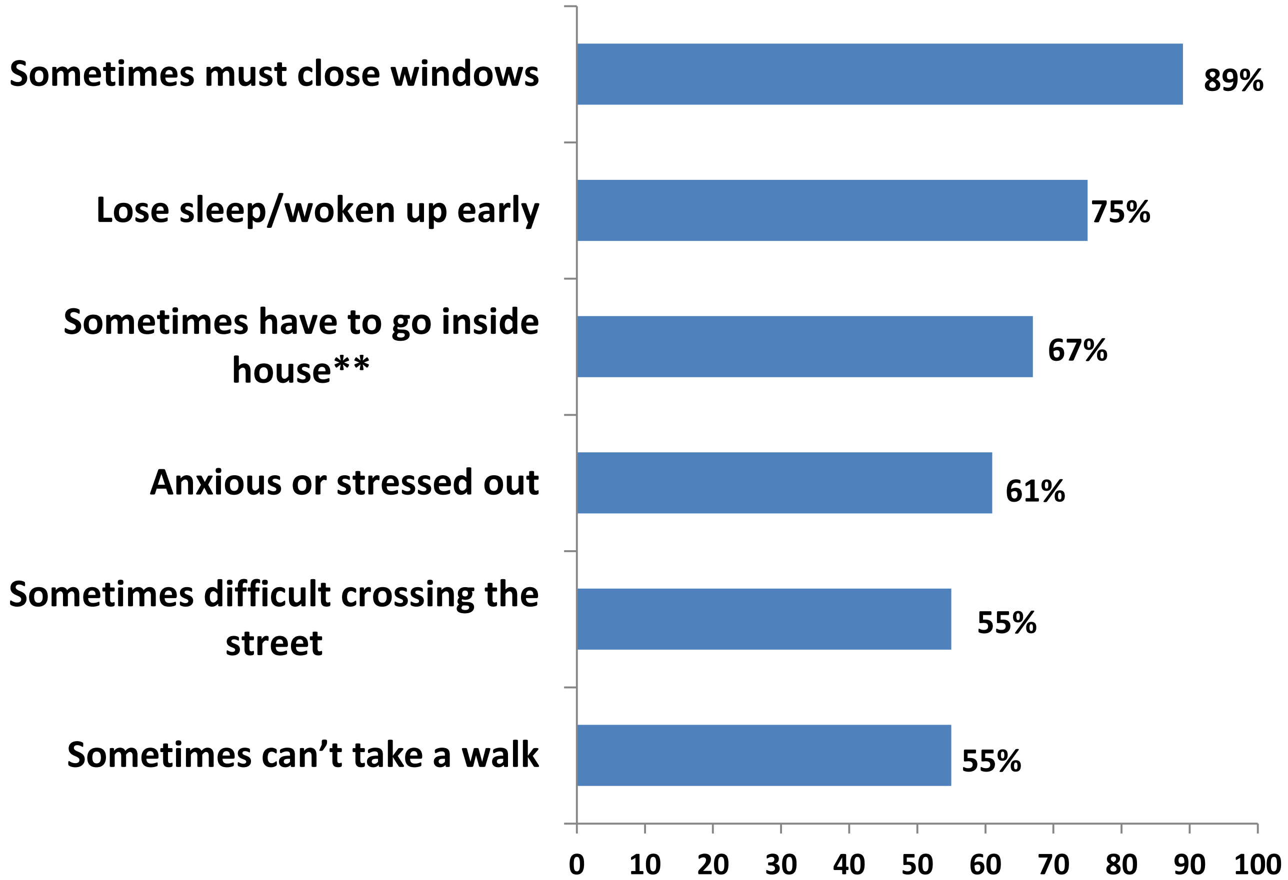
	Often		Sometimes		Rarely/never	
	#	%	#	%	#	%
Noise	40	**91**	2	**5**	2	**5**
Vibration	39	**89**	2	**5**	3	**7**
Dust	33	**75**	7	**16**	4	**9**
Diesel exhaust smell*	26	**62**	13	**31**	3	**7**
Traffic Congestion**	25	**58**	11	**26**	7	**16**

*2 missing
**1 missing
Percentages are based on number of non-missing responses. Total percents may not add up to exactly 100% due to rounding.

What time of day are the trucks most bothersome?



Do you or your family experience any of the following due to impacts from the landfill trucks?



Sometimes difficult driving to work or elsewhere: 45%

*3 missing/NA
** 1 missing/NA
Percentages are based on number of non-missing responses. Totals may not add up to exactly 100% due to rounding.

How would you rate your quality of life before and after landfill began operating? (N=29)

	Before*		After*	
	N	%	N	%
Excellent	13	**45**	3	**10**
Good	15	**52**	0	**0**
Fair	1	**3**	8	**28**
Poor	0	**0**	18	**62**
*1 Unknown/NA **14 residents living here less than 5 years omitted				

Some comments

- It's so noisy in the morning shakes the whole house.
- Can't have a conversation on your phone inside your house
- I created an upstairs bedroom in the back of the house with sound insulation so I would not be awakened.
- Hard having children sleep with the loud CONSTANT noise! Woken up early every single morning!! Can't enjoy playing in yard.
- Never can sit on porch. Mon-Friday during the day.
- The dirt from the trucks is awful.
- Should wash people's houses and cars-it's disgusting-both cars and houses.
- That kind of traffic does not belong on a little street or a little bridge!! Please find another spot to dump trash!
- It should not be here. My kids go to school here. Looking to move out of Rensselaer if something is not done.
- We are scared to let our kids ride their bike and take our dog for a walk and we miss picking blackberries along the side of Partition St.

More comments

- Absolutely horrible. Our granddaughter has experienced and increase in headaches and sickness since the dump has increased activity. Standing at a bus stop with truck traffic is horrible. Dust and debris have increased significantly. Noise and traffic during our morning commute is frustrating and bothersome. I've lived here my whole life and my quality of life has never been worse!!!
- The truck traffic is outlandish. The noise, the dust, the traffic congestion. All these trucks are causing damage to our roads which taxpayers foot the bill for!!
- Please, please do something.

Summary and Conclusions

- This is not a scientific survey. It is a community survey designed to get a picture of what bothers people about the trucks and how they affect people's daily lives.
- It is clear that most of the people who completed the survey are significantly affected by the trucks.
- Almost all participants thought truck noise and vibration was often bothersome and a majority thought diesel exhaust, dust and traffic congestion was.
- Majority said trucks most bothersome all day long; many said early morning.
- Having to close windows, having to go inside and getting woken up early were the most commonly cited quality of life problems.
- Steep decline in perceived quality of life since the landfill began operating.

Thanks to:

Lou Sebesta and Tom Ellis who helped with the survey

Everyone along the truck route who made this possible by completing a survey

Supervisor Jack Conway and East Greenbush Town Board

APPENDIX

Other slides

Locations surveyed

- Broadway south of Veterans Memorial Bridge
- Partition St
- Street segments near Partition St:
    - 1^{st},2^{nd} and 3^{rd} Streets
    - East Street
    - Lansing Place
    - 5^{th}, 6^{th} and 7^{th} Streets
    - Wilson Street (eastern part)
    - Cottage Hill

Health Symptoms experienced when trucks passing by

	N	%
Eye irritation	24	**55**
Headache	20	**46**
Cough/wheeze	19	**43**
Nasal congestion	19	**43**
Shortness of breath	12	**27**

Health question exploratory for symptoms often associated with diesel pollution and dust

To better assess potential association between health symptoms and environmental exposures, the following is important:

- Larger sample size
- Information about the indoor home environment
- Information about demographics and individual risk factors
- A comparison group
- Health records

Other environmental burdens

	N	%
Rail yard*	20	**47**
Asphalt plant**	10	**24**
*1 Unknown; **2 Unknown		

Rensselaer Community Survey – Dunn Landfill Truck Route

Below is a survey to find out how truck traffic going to and from Dunn Landfill is affecting residents near and along the truck route, which includes Broadway and Partition Street. This survey is supported by a grant from the Center for Health, Environment and Justice, and conducted by Rensselaer Environmental Coalition (REC), a group formed to fight for a livable environment in Rensselaer and surrounding areas.

Please take 5 minutes to complete this survey. Try to answer each question as best you can. Your answers to the survey questions are <u>strictly confidential</u>. They will not be used to identify you personally. They will only be used to compile statistics for the study results. A summary of these results will be provided to the public.

1. **Where do you currently live?** On/near Broadway ____ On/near Partition St ____

2. **How many years have you lived at your current residence?** _____

3. **How often are you or your family bothered by the following due to the landfill trucks?**
   a. **Noise** Often ___ Sometimes ___ Rarely/Never ____
   b. **Vibration** Often ___ Sometimes ___ Rarely/Never ___
   c. **Diesel exhaust smell** Often ___ Sometimes ___ Rarely/Never ___
   d. **Dust** Often ___ Sometimes ___ Rarely/Never ___
   e. **Traffic congestion** Often ___ Sometimes ___ Rarely/Never ___

4. **What time of day are the landfill trucks most bothersome to you or your family?**
   Early in the morning ____ Later in the day ___ All day long ____

5. **Do you or your family experience any of the following due to noise, pollution, dust or traffic congestion from the landfill trucks? (Please check all that apply)**
   a. Sometimes have to close the windows ____
   b. Sometimes can't take a walk ____
   c. Sometimes it's difficult crossing the street ____
   d. Sometimes it's difficult driving to work or elsewhere ____
   e. Sometimes have to leave the yard or porch/deck and go inside the house ____
   f. Lose sleep/woken up early ____
   g. Feel anxious ____ Stressed out ____
   h. Other (please specify) ____

6. **Have you or any member of your family experienced any of the following symptoms when the landfill truck traffic is passing by? (check all that apply)**
    a. Coughing or wheezing ____
    b. Shortness of breath ____
    c. Nasal or sinus congestion ____
    d. Eye or nasal irritation ____
    e. Headache ____
    f. Other (please specify) ____

7. **How would you rate your quality of life BEFORE the Dunn Landfill began operating?**
   Excellent ____ Good ____ Fair____ Poor____

8. **How would you rate your quality of life SINCE the Dunn Landfill began operating?**
   Excellent ____ Good ____ Fair____ Poor____

9. **Are you or your family affected by the following?**
    a. Noise or fumes from Amtrak train station or rail yard ____
    b. Odors from the asphalt plant in the Port of Rensselaer ____

10. **Please put any comments you have about the Dunn landfill truck traffic here:**
   ____
   ____

THANK YOU FOR COMPLETING THIS SURVEY!

Your participation will help us learn about how the Dunn Landfill is affecting our community.

PLEASE MAIL THE SURVEY IN THE STAMPED RETURN ENVELOPE PROVIDED.

Optional:

Please put your contact information below if you can. It will only be used for administrative purposes. If you would like to know about future REC events please add your email:

NAME: ____________________________________ **ADDRESS:**____________________________________

EMAIL OR PHONE: ________________________________

Our website: https://rensselaerenvironmentalcoalition.org/

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Chemicals of concern in construction and demolition waste fine residues: A systematic literature review

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ARTICLE INFO

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Characteristics of C&DW chemicals in construction debris
Chemicals of environmental concern
Heavy metals
Leaching of C&DW fines
Landfill leachate
Persistent organic pollutants

ABSTRACT

Despite the increasing use of chemical additives in construction and their potential threat to the environment and human health, many C&DW studies lack a comprehensive view of chemicals of concern (COC) in C&DW. This study systematically reviewed published studies from 2010 to August 2021 using a keyword search methodology to explore COC in C&DW fine residues based on 73 articles identified from 5 prominent databases. Results show that trace/heavy metals (As, Cr, Cu, Cd, and Pb) as well as high concentrations of toxic gasses (methane, hydrogen sulphide and mercury vapour) have been reported in landfills. Besides, organic chemicals such as polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and brominated flame retardants have been found in landfill leachates in the Netherlands and widely detected in landfill leachates in Sweden, Japan, and Canada. The potential of these contaminants to cause health complications has also been reported. Carcinogenicity, liver and kidney damage, cumulative damage, neurological disorders and foetal damage were reported as associated health implications of exposure to COC from C&DW. A waste disposal lens was used to explore the factors that influence the environment and human health impacts (pH, gypsum and organic content, size fraction, atmospheric exposure and liquid infiltration rate). Despite environmental and health issues relating to C&DW fine residues, the ultimate destination for C&DW fine residues remains in general landfills. Although significant efforts in managing C&DW have been implemented at various levels, those specifically targeting C&DW fine residues remain sparse.

1. Introduction

Every year, over 10 billion tonnes of construction and demolition waste (C&DW) are generated globally (European Commission, 2019; Huanyu Wu, Jian Zuo, George Zillante, Jiayuan Wang and Hongping Yuan, 2019). In terms of total materials purchased by weight, between 1 10% usually ends up as C&DW (Ajayi et al., 2014), and this constitutes 50% of the total waste sent to landfill globally (Brennan et al., 2014; Dixon, 2010). These large and generally increasing quantities of C&DW consume landfill space; waste useable building materials; contaminate landfills leading to serious negative health effects; and damage the environment (Marzouk and Azab, 2014; Podlasek et al., 2021). In response, efforts to reduce C&DW generation and enhance their recycling and reuse have been practiced over the years (Elgizawy et al., 2016). Nonetheless, despite the massive recycling and reuse potential of C&DW, diverting substantial waste from landfill remains a challenge (Lukumon et al., 2013). Moreover, with the increase in the use of chemical additives and organic polymers, much of the C&DW previously been regarded as inert is now liable to contamination and is likely to generate harmful leachate with elevated levels of total dissolved solids (TDS) (Duan et al., 2016; Lingard et al., 2001; Lingard et al., 1997; Liu et al., 2017).

Given the increasing use of chemical additives in construction and their potential presence in C&DW, the characteristics of mixed C&DW delivered to material recovery facilities (MRF) for processing and recovery is largely irregular and inconsistent. This renders the available information unreliable (Davis et al., 2018). From the perspective of MRF feedstock and the widespread use of chemicals, the chemical composition of residual fines produced from MRF warrants investigation. Nonetheless its disposal and use as alternative daily cover (ADC) has not adequately been studied (WMRRAA, 2019). As a result, the potential environmental impacts from its reuse and disposal are not well

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established.

Several studies on C&DW management have been published over the past decades. Reviews on these studies broadly classify articles about C&DW into two categories (H. Wu, J. Zuo, G. Zillante, J. Wang, & H. Yuan, 2019). The first investigates general perspectives about C&DW management. For example; Jianguo Chen, Su, Si, and Chen (2018) summarized the knowledge domains in the managerial areas of C&DW into four pillars, namely; factors and challenges, composition and quantification, assessment and comparison, and technology and methods. A recent review by Aslam et al. (2020), compared C&DW management practices in China and the USA. This study pointedout that C&DW generation and its management is influenced by several factors such as population, urbanization, GDP, and regulatory measures. Previous reviews on research trends up until 2010 on C&DW management identified human factors approach on C&DW management to be popular (Yuan and Shen, 2011). A recent review by Kabirifar et al. (2020) critically examined managerial issues of C&DW, identifying two main fundamental factors affecting C&DW management. The first is the hierarchical nature of C&DW management in terms of C&DW reduction, reuse and recycling whilst the second relates to factors that contribute to effective C&DW management such as sustainability, stakeholders' attitudes, project lifecycle perspectives, and the use of C&DW management tools. A review by H. Wu et al. (2019a, 2019b), on the other hand, scrutinized the status quo of C&DW research and future research agendas based on 156 articles published since 1990s. This review identified five thematic areas of C&DW research; environmental concerns of C&DW, C&DW recycling, addressing the sustainability of C&DW, improving C&DW management, and reducing C&DW. Furthermore, this review (H. Wu et al., 2019a, 2019b) identified several research opportunities including identifying pollutants in C&DW, developing comprehensive pollutant control measures to treat C&DW, and improving recycling of C&DW.

The second category of research focused on specific aspects of C&DW management and recycling. Several researchers have explored the production and use of recycled aggregate (RA) in various concrete applications. One notable example is the identification of factors critical for improving the physicochemical properties of RA and their environmental benefits (Silva et al., 2014; Tam et al., 2018). Gedik (2020), evaluated the potential use of recycled concrete aggregate (RCA) in asphalt pavement projects. Another comprehensive study reviewed the physical, chemical and mechanical properties of concrete manufactured using alternative fine aggregates from different sources such as crushed rock sand, industrial by products and recycled fine aggregates (Kirthika et al., 2020). The chemical properties investigated were principally from the perspective of parent materials rather than the chemical additives used in buildings.

These reviews provide valuable insights from managerial and technical perspectives. They either provide an overview of the discipline or explore specific topics that warrant further investigation. Despite the growing use of chemicals in construction and an historical account of hazardous materials associated within the construction industry (Nie et al., 2015), existing reviews generally lack a rigorous overview of environmental contaminants within C&DW. Environmental contaminants within C&DW leachate stem largely from its TDS content (Jang and Townsend, 2001). Nevertheless, the associated health risks defying the popular claim that "C&DWs are inert" emanates due to the presence of persistent organic chemicals and inorganic species such as heavy metals. Therefore, in this review, special emphasis is given to COC within the TDS of C&DW fine residue. Heavy metals and organic chemicals (either used in buildings as chemical additives, or due to the historical use of the building, or due to the abrasion of various household materials) might end up as waste materials mixed with C&DW. Other chemicals such as paint additives, wood rendering chemicals, and flame retardant materials can release different types of organic contaminants and are reportedly found in C&DW. Researchers including Duan et al. (2016), Van Praagh, Modin, and Trygg (2015), Nie et al. (2015), Kajiwara et al. (2014) and Rani et al. (2014) investigated Brominated Flame Retardants (BFR) such as Hexabromocyclododecane (HBCDD) and organic pollutants such as polyaromatic hydrocarbons (PAH) found in C&DW. Many other researchers found heavy metals to be associated with the disposal of C&DW. These chemicals contaminate surface and groundwater resources as well as surface soils (Hou et al., 2018; Krüger et al., 2012; Letman et al., 2018; Li et al., 2020; López and Lobo, 2014; Podlasek et al., 2021; Rajasegaran et al., 2018). Geraldo et al. (2017), Yilmaz and Ercikdi (2021) and López Uceda, Galvín, Barbudo, and Ayuso (2019) found that gypsum mixed with organic materials can accelerate the leaching process of many of these chemicals, resulting in contamination of the surrounding environment.

Li et al. (2020) and Zimová et al. (2018) evaluated the potential health risks of chemicals released from C&DW on surrounding communities. Moreover, Rodrigues et al. (2020) evaluated the potential ecotoxicological impacts of different proportions of recycled concrete aggregate in concrete. Despite significant research over the last 10 years into the massive generation of C&DW and its associated environmental impacts, there are generally few outputs that endeavour systematic reviews of the environmental impacts of C&DW (K. Chen, Wang, Yu, Wu and Zhang, 2021). This shortcoming relates particularly to COC within C&DW residues and the manner in which they are disposed. To fill this gap, a systematic literature review is conducted to answer the research question of what are the occurrence of COC in C&DW, their health and environmental impacts as well as efforts to minimize their potential impacts.

2. Review methodology

Based on recommended procedures for systematic literature reviews (Laake and Benestad, 2015; Webster and Watson, 2002), samples of literature were selected, structured, read and analysed, and updated. To identify relevant papers addressing the research questions posed (occurrence and types of COC within C&DW), a structured keyword search was conducted using four popular databases in science and engineering, namely: Web of Science, Scopus, ProQuest, and EBSCOhost. Google Scholar was used to add relevant articles not captured by the selected databases.

To identify pertinent keywords, the research question was categorized into the PICO (problem/population, intervention, comparison/control and outcome) framework (Laake and Benestad, 2015; Schardt et al., 2007). The fundamental research question underpinning the study has been broken down into its PICO components to help categorically identify relevant key words and their synonyms explicitly. Full list of PICO table describing the combination of selected keywords are presented in Table 1 below. The selected keywords are then used to search for all fields in a general search technique or identified as field tags in an advanced search techniques to help generate stronger search results (Laake and Benestad, 2015; Science, 2021). An example of advanced search string for Web of Science database is illustrated as follows (NB. The term 'TS' is a field tag that stands for 'topic search'): (TS = "construction and demolition waste*" OR TS = C&DW* OR TS = CDW* OR TS = "C&D waste*" OR TS = "C&D refuse*" OR TS = "construction and demolition refuse*" OR TS = "C&D residue*" OR TS = "construction and demolition residue*" OR TS = "C&D material*" OR TS = "construction and demolition material*" OR TS = "construction waste*" OR TS = "construction residue*"OR TS = "demolition waste*" OR TS = "demolition refuse*" OR TS = "demolition residue*" OR TS = "building residue*" OR TS = "building waste" OR TS = "building debries" OR TS = "construction fine*" OR TS = "construction and demolition fine*" OR TS = "demolition fine*" OR TS = "recovered fine*" OR TS = "material recovery fine*" OR TS = "material recovery residue") AND (TS = "heavy metal*" OR TS = metal* OR TS = "fire retardant*" OR TS = asbestos OR TS = "PCB*" OR TS = "polychlorinated biphenyl*" OR TS = "polychlorobiphenyl*" OR TS = "poly chloro biphenyl*" OR TS = "PBDE*" OR TS = "polybrominated diphenyl ether*" OR TS = "polybromodiphenyl

Table 1
PICO characteristics of the study terms.

P (Population)	Construction and Demolition Waste, Material Recovery Residue, C&DW Fine Residue
I (Intervention)	N/A
C (Comparison)	N/A
O (Outcome)	Chemicals of environmental concern: flame retardants, polybrominated diphenyl ethers (PBDE), hexabromocyclododecane (HBCDD), persistent organic pollutants (POP), polychlorinated biphenyls (PCB), polyaromatic hydrocarbons (PAH), paint additives, heavy metals, mercury, lead, arsenic, chromium etc.
Key Words	Brominated flame retardants; characteristics of C&DW; chemicals in construction debris; chemicals of environmental concern; heavy metals; leaching of C&DW fines; landfill leachate; persistent organic pollutants;

ether*" OR TS = "HBCD*" OR TS = "HBCDD*" OR TS = "hexabromocyclododecane*" OR TS = "hexabromo cyclododecane*" OR TS = "PAH*" OR TS = "polyaromatic hydrocarbon*" OR TS = "poly aromatic hydrocarbon*" OR TS = "polycyclic aromatic hydrocarbon*" OR TS = sulphate* OR TS = "leachate pollution*" OR TS = contamination* OR TS = "chemical contaminant*" OR TS = "chemical pollutant") AND (TS = "environmental impact*" OR TS = impact* OR TS = "groundwater impact" OR TS = "groundwater pollution" OR TS = "environmental pollution" OR TS = "landfill impact*" OR TS = "leachate pollution*" OR TS = "leachate contamination")

Initially, only papers from peer reviewed journals in English published between 1990 and 2021 were considered, resulting 1292 articles, book sections and conference proceedings. After conducting a thorough review to identify duplicate resources, 902 articles were considered for further screening. Although there are a number of literatures prior to 2010 demonstrating the significance of C&DW management and environmental impacts, research suggested that C&DW research globally and in Australia grew significantly from arround 2010 2013 onwards (Liu et al., 2017). More over, over time, there are quite significant developments in the state of practice of the weaste management industry that can have repercussions on the outcomes of previous studies. Consequently studies conducted before 2010 were excluded to emphasise studies from 2010 and beyond. A total of 600 studies were progressed through the following three filters: title and abstract analysis, full text analysis, and extraction using Covidence, a web based software application that streamlines the production of systematic and scoping reviews (UON, 2020). The 600 articles have been imported into Covidence for a step by step screening from title and abstract screening to full text extraction. 60 articles not captured as described above were added by manual searching using Google Scholar with a combination of keywords of interest including latest publications published at a later stage. Finally 73 articles were selected for detailed analysis via a thorough full text reading, NVivo coding and text analysis using NVivo 12. Following this, the key research areas addressed in these articles were organized into five themes related to environmental impacts of chemicals from C&DW: vis à vis levels and types of hazardous chemicals found in C&DW *theme 1 (#20),* destination of C&DW fine residues from MRF *theme 2 (#6),* environmental impacts associated with the use and disposal of C&DW fine residues *theme 3 (#16),* factors exacerbating the environmental impacts of C&DW fine residues *theme 4 (#15)* and, efforts implemented to minimize environmental impacts of C&DW fine residues *theme 5 (#16)*. Fig. 1 below portrays the article screening process and outputs obtained.

3. Results and discussions

3.1. Description of articles

The majority of articles reviewed originated in Spain (21.9%) followed by China (15%) and USA and Japan (10.9% each) as shown in Table 2.

Regarding areas of research, 36% of the articles dealt with health and environmental impacts associated with the use and/or disposal of C&DW. Twenty five percent engaged with influencing factors that affect the release of COC from C&DW whilst another 8% explored different approaches to minimize the impacts of these chemicals. Moreover, 21% of the articles sought to characterize the sources and types of hazardous chemicals arising from C&DW. Meanwhile 10% dealt with the environmental and health concerns arising from different productive uses of C&DW.

With respect to C&DW components of interest, 63% of the studies engaged with concrete and concrete based waste products. On the other hand, 14% of articles were concerned with C&DW in general, with only 6% focussing on C&DW fine residues (with some characterizing its composition, others investigating leachate composition, the impact of gypsum on its disposal and ways to solve associated problems as well as

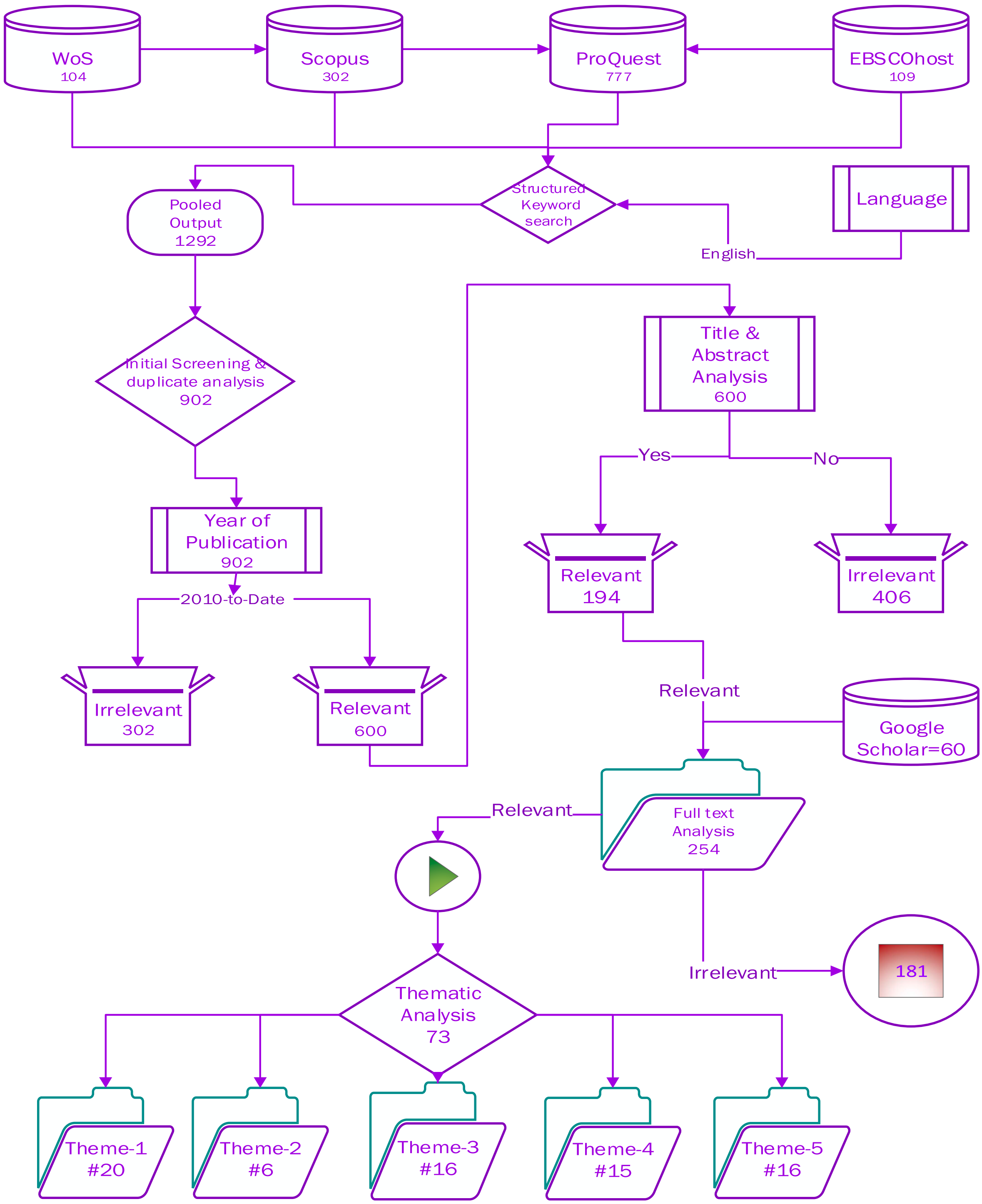

Fig. 1. Article retrieval and screening process.

developing safe reuse options to abate its disposal related problems). Several articles addressed specific aspects of C&DW; gypsum plaster waste (3%), leachate from C&DW landfill (4%), soil conditions nearby C&DW landfill (3%), and heavy metal content of wood waste (2%).

3.2. Types and occurrence of hazardous chemicals found within C&DW

Although C&DW is mainly composed of inert materials, a small proportion contains potentially hazardous substances. Many of these substances are used in the manufacture of several products for various purposes including enhancing weather resilience and increasing architectural and aesthetic qualities. They are also incorporated in building equipment, and end up in the waste stream of construction and/or demolition activities (Quaranta et al., 2010). Some of these substances may include building components coated with paints containing lead and PCB; insulation, floor tiles and mastics containing asbestos; asphalt roofing and weather proofing products containing PAH; wood fragments containing arsenic, chromium and copper; electronic devices containing mercury and cadmium; and emergency lighting systems with batteries containing heavy metals (Su et al., 2018). Construction products are generally complex mixtures containing many more chemicals than those mentioned above. In addition to the

Table 2
Distribution of articles by country of origin/research conducted.

S.No	Countries of origin	No. Articles	Percentage
1	Spain	16	21.9%
2	China	11	15%
3	Japan	8	10.9%
4	USA	7	9.6
5	Czech Republic	5	6.8%
6	N.A[a]	4	5.5%
7	Germany	3	4.1%
8	Brazil France Portugal South Korea	2 articles each	2.7% each
9	Australia Canada Denmark India Iraq Ireland Malaysia Sweden Italy Turkey Norway	One article each	1.4% each

[a] Country of research is not applicable (it is either a review, critics or commentary).

mainstream components of construction materials, process residues for their manufacturing and additives such as plasticizers, stabilizing agents, pigments, surfactants, and solvents contribute to the eventual C&DW stream. During their service life, construction materials can undergo transformations resulting in as yet unknown substances. This is an important task for non targeted analysis and fundamental research (Bandow et al., 2018). Depending on their chemical nature and concentration within C&DW, these chemicals can be classified as heavy metals, organic chemicals and flame retardant substances particularly those of brominated formulations. These are explored below.

3.2.1. Trace/heavy metals and other inorganic chemicals

Fifty one percent (#32) of articles addressed issues relating to heavy/trace metals found within C&DW and recycled construction materials. As a result of its durability, resistance to all forms of weather and all round strength and resilience, metals are materials of priority choices in construction and manufacturing. On top of the strong and durable structural uses of metals such as steel, iron, aluminium, copper and brass, different types of heavy metals are used as insulation materials, electrical wiring, roof and wall claddings, painting formulations and wood treatments against decay and weathering actions (Robey et al., 2018). Many of these applications contribute to the release of heavy metals such as arsenic (As), chromium (Cr), copper (Cu), cadmium (Cd), lead (Pb) and other harmful metals that present substantial environmental and health hazards. Moreover, high concentrations of toxic gases such as methane, hydrogen sulphide and mercury (Hg) vapour were reported from C&DW dump site runoffs (Rajasegaran et al., 2018). The use of CCA to protect wood used in construction is no longer in use in many countries (because of potential health problems and the availability of alternative wood preservatives that do not contain arsenic). However, due to their longevity of CCA treated wood, it is likely to remain in C&DW for many years (NSW EPA, 2017; Quaranta et al., 2010). Another source of heavy metal contamination within C&DW is the use to which the building has been put. Quite significant amounts of heavy metal contamination arise from the demolition of the chemical industry (electroplating factories), metallurgical industry (zinc smelting plants, steel plants), light industry, processing enterprises, and fire/explosion disaster sites as well as worn out equipment (Gao et al., 2015). All such wastes destined into a common MRF where they get mixed in the processes and subsequently end up as C&DW fine residue.

An experimental study to assess metal contamination from C&DW using a bio indicator organisms (slugs), *Deroceras reticulatum* (Mollusca: Gastropoda) has shown a significantly elevated concentration of metals (As, Ba, Cd, Co, Sb, Se and Ti) in slugs collected from C&DW filled wetlands compared to those collected from unimproved pastures (control sites) (Staunton et al., 2014). Elevated lead concentrations have been documented in soils adjacent to structures with exterior lead based paint. Although lead paints are no longer in use, many old buildings have this paint on their walls, windows or doors. Lead can also be found in discarded pipes, welding and electroplating services, lead pipes and connections used in the distribution of water among others (Su et al., 2018). Various researchers have investigated the types, levels and origins of heavy metals and other inorganic chemicals from C&DW and recycled construction materials. For example, Y. Chen and Zhou (2020) reported relatively high levels of Cd and As in C&DW used for road construction in China, with a total exceeding standard rate (ESR) of 42.6% for Cd and 30% for As. A C&DW landfill leachate study by López and Lobo (2014) found high levels of conductivity, ammonia nitrogen, lead and arsenic in addition to moderate concentrations of different inorganic ions and metals. Butera, Christensen, and Astrup (2014), also reported high levels of leaching of chromium, sulphate and chloride from concrete containing masonry and partly carbonated concrete samples. Moreover, a leaching based study by Del Rey et al. (2015) examined the origins of chromium and sulphate from recycled construction materials. They asserted that leached sulphate and Cr were mainly released by the ceramic materials (bricks and tiles). Acid digestion results by Jiannan Chen, Tinjum, and Edil (2013) on the other hand, concluded that As and Cr were mainly sourced from cement mortar. The findings of Del Rey et al. (2015) and Galvin et al. (2018) in their long term pollutant release study confirmed that chromium and sulphate originate from ceramic materials and are the elements which exceed European Union (EU) legal limit values for inert wastes. Different leaching studies to identify the fraction of C&DW contributing higher levels of trace metal contaminants established that fine fractions, (particles <75 μm) tend to leach more trace metals than those of sand sized (75 μm 4.75 mm) and gravel sized (4.75 mm 75 mm) particles (Jiannan Chen, Bradshaw, Benson, Tinjum and Edil, 2012; Coudray et al., 2017). A study on the characterization of COC in C&DW and RA reported Al, Fe, Cr, Mn, Si, Pb, and Zn as most abundant elements in C&DW fractions with concentrations as high as 12,021 mg(Al)/kg, 211.30 mg(Fe)/kg, 277.70 mg(Cr)/kg, 1070 mg(Mn)/kg, 421,000 mg(Si)/kg, 236 mg (Pb)/kg and 800 mg(Zn)/kg respectively (Diotti et al., 2020).

The studies highlighted above confirmed that different types of heavy metals are found from C&DW, some as intrinsic components of the material make up, and others as additives during manufacturing. Heavy metals such as Cr, As, Pb, Zn and Cd particularly are toxic, carcinogenic and accumulate in the environment for many years, posing a potential threat to human exposure in the environment. Moreover, the fine fractions of C&DW being prominent source of heavy metals to the environment signals the need for adequate attention towards the management and disposal of C&DW fine residue, which is often neglected.

3.2.2. Organic chemicals and flame retardants

Persistent Organic Pollutants (POP) such as PCB, PAH and BFR are hazardous chemicals that have the potential to adversely affect human health and the environment. As they can be easily transported by environment media such as wind and water, most POPs can affect humans and biota far from the source of release. POPs are persistent in the environment and hence can accumulate and migrate from species to species via the food chain. Some of these compounds are used to treat wood used in construction. For example, creosote, a complex mixture of organic compounds produced from the distillation of tar from wood or coal (and whose composition varies according to the source) may contain varying amounts of phenol, cresols, creosol and benzene derivatives (NSW EPA, 2019). 19% of the articles reviewed addressed organic chemicals such as PAH, PCB and BFR. More specifically, BFR such as HBCDD and PBDE are prominent organic chemicals discussed in relation to C&DW in the articles reviewed. Several high production volume chemicals are used to inhibit or impede the flammability of construction materials such as floor carpets and partition walls. HBCDD and PBDE are the two commonest flame retardants used in the construction industry in Australia and elsewhere ultimately destined as C&DW (Gallen et al., 2016).

Its heavy usage in various consumer products combined with resistance to degradation and weathering has resulted BFR to be ubiquitous in the environment. HBCDD is one of the most widely used additive BFR. It has received substantial global attention as a result of its persistence in the environment and its negative impacts on humans and animals. A study by Nie et al. (2015), mentioned that over 90% of HBCDD has been extensively used in flame retardant polystyrene, in rigid insulation panels/boards in the construction industry, while its use in textile applications and electronic appliances is on a smaller scale. Although separated polystyrene materials are recyclable, the internationally recognized Stockholm Convention on POPs prohibits the recycling of products that contain HBCDD (Pasek et al., 2016). Consequently, these products will become part of the C&DW at the end of their life cycle (30–50 years) and will typically be disposed of into landfills or incinerated (Nie et al., 2015). Substance flow analysis in Japan and Switzerland has highlighted landfills as long term sources of HBCDD release (Weber et al., 2011). Moreover, HBCDD as high as 36,000 ng/g dry weight are found in the particulate phase of leachate in the Netherlands and widely detected in landfill leachates in Sweden, Japan, and Canada (Nie et al., 2015). Emission of BFR such as HBCDD even at a low concentration can be catastrophic to landfills receiving C&DW, particularly when such landfills contain organic matter. This is because, organic matter mixed with C&DW components can accelerate leaching of various chemical constituents (Kajiwara et al., 2014). Studies document that flame retarded wastes (even in industrialized countries such as Australia) are mainly deposited in municipal landfill sites if not exported. Weber et al. (2011), highlighted that BFR, including those listed as POPs, are leaching from landfills thereby contaminating the environment.

A study characterizing BFR from C&DW in China revealed an extremely high content of HBCDD and PBDE in typical C&DW such as polyurethane foam materials (Duan et al., 2016). PBDE, commercially produced as pentaBDE, octaBDE, and decaBDE, are another group of organobromine chemicals in use since the 1970s as flame retardant additives in a a number of consumer products and building material constituents (Bergman et al., 2012). Although commercial production of pentaBDE and octaBDE terminated in 2004 due to its persistence, bioaccumulation, and toxicity, many congeners of PBDE are still are common in consumer products and articles. They constitute an immense threat to the environment and human health. An investigation of PBDE in obsolete consumer products in India exhibited up to 4798.72 mg/kg of decaBDE in window blinds and up to 7.3 ng/g PBDE in rolls of wallpaper in Japan (Jinhui et al., 2017). A landfill leachate study (three municipal, one industrial and one demolition landfill) for PBDE in Minnesota, USA, documented total PBDE concentrations ranging from 29 248 ng/L, the highest result coming from demolition landfills (Weber et al., 2011).

An extensive C&DW characterisation study in Denmark detected PCB and PAH in all samples collected from MRF (Butera et al., 2014). Human exposure to PCB from landfill deposits has been documented in Switzerland and India. Results from Switzerland indicated that fish samples from two rivers were frequently found to be above EU limits for human consumption, the sources of exposure being nearby landfills (Weber et al., 2011). Moreover, the same study documented that high levels of PCB in a screening of human milk in the population living around an Indian landfill. These two country case studies highlight that PCB in landfills are a contemporary threat to humans and the ecosystem in both developed and developing countries.

A comprehensive field study for organic pollutants in industrial construction and demolition wastes revealed severe and long term contamination by organophosphorus (23,429 mg/kg), intermediate by products (3538 mg/kg) and pyrethroid pesticide (179.4 mg/kg), (Huang et al., 2016). Another study on reclaimed concrete from three industrial sites in Sweden reported high concentrations of PAH and pesticide components such as phenoxy acids, chlorophenols and chlorocresols (Van Praagh et al., 2015). Moreover, a leaching based assessment from three brands of reactive fire retardant coatings in Germany has shown progressively increasing release patterns. This indicates that such substances can present long term impact on the environment (Heisterkamp et al., 2019). Most of these chemicals have known toxicological effects such as neurotoxicity, metabolic disruption, endocrine effects, and genotoxicity on prolonged exposure.

3.3. *Fate of C&DW fine residues from MRF*

With the advent of a new ecological era where the built environment of the future is based, governments are shaping markets with regulations and legislation to proactively react the threats of environmental sustainability and resource depletion. C&DW fines are defined as the materials from mixed C&DW that are less than 4.75 mm in size and are regarded as inert industrial solid waste when its loss on ignition (LOI) is 5% or less after separation (Asakura et al., 2010a, 2010b). The LOI and gypsum content of processed residues are simplified indexes of the biochemical processes in the leachate. They are indicators of water pollution and the generation of hydrogen sulfide gas. This is in addition to the full scale chemical analysis that is difficult to undertake on routine practices.

According to Waste Management and Resource Recovery Association of Australia (WMRRAA), fine residues are used as ADC for general landfill sites. Mixed process residues from MRF are also dumped into general landfill whenever they are not fit for other uses (WMRRAA, 2019). A waste audit report on mixed C&DW processing facilities in Japan and Australia estimated that fine fractions account for 22% and 21.6% respectively of the mixed C&DW delivered to MRF and end up in landfill (ALFARO, 2011; EPA NSW, 2017). In Japan, one third of the C&DW deposited in landfill is mixed C&DW. On the other hand, the percentage of waste processed at intermediate MRF is estimated at 46% of the total generated mixed C&DW. This is equivalent to 72% of the overall mixed C&DW generated and deposited in landfills (Asakura et al., 2010a, 2010b). In Andalusia, Spain, the fine fractions of C&DW residue disposed of in landfill accounts for 13.5%, whereas mixed RA accounts for over 70% of the total RA processed and recovered for road base applications (López Uceda et al., 2018). Dahlbo et al. (2015), conducted a holistic evaluation of the environmental performance of various fractions of C&DW and concluded that mixed waste was the most difficult fraction in relation to environmental impacts, costs, and material recycling. In summary, quite significant amount of C&DW are being loaded to MRF as mixed fraction and end up into landfills for deposition or use as ADC. In countries such as Australia, where onsite sorting practices on construction projects are poor and very limited selective deconstruction to demolition projects, cross contamination of materials in mixed C&DW streams is a common problem which subsequently hampers the recovery of useful materials (EPA NSW, 2017). This difficulty for recycling and associated environmental impacts warrants that the residue generated deserve considerable attention to protect the environment and human health.

3.4. *Environmental and health impacts associated with C&DW fine residues*

Forty eight percent of articles included in this review studied environmental and health impacts from the use and/or disposal of C&DW materials. Between 50% and 75% of the annual material input in industrialized countries is reported to be returned to the environment as waste within one year (Osmani and Villoria Sáez, 2019). Failure to recognize the broader consequences of economic development coupled by wasteful material resources has resulted in a worldwide environmental crisis. Using C&DW is one of the main goals of the circular economy and the waste management plans of many of developed and developing countries. However, while reusing materials helps to decrease the amounts of waste that need to be managed, it can only be done if human health and environmental risks associated with C&DW are minimised. Given the limited information available on environmental and health impacts of C&DW in general and fine residues in particular (K. Chen et al., 2021; Nie et al., 2015; WMRRAA, 2019), and the fact C&DW processing in MRF generates fine fractions from a mixture of C&DW components, the great majority of chemical constituents likely join the fine fractions. Therefore, this section implicitly explores the health and environmental impacts of C&DW to highlight the health and environmental impacts associated to fine residues of C&DW.

3.4.1. Environmental impacts of C&DW

Park et al. (2020), investigated the environmental impacts of major C&DW categories. Their study revealed that concrete, concrete blocks, and cement waste accounted for over 70% of all environmental impact categories. Moreover, insulation materials accounted for 1% of the total waste generated but were identified by the environmental impact assessment to contribute the most. C&DW is a novel, widespread environmental stressor that negatively affects the environment, organisms and the ecosystem. However, the effects of its cumulative consequences remain unclear (Hou et al., 2018). Consequently many countries have introduced plans to regulate the dangerous substances emitted from C&DW (Zimová et al., 2018). Legislation that regulates C&DW reuse and disposal emerges from extensive research and experimental activities relating the use and disposal of C&DW.

Studies concerning environmental impacts of C&DW materials are mainly based on a characterization of their chemical composition. Permissible limit values are compared or cumulative indexes are formulated. These are then subjected to health risk analysis to evaluate associated environmental and health risks (Li et al., 2020). Although there are studies based on experiments performed with test organisms (ecotoxicological bioassays), they are mainly limited to specific C&DW components. Studies attempting to ascertain the impacts of real mixed samples based on ecotoxicological bioassays are very rare. For example, Mocová et al. (2019), investigated the ecotoxicity of different concrete materials against the leachate from concrete based C&DW. The leachate had been found to be lethal to test organisms, revealing that leachates from C&DW behave differently as a result of the physico chemical interactions of the various mixes in the waste stream. Another ecotoxicological study conducted to compare results of chemical analysis by replacing natural aggregate with RA and fly ash has shown that the RA to be ecotoxic to Daphnia magna mobility whereas its eluate concentration to various COC have shown no or low levels of toxicity (Rodrigues et al., 2020).

3.4.2. Human health impacts of C&DW

Human health can be influenced by many factors, including exposure to physical, chemical, and biological contaminants in the environment. Chemicals relating C&DW can reach the environment, through waste handling, waste incineration and/or leakage from disposal sites where humans could be affected through direct exposure via inhalation, skin deposits or consumption or indirectly through the contamination of soil and water bodies via food and water. Several health outcomes such as ulcers, diarrhoea, respiratory disorders, cancer, cardiovascular disease, liver damage, endocrine disruptions, neuro toxicity and foetal malformations have been associated with human exposure to different chemicals (Engwa et al., 2019). Nevertheless, exposure to and health impacts of C&DW management and disposal lack adequate evidence. One of the main reasons for this is that cumulative health effects are affected by multiple factors and that C&DW has long been regarded as inert. As a result of which, inadequate attention has been given to study its contribution to these impacts.

A C&DW characterization study to evaluate the risks of heavy metals to human health in China showed that Cd, Cu, As and Zn demonstrated relatively higher human health risks than other metals. Besides, As and Cd risks were mainly from non inert C&DW such as wall insulation and foamed plastic (Yu et al., 2018). As a result of their high degree of toxicity, As, Cd, Cr, Pb, and Hg are ranked as priority metals impacting on public health (Tchounwou et al., 2012). Adela P. Galvín, Ayuso, Agrela, Barbudo, and Jiménez (2013), noted that Ni, Cr, Sb, Zn and Cu should be considered in impact characterisation studies from an environmental point of view. Yu et al. (2018), besides identifying specific heavy metals of concern, also compared the different waste streams as sources of heavy metals risks and depicted red brick, tile, wall insulation, foamed plastic, and non inert C&DW mixtures (plastic, paper, foam, or other substances) to have greater contaminating risks. Moreover, this study argued that extreme contamination prevails from landfill sources, signifying the impacts of mixing C&DW with organic matter in changing the chemistry of landfills. A study evaluating human health impacts and distribution of heavy metals depicted peak points in the soil around the landfill. For example, the distribution of Cu changed significantly whereas the cumulative pollution of Fe, Cu, and Hg in the soil reached the heavy level. Moreover, the non carcinogenic risks of As and Cr were relatively high, where Cr further poses a carcinogenic risk to the human body warranting for a relocation of the landfill (Li et al., 2020).

Nanoparticles from construction wastes present other potential health risks. Uncontrolled dumping of C&DW and poor management practices in disposal sites may increase exposure risks to surrounding populations. Moreover, degradation of construction materials may unlock and enhance the release of nano particulates (particularly those of inhalable particles as well as their synergistic contamination with various COC) that might cause adverse health impacts to local communities. Oliveira et al. (2019), studied the ultrafine aerodynamically favourable, spherically shaped nanoparticles of Magnetite, Rutile and Anatase within C&DW streams. They found an enrichment in metals and metalloids including As, Cd, Co, Cr, Cu, Hg, Fe, Sn, Ta and carbon nanotubes. According to the European Directive, the leaching assessment did not detect any of these contaminant limits to a hazardous level. However, it is evident from this finding that possible migration to surface and groundwater bodies as well as direct exposure through inhalation could be a vivid health risk (Oliveira et al., 2019).

BFR are the other chemicals that pose substantial health concerns. Of these BFR, much attention has been focused on PBDE, which are known to persist within the environment, accumulate in food chains, and have toxic effects. PBDE have been shown to negatively affect processes of hormonal regulation in living organisms, and are regarded as environmental "endocrine disruptors" (Beard and Angeler, 2010). Research on HBCDD proved to have accumulated in organisms and can magnify with the food chain in the upper trophic living organisms (Nie et al., 2015). Rani et al. (2014), detected a relatively high concentration of HBCDD in the polyurethane foam materials that make up an ice box (960,000 ± 29000 ng g^{-1}), aquaculture buoy (53,500 ± 2100 ng g^{-1}), and disposable tray used in fish market (8430 ± 730 ng g^{-1}) which raises concern for public health. In this regard, a risk assessment study in Europe have also shown high concentrations of HBCDD residues in the fishes with bioaccumulation factor (BCF) as high as 18,100 (log BCF 4.26) (Nie et al., 2015). Moreover, incineration of HBCDD containing wastes under certain conditions can form polybrominated dibenzo p dioxins and dibenzofurans, a well known carcinogens to humans (PE, 2014: as cited in Nie et al., 2015). Some flame retardants accumulate in the environment where they present cumulative damage, whereas others can undergo depletion but react with different chemicals to form a new by products, which present further hazards to the environment (Bandow et al., 2018; Heisterkamp et al., 2019).

As illustrated in many of the studies described above, the health and environmental impacts have been assessed and evaluated for specific components of construction materials or for source separated reusable products or raw materials such as concrete, brick and treated timber, or for specific hazardous chemicals within the waste stream in general (Bandow et al., 2018; Heisterkamp et al., 2019; Li et al., 2020; Rodrigues et al., 2020; Yu et al., 2018). However, studies for mixed fine fractions which are considered problematic in terms of their environmental impacts (Dahlbo et al., 2015) are very limited or absent to an extent (Mocová et al., 2019).

3.5. Factors exacerbating the environmental impacts of C&DW fine residues

When C&DW is disposed of in landfill, several mechanisms interplay in the leaching of chemicals. These mechanisms include a common set of chemical events which may include dissolution, desorption and complexation, and mass transport. These events are in turn affected by other factors that can change the extent of leaching. Such factors include internal reactions (chemical and physical); external pressures from the surrounding environment; physical degradation of the matrix due to erosion or cracking, and loss of matrix constituents due to the leaching process itself. Because chemical reactions and transport of dissolved species are dynamic processes, it is difficult to distinguish their individual effects. This dynamic process can modify structural changes such as alteration of porous structures as well as the chemical constituents and/or arrangements of the material and hence the release of harmful chemical species (Tiruta Barna and Barna, 2013). Moreover, oxidation and carbonation processes, as well as other corrosive impacts of aggressive media, involve complex phenomenon of weathering of C&DW thereby releasing contaminants (Abbaspour et al., 2016; Vu, 2019). Structural changes due to external impacts (changes in temperature, in pH, contact with water) on the other hand, may escalate the release of heavy metals and organic contaminants to the environment.

Previous studies argued that pH highly influences the release patterns of different inorganic elements from recycled concrete aggregate (Christian J. Engelsen et al., 2010). A study by A. P. Galvín et al., (2014a, 2014b) investigated the influence of pH on the release behaviour of inorganic contaminants in C&DW and established two distinctive patterns. Typical metal cations such as Zn, Cu, Ni, Pb and Cd portray an increasing release pattern from pH 7 to 4 implying an increasing leachability in the acidic region. On the other hand, elements that form oxyanions (Mo, Se, As, Sb and Cr) exhibit a high leachability at neutral pH and alkaline environments (Jiannan Chen et al., 2013; A. P. Galvín et al, 2014a, 2014b). Adela P. Galvín et al, 2014a, 2014b and Vu (2019), revealed in their experiments that the influence of mineralogical composition was minimal whereas, particle size distribution, pH, degree of compaction, organic content and L/S ratio were highly influential in the leaching characteristics of C&DW. Galvin, Ayuso, Jimenez, and Agrela (2012), studied the main factors that affected the release of pollutants from recycled aggregates, reporting the most relevant ones to be: the liquid to solid ratio, the contact time of the water with the material, and the pH value (pH being the most influential of the three in the release of polluting elements). This study conforms with the findings of López Meza, Kalbe, Berger, and Simon (2010) which asserts that the leaching of constituents increases with increasing liquid to solid ratio and higher contact times.

At the liquid–solid interface (the apparent material surface, pores or anywhere a liquid phase is present) different interactions occur. These include dissolution–precipitation, adsorption–sorption, complexation and bio chemical reactions (Abbaspour et al., 2016; Tiruta Barna and Barna, 2013). The interactions depend on the chemistry of the system components and on the presence of external chemical species, such as gases (carbon dioxide, oxygen) and dissolved compounds in natural waters as well as microbial activity (Qiang et al., 2015; Tiruta Barna and Barna, 2013). The dispersion of the dissolved chemical species (pollutants) is a combination of physical and chemical processes that takes place by different transport mechanisms such as diffusion and convection (Tiruta Barna and Barna, 2013). Carbonation and the presence of organic matter significantly influences the release potential of contaminants (Alfaro et al., 2010). As described by Mahedi and Cetin (2020), carbonation consumes the portlandite component of RCA and neutralized OH^-, causing a decline in alkalinity of the solution, consequently increasing the leached fractions of elements. Moreover, the effect of carbonation presented an opposing trend with the type of test method employed (carbonation in batch leaching tests causes higher leaching of Cr and SO_4, whereas non carbonated samples in TCLP leached higher Cr and SO_4). This study supplemented previous studies with respect to the influence of particle size. Whereas finer fractions tend to release more contaminants, the coarser fractions behave differently (Bestgen et al., 2016; Mahedi and Cetin, 2020). Bestgen et al. (2016), evaluated the effects of extraction methods (TCLP, SPLP, batch leaching tests, and pH dependant leaching methods) along with the different factors affecting leaching. The results suggested that the highest metal leaching obtained with TCLP, followed by batch leaching method and SPLP. This confirms the reliability of TCLP test in its application for waste characterization practices for human health and environmental safety.

The continuous disposal of drywall waste present in C&DW has been associated with many environmental problems. It has long been linked to the generation of hydrogen sulphide in landfill sites. This is a toxic and foul smelling gas. The incineration of this waste results in the potential release of sulphur dioxide gas, a contributor to acid rain formation (Ndukwe and Yuan, 2016). Gypsum ($CaSO_4 \cdot 2H_2O$) is used in the construction sector firstly as an addition to Portland cement, to regulate its setting time and to prevent flash setting, and more specifically, as the major constituent of wall and ceiling plaster in buildings (Colman et al., 2020). Under anaerobic environments, that characterize landfills, microbial processes by sulphate reducing bacteria can convert the sulphate content of gypsum into hydrogen sulfide (H_2S) (Barbudo et al., 2012). Moreover, the decomposition of gypsum mediated by organic matter complicates landfill systems, changing the chemistry of the leachate and speeding up the release of heavy metals and other contaminants within the deposited waste (López and Lobo, 2014). López Uceda et al. (2019), studied the impact of gypsum on heavy metal release trends even at low gypsum levels. Accordingly, and as expected, the more gypsum added to RCA, the greater the release levels of pollutants, with RCA +4% being the material yielding the highest levels. Summing up, several factors interplay the leaching and weathering behaviour of C&DW, of which however the gypsum content demonstrated a central role by changing the pH environment.

3.6. Efforts to minimize the environmental impacts of C&DW fine residues

Several construction waste management tools, methods, and technologies are used in the construction industry. Some of these tools used to forecast and design out waste, or manage on site waste, and recycle and recover end of life materials and products during preconstruction, construction, and demolition stages. The use of such methods, and management tools facilitates effectiveness thereby helping solve associated contamination problems. A study ascertaining the status and future directions of C&DW research, pointed out the various efforts of researchers, regulatory agencies and industry towards minimizing or avoiding environmental impacts associated with the use and disposal of C&DW as popular research topics (H. Wu et al., 2019a,b). As a result of a generally limited information pertaining C&DW residual fines (K. Chen et al., 2021; Nie et al., 2015; WMRRAA, 2019), and the fact C&DW processing in MRF generates fine fractions from a mixture of C&DW components, efforts aimed to minimize and reuse C&DW in general can implicitly contribute towards minimizing significant quantities of fine residues and associated environmental and health impacts thereof. Accordingly, several efforts pertaining C&DW management have been investigated and discussed as follows.

3.6.1. Identification and mitigation of pollutants

Identification of hazardous constituents from C&DW plays critical role in understanding environmental concerns relating to C&DW. Pollutants in C&DW include heavy metals (e.g. Cu and Cd), organic matter (e.g., PAH), carbon, methane, sulfuret and hydrogen sulphide (Bestgen et al., 2016; Mahedi and Cetin, 2020). Notably, efforts have been made to identify and quantify heavy metals released from C&DW and associated impacts on the surrounding environment (H. Wu et al., 2019a,b). Duan et al. (2016), found toxic organic components such as PAH and hydrogen sulphide in mixed C&DW from the demolition of an industrial building. The characteristics and constituents of mixed C&DW are diverse and complex. In view of this, the environmental and health risks associated with C&DW have fascinated extensive concerns (Huang et al., 2016). Some studies on the other hand, investigated the actual rates of heavy metals and organic contaminants released from C&DW (Adela P. Galvín et al., 2013; Krüger et al., 2012), while others focus on measuring the migration of heavy metal (Shin and Kang, 2015).

In order to manage and abate pollution from C&DW, different studies on sorption, adsorption, release, immobilization, incineration, and pyrolysis have been conducted to further understand the underlying mechanism. For example, a long term monitoring study by, Kajiwara et al. (2014) revealed the release of leachate containing BFR, and landfill gas from C&DW landfills. A landfill study that receives mixed demolition waste containing gypsum based plasterboard revealed the generation of H_2S gas, which is typical and major odorant landfill gas (Bergersen and Haarstad, 2014; Podlasek et al., 2021). As a result of which removal of nitrogen and organic substances from landfills has become a key issue to control the generation of noxious leachate and gasses. Montero et al. (2010), and Jiménez Rivero, Justo García, and Sathre (2016), studied the side effects that gypsum content could have on productive uses of C&DW materials. They devised methods to obtain aggregates with lower contents of gypsum, which successfully demonstrate productive uses of C&DW as well as minimization of associated environmental impacts. Most of these studies are based on experimental studies in the laboratories of leading universities and institutes and form strong evidence to develop control measures and formulate policies. For example, from the perspectives of pollution control, three basic approaches are followed in many developed and developing countries. These include: organizational approaches to enhance understanding of externalities; regulatory instruments and fiscal motivation (market based) instruments (Pasek et al., 2016), where such policies are based up on several experimental and applied studies.

3.6.2. Reuse and recycling of C&DW

Recycling C&DW include understanding the recyclables and inventing recycling technologies, uses of recycled items and performance testing of recycled materials. Recycling plays pivotal role in enhancing waste diversion from disposal. However its productive role needs continuous improvement to minimize associated impacts. One way to improve is by investigating the physical and ecological impacts of recycled C&DW. This is mainly assessed by analysing the release of heavy metals and organic compounds as leachate from the intended use of the recycled product (Agrela et al., 2021; Christian John Engelsen, 2020). The other way to enhance recycling is by testing and improving the physical performances such as the strength and durability of recycled products (A. P. Galvín et al, 2014a, 2014b). In order to promote the reuse of C&DW, several researchers have exerted concerted effort into investigating the suitability of recycled items based on their structural and environmental performance. For example, Medina et al. (2014); Rahman et al. (2014); Wang et al. (2015); Vieira et al. (2016); Puthussery et al. (2017), and Ali and Abd Ali (2020) have investigated the suitability and effectiveness of C&DW recycled materials for pollutant remediation uses, as filling materials, permeable barriers for improving its environmental impacts through plant uptake as well as promoting productive uses. Montero et al. (2010).

3.6.3. The sustainability perspectives of C&DW

Considering C&DW from the perspectives of industrial ecology involves tracking material flows, life cycle assessment concepts as well as waste reduction by design and implementation of greener construction practices. Moreover, improving C&DW management including quantification of generation rates, waste reduction via management measures, design and construction stage, and economic feasibility enhances the sustainability thinking of C&DW. To solve environmental and health aspects of C&DW, substantial efforts have been exerted to understand issues unfolding due to C&DW such as by investigating the waste management experiences in major economies like Canada (Yeheyis et al., 2013), United Kingdom (Soutsos and Fulton, 2015), Australia (Udawatta et al., 2015) and Malaysia (Esa et al., 2017). Other studies endeavour to investigate material flows from waste generation to final disposal and other related waste flow networks (Kucukvar et al., 2014). Furthermore, the efficiency of C&DW management has been evaluated from the perspective of sustainability, feasibility, viability (Dahlbo et al., 2015; Jung et al., 2015), and waste management performance (Ajayi et al., 2014). Several other such instruments as well as managerial and practical aspects have been widely researched. However much needs to be accomplished for the construction industry to solve the vicious cycle of pollution and development. This principally involves the handling and disposal of C&DW fine residues which have received adequate attention to date.

4. Conclusion and recommendation

This review has addressed COC within C&DW. From the perspectives of heavy metals and inorganic chemicals; Cr, Cd, As and sulphate are depicted as priority chemicals. On the other hand, flame retardants mainly HBCD and PBDE were also highly influential, mainly due to their associated hazard and its reported occurrence within the waste stream. Different approaches in investigating environmental impacts from these chemicals suggest that chemical analysis needs to be supplemented with ecotoxicological investigations to portray the long term and cumulative impacts. It is also clear that the destination for fine C&DW residues arguably is landfill be it in an attempt to dispose or to be used as an alternative daily cover for the landfill. Nevertheless, target studies have pointed out that fine fractions of C&DW are the worst when it comes to the release of contaminants and its composition.

Although quite significant efforts have been employed to addressing environmental and health issues relating to C&DW use and disposal, there are few that specifically unpack issues regarding C&DW fine residues. This indicates that little attention is paid to this waste fraction in many countries. Given the importance that fine residues hold in C&DW management, as documented in this review, further research into their safer disposal and management needs to be conducted to address the environmental issues of concern. Moreover, a material balance of chemicals of concern within C&DW deserves further investigations to quantitatively estimate its environmental burden based on C&DW generation scenarios. Regarding disposal and reuse applications, conducting a series of leaching column experiments by mixing different proportions of organic matter and gypsum with C&DW could provide evidence for future placement of this residue stream. On the other hand, investigating the potential impacts from existing landfilled waste streams, and conducting ground water analysis could provide evidence of pollution or safety of C&DW disposal.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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OPINION ON LANDFILL PROJECT

TO THE CITY COUNCIL OF EAST GREENBUSH, NEW YORK

THIS IS AN OPINION. I AM VICTOR BATORSKY RENSSELAER CITY HISTORIAN.

Your first duty is to those you represent and not the State's arbitrary authority.

The State has the same duty as local municipalities under the U.S. Constitution. In the matter of this landfill, the state authority fails in its duty to those it rules over. In a democracy, the State's duty defines its authority and not otherwise.

In March of 1860, by passing Anti-Rent legislation ending the abuse of property rights described as an "enormous feudal wrong", the New York State Legislature put an end to the arbitrary authority to which we are now being subjected. Creating these landfills, however, is exactly the illegal reversion and reentry that Anti-Rent Laws ended.

The duty of government is to "promote the general Welfare, ... [for] ourselves and our Posterity.

NYS now presumes to make deals with private land owners to fill excavations by disregarding the best interests of local communities. When a deal violates constitutional purpose and should never have been made, it is simply wrong on so many levels.

Private owners are permitted to strip and sell the soil, and exploit its materials to make a profit at environmental expense. They then make a deal with the state to take dirty refuge and dump it into the ground which they get paid for doing. They replace good land with bad. The property then sold to or taken over by the state places the burden of maintenance and actual disposal or recycling on the taxpayers and their posterity. That's unconstitutional.

The process exploits the ignorance and jejunity of the public. It causes a nuisance per se by polluting the air with noise and dust. It compromises and subverts health policy. It violates the government's mission to protect in this time of pandemic. It harms the public. It violates intent of law. It conspires to suppress the probity of elected representatives in their duties to the people. It is illegal combination in restraint of peaceful habitation. It is, in a word, corruption.

Unless you do something about it.

When it is obvious, and forthright but deleterious of the general good, it is still fraud betrayal.
When it goes against intent of legislated purpose;

When it harms the happy occupation of homes and protection of property now and in the future;
When it profits one at the loss of value of others property;

When it compromises the education for citizen participation in government deliberation;
When it frustrates democracy;

When it is protected by authority acting against the best interest of the public good;
When it circumvents planned community development that has been in place for 50 years;

When that planned development, registered with the state is not consulted;

When it interferes with the residency, taxing system, maintenance of the community; and
When foist upon representatives unschooled in their responsibility to the public interest;
Then it is called betrayal.

Unless you do something about it

Local municiple councils not affirmatively defending the people stand in the way of the people's due process rights and their right to redress of grievance. Failure to perform ministerial duties blocks citizens' right to "institute government that to them shall seem most likely to affect their safety and happiness." It threatens Democratic process and is subversive of democratic participation. In the home of the Rent Wars of 1840's, against the abuses of land ownership, a tax strike against the abuse of land usage is a legitimate answer to corruption and abuse of authority.

Unless you do something about it.

The Dunn landfill is the largest such attack on the citizens of New York State. It would not and could not have been approved by the people against their own interests. As it stands, the nuisance per se by the land fill violates the very Preamble to the Constitution to "promote general welfare".

Unless you do something about it.

Mitigation of these nuisances should include substantial compensation to the public for protection against disease and the physical compromising of the public safety and happy habitation disturbed by the nuisances. Not only should its license not be renewed, it should be totally revoked and shut down for disturbance of the peace, and dilatory use of the property. The people never voted to take upon themselves this obligation. Even if they had, the problems caused by its performance, fully well expected, cannot be permitted to continue.

The problems caused by this landfill are substantive violations of right to happy occupation of people's homes, schools and thoroughfares. These violations are material grounds for an action to cease operation, and correct problems created by the nuisance of landfill operations.

An Order restraining landfill operations should be issued to mitigate circumstances that contribute to the possible infection of citizens. Shut down should be in place for the full duration of this world wide epidemic. Covid-19 related funding should be used for legal restraint on none essential environmental threats. The Dunn Landfill is not an essential service. Restraint should also be placed on machinery such as gas and diesel trucks barreling down and wearing out our already compromised infrastructure, water supply and air quality.

Government's Fourth Branch, the governing authorities of municipalities, have authorization, under their respective codes, to shut down the operation as nuisance per se. That authority should be used immediately. Force the State to show cause why an immediate shut down is not needed. The State wants YOU, the municiple leaders to put the burden of proof on the victims, those too sick to fight. That's absurd. It is your job to shut down a nuisance: landfill operations. It has become an action you must take against the state agency sitting up there at the landfill. The State has no business participating in the poisoning of our land.

Because we are already mandated to wear masks, and because first responders must wear masks, it is impossible for the State to declare the particulate pollutants are not a direct threat to health and well being. Every cough, sneeze or shock tremor from air and air horns and diesel motors is proof of continued environmental piracy against an unprotected citizenry. How could a school or hospital ever be built on that hill if it requires excavation of pollutants? How can you even plant a tree without disturbing pollutants? If the caps never deteriorate, that's just as bad as if they do. The changing of the land is what makes life possible, not its encapsulation. Local authorities have begged off their responsibilities by saying they are leaving guidance up to the scientists. Encapsulating levels of pollutants is not a question of science. It is a question of public policy. It is not empirics. It is politics. DEC admitted it had to increase "enforcement" at the landfill. That's proof enough to shut it down.

TO CLOSE THE DUMP, EXPEDITE THE DUMPS AUTHORIZED CLOSURE PLAN.
But nothing will be done until and UNLESS YOU DO SOMETHING ABOUT IT

Respectfully,
Victor Batorsky, Rensselaer City Historian

Statement on the Dunn Construction and Demolition Landfill from Gwen Wright
Candidate for Rensselaer County Executive 2021
Submitted 9/29/21

The Dunn Landfill is the largest construction and demolition dump in the State of NY. It poses a serious health threat to the immediate community, the City of Rensselaer, as well as surrounding communities in East Greenbush, such as Couse Corners, Hampton Lake, and the subdivisions of Governor Square and Capital View. Unlike the City of Rensselaer, many of the residents of the most affected neighborhoods in East Greenbush are private homeowners. But like residents of the City of Rensselaer, residents in these neighborhoods take advantage of the many outdoor activities offered by the town, including walking/cycling trails, parks and Hampton Lake. Also like the City of Rensselaer, residents enjoy sitting in their backyards and opening their windows when weather allows. These everyday and common activities are often curtailed by the residual dust and odors wafting from the landfill, miles away, This jeopardizes the quality of life the residents, homeowners and taxpayers are entitled to.

It is well documented that the Dunn Landfill, owned by the Texas based Waste Connections, poses a serious health threat to the residents in the immediate and surrounding neighborhoods, including the students of the Rensselaer public school which is down-wind of the Landfill. Health concerns include the presence of the forever chemical PFAS, which continue to plague water systems throughout Rensselaer County. In addition, the noise and dust from the massive dump trucks traveling through narrow residential streets from 6:30 AM to 4:30 PM and the smell make it difficult for residents to carry on their day-to-day activities without interruption. The weight of these trucks, up to 100 a day, are affecting the streets and the homes that line those streets, causing foundation problems and stress to the roads. This stress results in a huge cost to the taxpayers, homeowners, businesses and towns to remediate the damage.

It is imperative that the Town of East Greenbush support the City of Rensselaer in their efforts to completely and permanently close the Dunn Landfill and call on the county and the state to deny the renewal and reissuance of the permit to the Dunn Construction and Demolition Landfill. The state and the county must make resources available for the environmental cleanup of the site after it closes and work with the affected communities to repurpose the land. The location of the current dump is an eyesore to travelers across the Dunn Memorial Bridge and Albany. The residents in the City of Rensselaer and East Greenbush feel that, once closed, the site could be better utilized. Suggestions include the creation of a solar farm or other environmentally sound project. The state and the county must also acknowledge that the truck route is in an Environmental Justice Zone and they must mitigate the deleterious effect it's existence has had on economically disadvantaged residents and communities of color. It is our responsibility to do so.

In closing, as a candidate for County Executive I pledge to work with the residents of the City of Rensselaer and East Greenbush to advocate for the closure of the dump and for funding for the cleanup of the landfill and to commit county resources to help in these efforts. I also pledge to ensure that the Rensselaer County Department of Health works closely with the state

Departments of Health and Environmental Conservation and take an active role in the testing and monitoring of the site.

I submit my comments in writing so that those most impacted by this hazardous operation have ample time to express their views.

Respectfully submitted

Gwen Wright
gwen@wright4rensco.com
(518) 469-1569

Rebecca Gausepohl
Campaign Manager
rebecca@wright4rensco.com
(845) 546-5459

By Alderperson : Bryan Leahey

Seconded by Alderperson : Council as a Whole

11

A Resolution Urging the Department of Environmental Conservation to Revoke the Operating Permit for the Dunn Landfill

WHEREAS, the S. A. Dunn & Company, LLC, located on Partition Street Extension in the City of Rensselaer, possesses a Mined Land Reclamation Permit for operation of an existing 73-acre sand and gravel mine, and a Solid Waste Management Permit authorizing conversion of the mine to a construction and demolition disposal site; and

WHEREAS, the Dunn Landfill received a Department of Environmental Conservation (DEC) permit to operate in July 2012 and began accepting debris for disposal in January 2015; and

WHEREAS, in December 2018, the DEC started to receive an increasing number of complaints and concerns associated with the landfill, including: odors and air quality impacts from landfill gas; dust, debris, and particulate matter due to construction and general operations and from the vehicular truck traffic to and from the facility; and the facility's proximity to residences and the City of Rensselaer's public school campus; and

WHEREAS, within the City of Rensselaer, residents living within close proximity of the Dunn Landfill have expressed concern about significant dust settling on their windowsills and outdoor furniture; have reported malodors that prevent residents from remaining outside; and have stated the noise from trucks has disrupted their quality of life; and

WHEREAS, in August 2018 the DEC issued an Order on Consent to the Dunn Landfill for inspection violations during January and February 2018; in February 2019 the DEC issued an Order on Consent to the Dunn Landfill for inspection violations during October 2018; in June 2019 the DEC issued an Order on Consent to the Dunn Landfill for inspection violations during April 2019; and

WHEREAS, on October 10, 2019 the DEC issued a Department Initiated Modification (DIM) to include specific and stringent conditions to protect public health and safety that the Dunn facility must undertake in order to continue operating; and

WHEREAS, the DIM conditions include installing and operating a robust gas collection system, covering disposed waste daily, constructing a berm before the construction of a new waste cell, and establishing a hotline to report complaints; and the DEC conducts air monitoring at the school campus and other nearby locations to measure air quality impacts, including measuring levels of hydrogen sulfide and particulates; conducts routine inspections of operations at the landfill; requires the facility to fund a full-time monitor to provide daily oversight of the landfill operations; modifies the facility's permit to improve collection and management of gas, requires cover of waste on a daily basis, and establishes mandatory complaint investigation protocols; and

WHEREAS, it has been urged in the past that the Department of Environmental Conservation hold the Dunn landfill operators responsible for implementing controls to prevent dust, odors, and truck noise, to ensure that residents in the City of Rensselaer are not exposed to any potential health or safety hazards, and to recognize that failure of the facility to comply with the DIM should result in DEC revocation of the facility's permits; and

WHEREAS, while the progressive actions enacted by the DEC have been responsive to the community concerns, the residents of City of Rensselaer assume health, safety, environmental, and quality of life risks associated with the continued and ongoing operations of the Dunn Landfill, and residents have indicated that the responsive actions have not resulted in the complete elimination of dust, odor, and truck noise impacting their quality of life;

NOW, THEREFORE, BE IT RESOLVED, that the Common Council of the City of Rensselaer urges the DEC, responsible for protecting public health and safety and for the protection of air, water, and natural resources within the State of New York, to revoke the facility's operating permits and not permit renewal of use; and

BE IT FURTHER RESOLVED, that the Common Council directs the City Clerk to send a certified copy of this resolution to Governor Andrew M. Cuomo and Basil Seggos, Commissioner of the Department of Environmental Conservation.

Ellen Pangburn

From: Lark Rutecki <lark.rutecki@gmail.com>
Sent: Wednesday, September 29, 2021 5:45 PM
To: Ellen Pangburn
Subject: Dunn Landfill Hearing - Submission for Public Comment

Ms. Pangburn,

Please accept the message below as part of public comment regarding tonight's hearing on the Dunn Landfill.

Sincerely,
Lark Rutecki

****

Honorable Members of the East Greenbush Town Board,

My name is Lark Rutecki and I am a resident of the City of Rensselaer. Thank you for welcoming members of the public to participate in this hearing. I may be unable to attend due to a long standing appointment for my son. The nature of his disability makes it challenging to reschedule. I respectfully submit this for consideration via email.

I speak today in my capacity as a mother of 3 young children in the Rensselaer City School District. Equally as important, my home is adjacent to the school meaning my family is never more than a stone's throw from the Dunn Landfill. Two little boys and a little girl have spent their entire lives in the shadow of the facility.

Yet in this whole time, no one ever asked for my personal opinion on the landfill.
I am calling on the Department of Environmental Conservation not to renew the permit for the Dunn Landfill when it comes up for review in 2022.

Please do so in a manner that will hold up under legal scrutiny. But deny the renewal nonetheless.

Please do so without making promises that cannot be kept. But deny the renewal nonetheless.

And please do so without allowing for bluster or political grandstanding. But deny the renewal nonetheless.

We all wish this landfill never was. The next best option is to ensure it can be no more.

Sincerely,
Lark Rutecki