Hazardous Waste Management Program
GOVERNMENTS WORKING TOGETHER FOR A HEALTHIER AND CLEANER KING COUNTY

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Final Report

Estimating the Burden of Occupational Exposures in King County Among All Workers and by Race/Ethnicity: A Job-Exposure Matrix-Based Approach

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This report was prepared by the Hazardous Waste Management Program in King County, Washington, a coalition of local governments. Our customers are residents, businesses and institutions with small quantities of hazardous wastes. Our mission is: to protect and enhance public health and environmental quality in King County by reducing the threat posed by the **production**, **use, storage,** and **disposal** of hazardous materials.

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Acronyms and Abbreviations

AIAN	American Indian and Alaska Native
BIPOC	Black, Indigenous, and People of Color
CANJEM	Canadian job-exposure matrix
EPI	Exposure Prevention Index
FINJEM	Finnish job-exposure matrix
Haz Waste Program	Hazardous Waste Management Program in King County
JEM	Job-exposure matrix
NAICS	North American Industry Classification System
NHPI	Native Hawaiian and Other Pacific Islander
OH	Occupational Health
P2	Pollution prevention
QWI	Quarterly Workforce Indicators
SQGs	Small quantity generators
U.S.	United States

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Executive Summary

What is the problem we are addressing?

Workplace settings are an important venue for exposure to hazardous materials, as employees working with or near hazardous agents often experience more frequent and higher intensity exposures than in community or household settings. Yet characterizing the burden of occupational exposures is challenging at the population level, as is evident by the current lack of exposure surveillance systems in the U.S. Additionally, existing evidence suggests that workers of color are overrepresented in some high hazard industries (e.g., agriculture or construction) and may suffer higher levels of occupational health (OH) outcomes (e.g., work-related injuries or lung cancer). However, to develop policies, practices, and tools that address racial/ethnic inequities in exposures to hazardous materials, ***more research is needed to understand the extent and distribution of exposures occurring in occupational settings*** that may in turn contribute to poor worker health and health inequities across race/ethnicity.

What we did

We conducted a study to characterize the burden of occupational exposures in King County, among all workers and by race/ethnicity. We combined worker demographic information from the U.S. Census Bureau's Quarterly Workforce Indicators (QWI) database with data from the Canadian job-exposure matrix (CANJEM), which provides information on the probability of exposure to over 245 hazardous agents within 136 King County industries. CANJEM represents the most comprehensive job-exposure matrix (JEM) in North America and is based on nearly 9,000 detailed interviews and expert evaluations of over 30,000 jobs held between 1930 to 2005 in the greater Montreal, Canada area.

What we found

CANJEM data provide good coverage of King County wage earners. CANJEM exposure information is available for industries covering 74% (1,040,900/1,413,400) of all King County workers and 73% (372,100/511,200) of Black, Indigenous, and People of Color (BIPOC) workers. Industries with no exposure information tended to be white collar industries in which chemical exposures are less likely.

Many King County workers are exposed to hazardous chemicals at work. We estimated that hundreds of thousands of workers in King County are exposed to hazardous materials on the job, with the most common chemical exposures including cleaning agents, organic solvents, and biocides.

Most common occupational exposures in King County by workers' race/ethnicity, 2019.

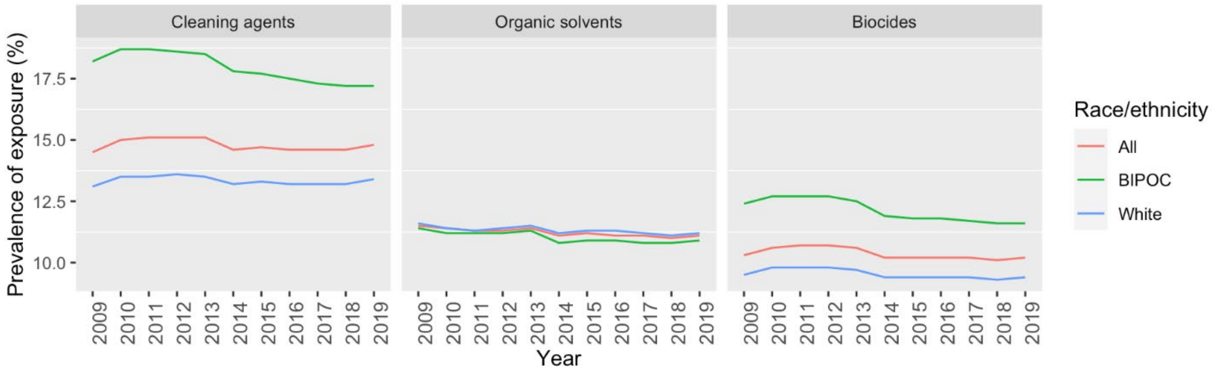
Rank	Agent	All workers exposed	BIPOC workers exposed	% Hispanic	% AIAN	% Asian	% Black	% Multiracial	% NHPI	% White
1	Cleaning agents	208500 (14.8%)	87,900 (17.2%)	19.7	16.8	15.6	18.9	16.6	14.9	13.4
2	Organic solvents	156900 (11.1%)	55,900 (10.9%)	13.5	11.6	10	10.1	10.9	10.6	11.2
3	Biocides	144200 (10.2%)	59,300 (11.6%)	12.2	10.3	11	13.1	10.8	10	9.4
4	Aliphatic aldehydes	123800 (8.8%)	52,100 (10.2%)	13.3	11.2	9.1	8.8	11.1	8.7	7.9
5	Engine emissions	123500 (8.7%)	41,200 (8.1%)	9.4	9.2	6.7	9	8.8	10.7	9.1

BIPOC = Black, Indigenous, and People of Color; AIAN = American Indian/Alaska Native; NHPI = Native Hawaiian/Pacific Islander
* Estimates rounded to nearest 100. Values highlighted in red indicate agent categories in which BIPOC employees are disproportionately exposed.

Occupational segregation within the King County labor market contributes to BIPOC workers being disproportionately exposed to many hazardous materials at work. We estimated that BIPOC workers are more likely to be exposed to many of the most common occupational exposures compared to non-Hispanic white workers. Patterns of occupational exposure varied by race/ethnicity groups, with Hispanic and American Indian/Alaska Natives generally experiencing a higher burden of exposure.

Disparities in occupational exposures have persisted over the last decade. Examining trends between 2009 and 2019, we estimate that the likelihood of exposure to many occupational hazards among BIPOC workers was consistently higher compared to non-Hispanic white workers during this period.

Prevalence of King County workers exposed to cleaning agents, organic solvents, biocides by race/ethnicity between 2009 to 2019.



Our novel Exposure Prevention Index (EPI) identifies industries that may particularly benefit from pollution prevention interventions. Our EPI measure identified certain industries that have both many exposed workers and a high probability of exposure to common occupational hazards, including Personal Care Services (e.g., nail and beauty salons) and Services to Buildings and Dwellings (e.g., janitorial, pest control, and landscaping services) industries. These industries may particularly benefit from public health and pollution prevention intervention efforts focused on reducing chemical exposures among workers.

What the Hazardous Waste Management Program can do

When conducting technical assistance to small businesses:

- ***Seek opportunities to reduce worker exposures.*** Our results suggest that workplaces are an important aspect of exposure to hazardous materials in King County. The Haz Waste Program should promote pollution prevention and technical assistance efforts that reduce or eliminate workers exposures, especially transitioning businesses to safer alternatives.
- ***Account for racial equity in our work with small businesses.*** Our results identify the existence of racial disparities in occupational exposures due to segregation of BIPOC workers into industries with higher probabilities of exposure. Characterizing the distribution of occupational exposure by demographic groups can identify where OH interventions have the greatest impact to reduce and eliminate exposure disparities.

When applying research and data analysis to support work planning and performance evaluation:

- ***Continue to research and advocate for quality OH surveillance data.*** JEM-based research approaches can help address the pressing need for OH surveillance to move "upstream" to characterize exposures rather than only health outcomes. However, JEMs have inherent limitations, including potential exposure misclassification (e.g., unaccounted for exposure variability within industries or across demographic groups) and the static nature of the data. Additional work is needed to improve OH surveillance in King County and elsewhere.
- ***Disaggregate data by race/ethnicity.*** Our findings of distinct patterns in exposures within specific race/ethnicity categories highlight the importance of disaggregating demographic data when possible.

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Study Rationale and Overview

The mission of the Hazardous Waste Management Program in King County (Haz Waste Program) is to protect and enhance public health and environmental quality in King County by reducing the threat posed by the production, use, storage, and disposal of hazardous materials. From a human health perspective, one of the most important venues of exposure to hazardous materials is the workplace setting: employees working with or near hazardous agents often experience more frequent and higher intensity exposures than in community or household settings. The Haz Waste Program provides pollution prevention (P2) technical assistance to small businesses that qualify as small quantity generators (SQGs)[a] of hazardous waste, including helping businesses implement proper storage and disposal of hazardous waste or transition to using safer chemical alternatives. These services not only prevent environmental contamination, but also often reduce hazardous exposures to workers in King County. To improve planning, prioritization, and evaluation of P2 activities, it is useful to characterize the types and extent of hazardous exposures occurring in King County workplaces; however, population surveillance of occupational exposures is challenging due to a variety of technical and logistical constraints, including a lack of accurate estimates of exposures.

The Haz Waste Program is committed to centering racial equity in all its operations and has adopted a racial equity strategic plan to ensure that race is not a determinant of hazardous exposure (Local Hazardous Waste Management Program in King County, Washington, 2018). While it is well established that Black, Indigenous, and People of Color (BIPOC) populations experience disproportionate exposure to harmful environmental pollution at the community level, less is known about whether BIPOC workers experience disparities in exposure to hazardous agents within occupational settings. There is existing evidence suggesting that BIPOC workers are overrepresented in some high hazard industries (e.g., agriculture or construction) and may suffer higher levels of occupational health outcomes (e.g., work-related injuries or lung cancer). However, to develop policies, practices, and tools that address racial/ethnic inequities in exposures to hazardous materials, more research is needed to understand the extent and distribution of exposures occurring in occupational settings that may contribute to health differences across race/ethnicity.

To address these gaps in our understanding, we conducted an analysis to characterize the burden of occupational exposures in King County, among all workers and by race/ethnicity. To accomplish this, we combined worker demographic information from the U.S. Census Bureau's Quarterly Workforce Indicators (QWI) database with data from the Canadian job-exposure matrix (CANJEM), which provides information on the probability of exposure to more than 245 hazardous agents within over 130 industries. The objectives of this analysis were fourfold:

[a] Small quantity generators are businesses in Washington that generate less than 220 pounds of dangerous waste, or less than 2.2 pounds of certain kinds of highly toxic waste, in any month. Regulations for this category of dangerous waste generators are less complex than they are for medium or large quantity generators.

1. **Characterize hazardous exposures occurring in King County workplaces –** This objective aims to improve our understanding of which types of exposures are most important in King County, including estimating the number and proportion of workers exposed to approximately 250 chemical agents.
2. **Examine patterns of occupational exposure by workers' race/ethnicity in King County –** This objective aims to improve our understanding of potential racial/ethnic inequities in occupational exposures, including estimating the number and proportion of BIPOC workers exposed and assessing whether certain hazardous exposures disproportionately burden BIPOC workers.
3. **Examine the extent and racial/ethnic distribution of occupational exposures over time –** This objective aims to characterize trends in the number and proportion of King County workers exposed between 2009 and 2019 and examine whether disproportionality in exposures across race/ethnicity has changed during this period.
4. **Develop an Exposure Burden Index to prioritize industries for intervention –** This objective aims to develop a novel index of occupational exposures to understand in which King County industries workers experience the greatest burden of occupational exposures.

Ultimately, the results of this analysis are meant to inform Haz Waste Program planning, resource allocation, service delivery, and performance evaluation, especially with respect to the Program's work to assist small businesses.

Background

Occupational Health Surveillance

Occupational health surveillance is the ongoing systematic collection, analysis, interpretation, and dissemination of data on work-related health outcomes and hazards in the workplace for the purpose of understanding and preventing illnesses and injuries (Greife et al., 1995; National Academies of Sciences, Engineering, and Medicine, 2018; National Institute for Occupational Safety and Health, 2016; Thacker & Birkhead, 2008). Occupational health surveillance informs priorities for research, policy development, and intervention efforts to improve worker health and safety (National Academies of Sciences, Engineering, and Medicine, 2018). However, current occupational health surveillance systems in the U.S. primarily focus on tracking health outcomes (LaMontagne et al., 2000; National Academies of Sciences, Engineering, and Medicine, 2018; Todorov & Reeb-Whitaker, 2021) and are known to underestimate the true burden of work-related injuries and illnesses (Azaroff et al., 2002; Boden & Ozonoff, 2008; Hilaski, 1981; Rosenman, Kenneth et al., 2006; Spieler & Wagner, 2014), especially for chronic diseases (Hilaski, 1981; Souza et al., 2010; Spieler & Wagner, 2014; Wegman, D. H. & Froines, 1985).

Some issues contributing to underestimates include a delay between initial exposure and the onset of work-related illness, lack of occupational health awareness within the medical community, and underreporting by employees due to factors such as lack of awareness of how work affects their health, fear of reprisal by their employer, and inability to afford lost work time (Azaroff et al., 2002; Hilaski, 1981; National Academies of Sciences, Engineering, and Medicine, 2018). These factors likely also produce differential undercounting of injuries and illnesses for certain working populations, such as low-wage workers and workers of color (Azaroff et al., 2002; Sabbath et al., 2017). Importantly, focusing surveillance primarily on health outcomes leaves unclear what specific exposures in the work environment contribute to adverse health outcomes among workers, and, more generally, difficulty in attributing work as the cause or contributor of a disease or injury that has many potential risk factors—making prevention of work-related illnesses difficult (Azaroff et al., 2002; Hilaski, 1981; National Academies of Sciences, Engineering, and Medicine, 2018).

Surveillance of Occupational Exposures

Exposure surveillance, which focuses on understanding the burden of *occupational exposures* rather than *health outcomes*, can supplement and address important gaps in current occupational health surveillance efforts. The main advantage of exposure surveillance is being able to identify specific opportunities for intervention to reduce exposures and improve working conditions before occupational injuries and illnesses occur, i.e., going "upstream" to emphasize prevention (Froines et al., 1989; Greife et al., 1995; National Academies of Sciences, Engineering, and Medicine, 2018; Sundin & Frazier, 1989). Additionally, in comparison to occupational illnesses, exposures can be easier to recognize, occur at greater frequency, and serve as better indicators of effective control measures as they are the targets of control themselves (Wegman, 1992). Improving surveillance of occupational hazards and exposures was identified as a key priority by the National Academies of Sciences, Engineering, and Medicine in a report entitled "A Smarter National Surveillance System for Occupational

Safety and Health in the 21st Century"(National Academies of Sciences, Engineering, and Medicine, 2018); however, there is currently no comprehensive exposure surveillance system in the U.S. In conjunction with current occupational health surveillance systems, exposure surveillance could allow for greater opportunity for early detection of hazardous exposures and implementation of more effective preventive measures to reduce exposures in King County and elsewhere.

Methods of Estimating Occupational Exposure Burden

Characterizing the burden of occupational exposures is challenging at the population level, as is evident by the current lack of exposure surveillance systems in the U.S. Some approaches that have been used to characterize occupational exposure burden include workplace observational surveys (National Institute for Occupational Safety and Health, 1976; Sieber, 1990), questionnaires (Carey et al., 2021; National Center for Health Statistics, 2011; National Center for Health Statistics, 2016; Steege et al., 2014b), exposure sampling data (Middendorf, 2004), workers' compensation data (Todorov & Reeb-Whitaker, 2021) job exposure matrices (Beckman et al., 2022; Gustavsson et al., 2022), or some combination of these (Kauppinen et al., 1998). However, each approach has its own limitations or advantages with respect to validity and feasibility.

For example, questionnaires can be costly to develop and maintain, rely solely on workers' assessment, and can be difficult to disseminate to certain populations. It can also be challenging to obtain specific exposure information. For example, the National Health Interview Survey includes an Occupational Health Supplement in 2010 and 2015 to collect data on occupational exposures and health outcomes (The National Institute for Occupational Safety and Health, 2020); however, the exposures measured were relatively non-specific (e.g., skin hazard; vapors, gas, dust, fumes; outdoor work) (National Center for Health Statistics, 2011; National Center for Health Statistics, 2016), limiting the utility of the data for informing targeted intervention measures.

Workplace observational surveys, in which occupational health and safety experts observe work environments and record exposure information, are also costly and time intensive, and further require access to worksites in which employers are often disincentivized to volunteer for fear of liability. The National Occupational Exposure Survey, a large-scale workplace-based direct observational survey conducted by the National Institute for Occupational Safety and Health (NIOSH) in the early 1980s, was the last nationwide effort to characterize exposures for a wide variety of hazards and occupations across workplaces in the US (Seta et al., 1988). This survey required an extensive amount of time and resources, and the data is now considered outdated and of limited use (National Academies of Sciences, Engineering, and Medicine, 2018; The National Institute for Occupational Safety and Health, 2017). Due to resource constraints, there are no plans to conduct such a large-scale survey in the future (National Academies of Sciences, Engineering, and Medicine, 2018; The National Institute for Occupational Safety and Health, 2017).

Exposure sampling measurements are also costly, require access to worksites, are only available for hazards with known sampling methods, and require specialized equipment and technical expertise. In addition, publicly available sampling data, such as in the Occupational

Safety and Health Administration (OSHA) Integrated Management Information System (IMIS), is typically collected for compliance purposes, so the number of agents for which data is available is limited and the samples are likely biased due to being mainly to support compliance, rather than characterization of workers' health risks. There are also well-described limitations associated with using workers' compensation data for surveillance, namely that these data underestimate the extent of occupational injuries and illness (Azaroff et al., 2002) and would therefore similarly underestimate exposures.

Another approach described in a recent report on the state of occupational disease in New York State was to estimate the number of workers employed in industries that reported using one or more chemicals that pose a risk to workers (Lax & Zoeckler, 2021). However, such an approach would likely underestimate the extent of actual exposures because substantial exposure could be occurring in many businesses that use chemicals at quantities below regulatory reporting thresholds.

The Job-exposure Matrix Approach

In this analysis, we characterize occupational exposures using a job-exposure matrix (JEM). A JEM is a source of data used in population-based studies to provide workplace exposure information for individual occupations or industries (Siemiatycki, 2000). That is, a JEM links a job title or industry classification to indices of exposure to various occupational hazards. JEMs therefore represent powerful research tools that can infer complex information on exposure to industries and occupations when data at the individual worker level is not available. A JEM can be developed by expert assessment, self-reported exposure information, worksite monitoring data, or some combination thereof, which is then pooled at the level of industry or occupation to create estimates of "average" levels of exposure.

JEMs have been used for many decades and are an accepted method to estimate workplace exposures to chemicals and other hazards. However, a major limitation of JEMs is that they cannot account for variability in exposures within the same job or industry, nor do they account for changes in exposure that may occur over time (e.g., due to changes in regulations or industrial practices). Nevertheless, JEMs have many advantages, being relatively inexpensive and highly efficient at estimating exposures for a wide variety of occupational hazards in population studies—without relying on individual-level self-reports, observations, or measurements of exposure (Siemiatycki, 2000; Siemiatycki & Lavoué, 2018).

Three recent studies applied JEM data to characterize population-level exposure burdens. Beckman et al. (2022) combined American Community Survey employment and demographic data with an internally developed qualitative JEM (i.e., based solely on expert assessment) to estimate the number and prevalence of California working women exposed to a large set of exposures linked to breast cancer. In another study similar to the present analysis, Doubleday et al. (2018) combined state employment data with CANJEM (Lavoué, 2018) to estimate the number and prevalence of workers in Federal Region 10 (i.e., Washington, Idaho, Oregon, and Alaska) exposed to approximately 20 chemical hazards on the job. Finally, in a study from Sweden, Gustavsson and colleagues (2022) merged data from national population registers with the Finnish job-exposure matrix (FINJEM) to examine occupational exposure prevalence of six chemicals over time and across some workforce characteristics (i.e., workers' sex, age, country of birth, size of company).

While the methods, underlying data, and working populations included in these studies varies, these analyses had a similar goal to the present study of providing population-level estimates of occupational exposure burden. More detail about these studies is included below (see discussion section entitled "Comparison to Other Studies").

Surveillance of Occupational Health Disparities

In addition to understanding the overall *burden* of occupational exposures affecting the health of workers, it is also important to consider the *distribution* of these exposures to understand how occupational hazards may disproportionately impact certain segments of the working population. This is critical because the U.S. workforce is heavily segregated by sociodemographic characteristics (Alonso-Villar et al., 2012; Washington Center for Equitable Growth, 2017). Put simply, who is employed, in what type of work, and with what kind of accompanying exposures and resources, is not evenly distributed in modern societies, with a general trend of worse working and employment conditions experienced by marginalized populations (Krieger et al., 2008; Krieger, 2010).

There are many mechanisms underlying occupational segregation (defined as a sociodemographic group being overrepresented or underrepresented in a certain job or field of work), but the selection of certain groups of people into particular types of jobs is generally rooted in the systematic denial of access to equitable economic opportunities for those with less power, status, and resources (Frumkin et al., 1999; Juon et al., 2021; Lipscomb et al., 2006; Murray, 2003; Roelofs et al., 2017; Rosenman, Kenneth D., 2016). This segregation occurs across many axes of inequality, including race, ethnicity, gender, education, age, geographical area, socioeconomic position, and more.

Importantly, occupational segregation results in the uneven distribution of hazardous exposures, and other harms and benefits of work, and may therefore contribute to health disparities (Birdsey et al., 2007; Briggs et al., 2003; Frumkin et al., 1999; Krieger, 2010; National Academies of Sciences, Engineering, and Medicine, 2018). Accordingly, researchers and policymakers are increasingly recognizing that work is an important social determinant of health and health inequities, as it is a source of both health-harming exposures—such as chemical and physical hazards and psychosocial stressors—and health-enhancing resources—including income and other benefits such as health insurance (Ahonen et al., 2018; Fujishiro et al., 2017; Lipscomb et al., 2006). There are many studies documenting occupational health disparities in the U.S., in which workers from marginalized groups are overrepresented in high-risk occupations and industries and experience worse occupational health outcomes (Baron et al., 2013; Marsh et al., 2013; Richardson et al., 2004; Seabury et al., 2017; Stanbury & Rosenman, 2014; Steege et al., 2014a). While these findings infer that some workers experience disproportionate levels of exposures, a lack of empirical information on the social distribution of hazardous exposures remains—especially for chemical exposures.

Occupational Segregation by Race/Ethnicity and the Role of Racism in Producing Racial Inequities in Occupational Exposures

In this study, we emphasize a particular need to understand racial and ethnic disparities in occupational exposures, which directly relates to the Haz Waste Program's racial equity goals. The concepts of institutional and systemic racism have increasingly gained understanding among policymakers, researchers, and the public at large. For example, racism was declared a public health crisis by the King County government and Public Health – Seattle & King County in June 2020 (Constantine & Hayes, 2020). Yet, there has been relatively little attention to racism and its potential role in contributing to unequal work-related exposures and health outcomes within occupational health and safety research.

At the same time, in order to avoid reinforcing nefarious stereotypes, scholars have called for appropriate application of race and ethnicity as a research variable. While an enormous literature exists describing racial and ethnic differences in a wide variety of risk factors and health outcomes, researchers rarely link these disparities to precise mechanisms that actually produce such disparities—namely manifestations of racism such as poverty (Fullilove, 1998; Kaplan & Bennett, 2003; Kaufman & Cooper, 2001; Williams, J. I., 1966). As a result, alternative explanations are often evoked to explain these disparities, including those involving genetic susceptibility or cultural inferiority, which can cause further harm among those experiencing worse outcomes (Lett et al., 2022; Payne-Sturges et al., 2021).

To avoid this pitfall, it is useful to clarify our conceptual and analytic frameworks in this analysis: we intend to examine occupational exposures in King County by race and ethnicity to characterize the potential role of racism in contributing to unequal exposures, and thus assess the potential value of applying a racial equity perspective to the Haz Waste Program's work on reducing exposures within workplaces. More technically, since our worker demographic data is at the industry level, we conceptualize our use of worker race and ethnicity by industry as a proxy for racial/ethnic segregation across industry (i.e., occupational segregation), which we posit is at least partially shaped by racism, based on decades of social science and economic research (Chung-Bridges et al., 2008; Krieger et al., 1993; Williams, D. R., 1999). For example, discrimination in public resources, including education, high unemployment, and a historical lack of land, business ownership, and other economic opportunities, all contribute to some racial/ethnic groups being disproportionately employed in hazardous jobs. Further, institutional racism has and continues to contribute to geographical segregation and other policies that result in the placement of hazardous, low-wage industries within disadvantaged communities, further contributing to racial/ethnic segregation in the labor market (Lipscomb et al., 2006). It is important to note that our data do not allow for examining potential racial/ethnic disparities in exposure within industries, which could occur, for example, if BIPOC workers in King County were systematically given more hazardous jobs or tasks across all industries.

Disparities in occupational health outcomes by race and ethnicity are consistently identified in the U.S., especially for outcomes such as work-related injury and diseases with well-characterized occupational origins (e.g., silicosis). An analysis of national 2010 nonfatal work-related injury and illness data by Baron et al. (2013) showed that workers of color (except those identifying as Asian or multiracial), males, foreign-born workers, and low-wage workers were overrepresented in high-risk occupations, defined as occupations with rates of nonfatal injury and illness greater than twice the 2008 national average rate of 113.3 cases per 10,000 full-time equivalent employees. Similarly, Seabury et al. (2017) found that non-Hispanic Black and foreign-born Hispanic workers in the U.S. were disproportionately employed in jobs with high risk of injury and suffered higher levels of work-related disability compared to non-Hispanic white workers. Using data from a large National Cancer Institute study, Juon and colleagues (2021) found evidence that occupational exposures may contribute to racial disparities in lung cancer: Black workers reported higher levels of exposure to occupational carcinogens (asbestos and silica) and higher rates of lung cancer, compared to white workers. In a study using Michigan data, Stanbury and Rosenman (2014) found that Black and Hispanic employees were overrepresented in lower wage and more hazardous occupations and suffered higher levels of several occupational injuries and diseases. Black workers were at greater risk of silicosis, work-related asthma, and work-related burns than white workers; and Hispanic workers had higher rates of work-related acute fatal injuries and pesticide injuries than non-Hispanic workers (Stanbury & Rosenman, 2014). Workers from racialized groups also are killed at work at higher rates than white workers. Marsh et al. (2013) found that Hispanic and foreign-born workers had the highest rates of fatal occupational injuries from 2005 to 2009. Overall, these studies—representing only a sample of more recent publications—suggest that workers of color are selected into jobs with higher risk of injury and illness which may contribute to health inequities.

To reduce such health inequities, it is helpful to understand the burden and distribution of occupational exposures by demographic groups to identify specific working populations disproportionately burdened by work-related exposures and at excess risk of injuries and illnesses. With this information, intervention efforts aimed at reducing disparities in occupational injuries and illnesses can be focused more effectively.

King County Labor Market

King County is home to a dynamic labor market, including a wide variety of industries and a demographically diverse workforce. King County is the largest county in Washington state, averaging over 1.4 million jobs in 2019. According to the Washington State Employment Security Department, more than 42 % of all nonfarm jobs in Washington state are located in King County, based on 2019 employment data (Vance-Sherman, 2022).

Employment by Industry

Employment estimates in King County by industry sector are presented in **Table 1**. Approximately 87% of King County jobs are in service-providing sectors, with the largest industries including healthcare and social services; professional, scientific, and technical services; retail trade; accommodation and food services; information; and educational services. Around 13% of King County jobs are in goods-producing sectors, especially manufacturing industries.

Table 1. Average King County employment estimates by industry sector, 2019.

NAICS[a] Sector Code	Industry Sector	Employee Count[b]	Percent of Workforce
11	Agriculture, Forestry, Fishing and Hunting	2,900	0.2%
21	Mining, Quarrying, and Oil and Gas Extraction	450	<0.1%
22	Utilities	5,600	0.4%
23	Construction	75,000	5.3%
31-33	Manufacturing	103,300	7.3%
42	Wholesale Trade	66,400	4.7%
44-45	Retail Trade	151,500	10.7%
48-49	Transportation and Warehousing	65,100	4.6%
51	Information	125,700	8.9%
52	Finance and Insurance	44,100	3.1%
53	Real Estate and Rental and Leasing	30,600	2.2%
54	Professional, Scientific, and Technical Services	133,400	9.4%
55	Management of Companies and Enterprises	35,500	2.5%
56	Administrative and Support and Waste Management and Remediation Services	79,000	5.6%
61	Educational Services	97,800	6.9%
62	Health Care and Social Assistance	170,100	12.0%
71	Arts, Entertainment, and Recreation	31,500	2.2%
72	Accommodation and Food Services	114,600	8.1%
81	Other Services (except Public Administration)	49,000	3.5%
92	Public Administration	32,000	2.3%
0000	All Sectors	1,413,500	100.0%

Source: U.S. Census Bureau Quarterly Workforce Indicators, annual average over four quarters in 2019.
[a] NAICS: North American Industrial Classification System
[b] Employee counts are rounded to the nearest ten if <1000, and to the nearest hundred if >1000.

Workforce Demographics
Employment estimates in King County by race and ethnicity are presented in **Table 2**. Of the estimated 1.4 million workers in King County, approximately 36.2% of the workforce identify as BIPOC.

Table 2. Average King County employment estimates by race/ethnicity, 2019.

Category	Race/Ethnicity[a]	Employee Count[b]	Percent of Workforce
Race	American Indian and Alaska Native	14,200	1.0%
	Asian	230,700	16.3%
	Black or African American	92,200	6.5%
	Multiracial	58,100	4.1%
	Native Hawaiian or Other Pacific Islander	11,500	0.8%
	White	1,007,000	71.2%
	Non-Hispanic White	902,300	63.8%
	Hispanic White	104,700	7.4%
Ethnicity	Hispanic or Latino	129,400	9.2%
	Not Hispanic or Latino	1,284,100	90.8%
BIPOC[c]		511,300	36.2%
Total		1,413,500	100%

Source: U.S. Census Bureau Quarterly Workforce Indicators, annual average over four quarters in 2019.
[a] Except for the non-Hispanic white race/ethnicity group, persons of any race are of any ethnicity. Persons of Hispanic or Latino ethnicity are of any race and are also counted in their preferred race category.
[b] Employee counts are rounded to the nearest hundred.
[c] Black, Indigenous, and People of Color (BIPOC) category includes all workers except those identifying as non-Hispanic white.

Labor Market Impacts of the COVID-19 Pandemic
It is important to note that the COVID-19 pandemic induced an economic recession in 2020, which dramatically impacted labor markets in King County and globally. Between February and April 2020, total nonfarm employment in King County dropped by more than 11 %—with more than 166,000 jobs lost (Vance-Sherman, 2022). County total employment has mostly recovered since then, with preliminary estimates from the Washington State Employment Security Department for March 2022 being just 10,000 fewer jobs than pre-pandemic levels (Vance-Sherman, 2022). However, the pandemic has impacted individual industries differently. The most affected industries were those within the leisure and hospitality sector, which as of March 2022 remain down 17,500 jobs, or approximately 13 % below pre-pandemic levels. The local manufacturing sector was also substantially affected in 2020, especially the aerospace industry due to decreased demand in aircraft during the pandemic. As of March 2022, King County manufacturing jobs remained down 9,600 jobs compared to two years earlier, roughly nine percent below pre-pandemic levels. Other industries that have not yet recovered to pre-pandemic employment totals include government, other services, wholesale trade, transportation, education, health services, warehousing, and utilities (Vance-Sherman, 2022).

Given the COVID-19 pandemic's large and ongoing impact on King County's labor market, as well as the fact that complete employment statistics for 2021 are not yet available, this analysis uses employment data from 2019. Thus, although we believe our analyses using 2019 data provide important insights, one must be cautious in interpreting our results as they pertain to a pre-pandemic labor market that may differ from King County's current and future labor market in important ways.

Methods

Overview

To estimate the burden of occupational exposures in King County, we combined exposure data on 245 occupational agents from the CANJEM database with worker demographic data from the QWI. The merged data were used to estimate the number and proportion of King County workers exposed by agent, industry, and race/ethnicity. An overview of the data sources and outputs is presented in **Figure 1**. All analyses were performed using R Statistical Software (v4.1.0).

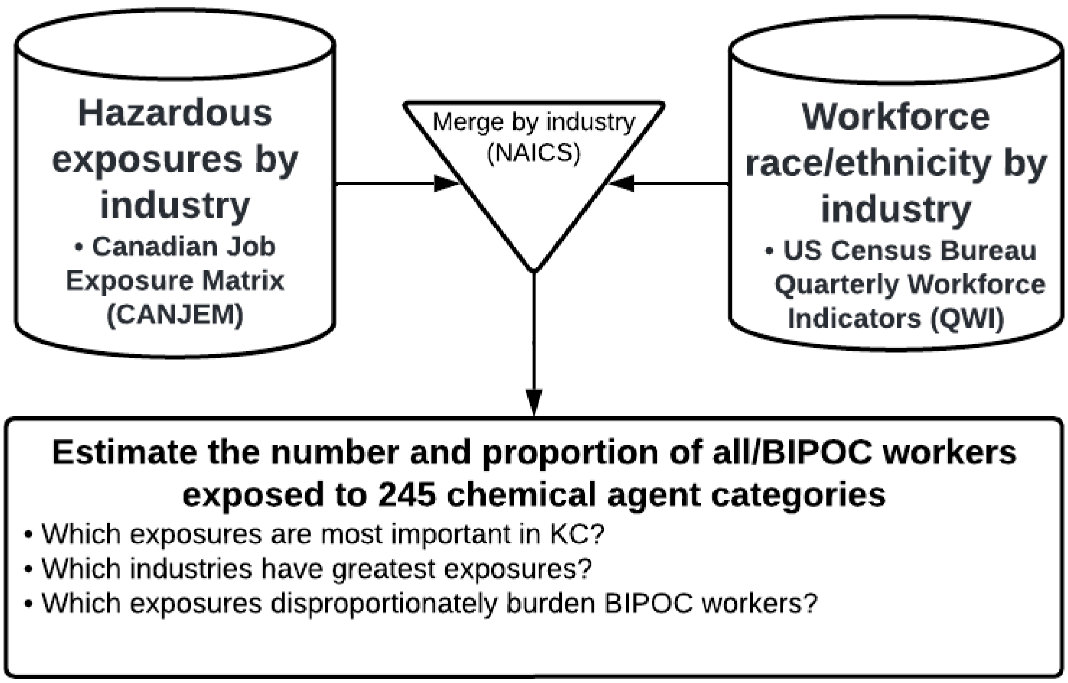

Figure 1. Overview of data sources and output.

Data Sources

Canadian Job-exposure Matrix (CANJEM)

The CANJEM occupational exposure information system is a JEM, which, as described above, enables estimates of workplace exposures by occupation and industry. For a given industry or occupation and time period, CANJEM provides information on the probability, frequency, and intensity of exposure to more than 250 hazardous agents (Siemiatycki & Lavoué, 2018). CANJEM was built from detailed worker interviews followed by expert evaluations of occupational exposures, completed during several research studies conducted between 1980 and 2010 in the greater Montreal area (Siemiatycki & Lavoué, 2018). During these studies, over 30,000 jobs from 1930 to 2005 held by over 9,000 subjects were evaluated; experts assigned exposures based on descriptions of tasks, processes, work environment, and exposure control measures (Siemiatycki & Lavoué, 2018). While easily available information on occupational exposures is generally difficult to obtain, CANJEM represents a uniquely large and extensive database of exposure information on a wide range of agents and industries/occupations that occurred in a mostly urban North American population in the late 20th/early 21st century (Siemiatycki & Lavoué, 2018). Thus, we believe CANJEM is an appropriate data source to characterize a wide variety of hazardous exposures in King County workplaces.

Exposure Metrics: We used two exposure metrics available in the CANJEM database.

- Probability of exposure – This measure provides a likelihood of exposure within a given industry and is calculated as the number of exposed jobs in an industry divided by total number of jobs in that industry (Sauvé et al., 2018). Exposed jobs were defined as having a frequency of exposure of at least 30 minutes per week, a reliability level of "possible" or greater, and a frequency-weighted intensity (FWI) score of at least 0.05. The FWI combines measures of intensity (low, medium, high) and frequency (<2 h, 2–12 h, 12 to <40 h, and ≥40 h per week), and an FWI of 0.05 is equivalent to two hours per week of exposure at low intensity (Sauvé et al., 2018).
- Probability of high exposure – This measure provides a likelihood of being highly exposed within a given industry and is calculated as the number of highly exposed jobs in an industry divided by the total number of jobs in that industry. We considered jobs highly exposed when the FWI was ≥5, which corresponds to jobs with medium levels of exposure for 40 or more hours per week or high levels of exposure for eight or more hours per week.

Matrix Restrictions: Matrix restrictions are selection criteria that affect how CANJEM summarizes exposure information. We used the following restrictions during CANJEM data extraction, which were informed by previous research (Doubleday et al., 2018; Sauvé et al., 2018).

- Time period – Exposure data included jobs between 1985 to 2005, balancing inclusion of jobs from the most recent time period with having a sufficient sample size.
- Minimum sample size – Exposure data was limited to industries with at least 10 jobs and five subjects to exclude those with very low sample sizes. This approach is similar to recent studies using CANJEM data (Doubleday et al., 2018).
- Agents – Exposure data included 245 categories of hazardous agents, including both individual chemicals and groups of agents.
- Industry classification – Industry is categorized by 2012 North American Industry Classification System (NAICS) codes available at the 4-digit level (industry groups). Due to differences in NAICS coding between the US and Canada, some exposure estimates were not transferable to US employment data, including all industry groups in the wholesale trade and public administration sectors and some industry groups in manufacturing sectors. Thus, data from these industry groups are not included in the present study.

Quarterly Workforce Indicators (QWI)
The U.S. Census Bureau QWI database provides local labor market statistics by industry and employee demographics (United States Census Bureau, 2019). A wide variety of record sources contribute to the construction of the QWI, including administrative records on employment collected by the states (e.g., unemployment insurance), social security data, federal tax records, and other census and survey data (United States Census Bureau, 2019). In this analysis, we used employment estimates, worker race/ethnicity information, and average monthly earnings provided for industries across four quarters in 2019. The data was extracted on July 15, 2022, using the Local Employment Dynamics (LED) data extraction tool (https://ledextract.ces.census.gov/static/data.html).

Time Period: QWI data are available on a quarterly basis (United States Census Bureau, 2019). In our primary analysis, we used average annual employment estimates across four quarters in 2019. We additionally used average annual employment estimates from 2009 to 2019 to analyze exposure trends over time.

Industry Classification: Industry information is categorized by 2017 NAICS codes available at the 4-digit level (industry groups) (United States Census Bureau, 2019). Industry groups with zero employees in King County were not included in this analysis.

Employment Estimates: Beginning of quarter employment counts were used to estimate employee counts by industry, as is recommended by the U.S. Census Bureau (United States Census Bureau, 2019). All employment estimates over 1,000 were rounded to the nearest 100. Estimates that were under 100 were rounded to the nearest 10. Estimates were rounded to convey to the reader that all results presented herein should be interpreted cautiously due to limits of precision inherent in administrative datasets.

Race/Ethnicity: Employment estimates were provided for the following eight race/ethnicity groups:

1. Non-Hispanic White
2. Black or African American
3. American Indian and Alaska Native (AIAN)
4. Asian
5. Native Hawaiian and Other Pacific Islander (NHPI)
6. Hispanic or Latino
7. Multiracial
8. Black, Indigenous, and People of Color (BIPOC)

Employee estimates for race and ethnicity groups are not mutually exclusive. All race groups except for the non-Hispanic white group include employees of any ethnicity. Additionally, the Hispanic or Latino group includes employees of any race and are also counted in their preferred race category. A group including all workers identifying as BIPOC was calculated by finding the difference between total and non-Hispanic white worker counts.

Earnings: Average monthly earnings of employees with stable employment were used to obtain wage levels by industry groups. Industries were considered *low wage* if average monthly earnings were below $3,814 per month, or ~$45,800 annually, which is two thirds of the median earnings in King County. This is a commonly used approach for classifying low wage industries and occupations (OECD, 2022).

Data merging process

Two steps were required to merge worker demographic data from the QWI (industry available by US-based 2017 NAICS codes) with exposure data from CANJEM (industry available by Canada-based 2012 NAICS codes). First, we used the 2017 NAICS to 2012 NAICS concordance file provided by the U.S. Census Bureau (https://www.census.gov/naics/) to crosswalk the CANJEM industry data to 2017 NAICS. Second, we manually created a crosswalk from Canadian to US NAICS codes to address some differences in the coding scheme between the two countries. The crosswalk was created by matching NAICS labels and International Standard Industrial Classification of All Economic Activities (ISIC) codes for each country-specific NAICS classification.

Coverage Analysis

Given that the CANJEM database does not contain exposure information for all industries, we first assessed the extent of industries and employees in King County that are covered by the CANJEM data. We determined the number of King County industries that CANJEM provided exposure information for by totaling the number of 4-digit NAICS codes that matched between CANJEM and the QWI data. We then determined coverage of the King County workforce by summing the total number of workers in each of the matched industries.

Primary Analyses

Analysis 1: Estimates of Occupational Exposure Burden in King County

In Analysis 1, we estimated the number and proportion of workers exposed to 245 occupational agents across all industries in King County. Estimates are provided for all employees, BIPOC employees, and employees by disaggregated race/ethnicity group.

Number of workers exposed: The estimated number of employees in each race/ethnicity group exposed to each agent was calculated by multiplying the industry-specific probability of exposure (from CANJEM) by the number of employees in that industry (from QWI) and summing the number of exposed employees across all industries, as demonstrated in Equation 1.

$$n_{exposed,d} = \sum(p_i \times n_{i,d}) \,, \tag{1}$$

where $n_{exposed,d}$ = total number of exposed employees of specified demographic group, p_i = industry-specific probability of exposure, and $n_{i,d}$ = number of employees of specified demographic group in a given industry.

Percent of workers exposed: The proportion of employees in each race/ethnicity group exposed to each agent was calculated by dividing the estimated number of employees exposed to each agent category by the total number of employees in the race/ethnicity group, as demonstrated in Equation 2.

$$p_{\text{exposed,d}} = \frac{n_{\text{exposed,d}}}{n_{\text{total,d}}}\,, \tag{2}$$

where $p_{exposed,d}$ = proportion of exposed employees of specified demographic group, $n_{exposed,d}$ = number of exposed employees of specified demographic group, $n_{total,d}$ = total number of employees of specified demographic group in the workforce.

Whether an agent category contributes to disproportionate occupational exposure for a specific race/ethnicity group was determined when the proportion of exposed workers within that group was greater than the proportion of all workers exposed.

Analysis 2: Estimates of Disproportionate Exposure by Race/Ethnicity

In Analysis 2, we estimated the extent to which employees of each race/ethnicity group were disproportionately exposed to each of the 245 occupational agents in CANJEM. This was achieved by comparing the estimated number of exposed employees in each race/ethnicity group from Analysis 1 with the *expected* number of exposed employees, based on each group's proportional representation in the workforce (that is, if there was no racial/ethnic segregation in the labor market). Specifically, the number of employees expected to be exposed to each agent was calculated by multiplying the industry- and agent-specific probability of exposure by the number of total employees in the industry and the overall percent of employees in a given race/ethnicity group in the total workforce, and then summing all industries (Equation 3).

$$n_{\text{expected,d}} = \sum (p_i \times n_{\text{i,all}} \times p_{\text{total,d}})\,, \tag{3}$$

where $n_{expected,d}$ = number of employees of specified demographic group expected to be exposed, p_i = industry-specific probability of exposure, $n_{i,all}$ = number of total employees in specified industry, and $p_{total,d}$ = percent of employees of specified demographic group in the total workforce.

Number of excess workers exposed: An estimate for the number of employees disproportionately exposed was calculated by the difference between the number of estimated (from Equation 1) and expected (from Equation 3) employees exposed, as demonstrated in Equation 4.

$$e_{\text{exposed,d}} = n_{\text{exposed,d}} - n_{\text{expected,d}}\,, \tag{4}$$

where $e_{exposed,d}$ = excess number of employees of specified demographic group exposed, $n_{exposed,d}$ = number of employees of specified demographic group exposed, $n_{expected,d}$ = number of total employees of specified demographic group expected to be exposed.

Percent excess workers exposed: The percent of employees disproportionately exposed was calculated by finding the percent difference between the number of estimated and expected exposed employees for each race/ethnicity group, as demonstrated in Equation 5.

$$pe_{\text{exposed,d}} = \frac{n_{\text{exposed,d}} - n_{\text{expected,d}}}{n_{\text{expected,d}}}\,, \tag{5}$$

where $pe_{exposed,d}$ = percent of excess employees of specified demographic group exposed, $n_{exposed,d}$ = number of employees of specified demographic group exposed, $n_{expected,d}$ = number of total employees of specified demographic group expected to be exposed.

Note that a negative value for the excess workers exposed measures, whether number or percent, indicates that a demographic group experiences less exposure than is expected based on their representation in the overall King County workforce.

Analysis 3: Time Trend Analysis

To understand trends in the extent and racial/ethnic distribution of occupational exposures over time, we examined the estimated number and proportion of King County workers exposed each year from 2009 to 2019 across race/ethnicity, as well as the estimated number and proportion of excess workers exposed across race/ethnicity during this time period.

Analysis 4: Development of an Exposure Prevention Index to Prioritize Industries

In Analysis 4, we developed an Exposure Prevention Index (EPI) to identify industries with high burdens of hazardous exposures. The EPI can be used to prioritize prevention and intervention efforts to reduce exposures.

The EPI was informed by previous research used to identify industries with high risk of workplace injury (Anderson et al., 2014). Specifically, researchers from Washington State's Department of Labor & Industries (L&I) created a "prevention index", calculated as an industry's average rank order of 1) injury claim count and 2) claim incidence rate based on the state's workers compensation system. The L&I prevention index thus identified industries with high burden of occupational injury as those with both a high number of injuries and high risk of injury, indicating a need to prioritize prevention efforts in these workplaces.

Here, we took a similar approach focused on exposure to hazardous agents in the workplace. The EPI for each industry was calculated as the average rank orders of 1) probability of exposure (i.e., the likelihood of exposure) and 2) estimated number of employees exposed (i.e., the extent of exposure) for a particular agent category. Industries were ranked by the EPI, with industries ranking higher being those in which hazardous exposures are both likely and affect many workers in King County. To provide further context by which to prioritize industries for intervention efforts, we present the EPI results along with information about which industries were overrepresented by BIPOC employees and were considered low-wage industries.

Additional Analyses

Estimates of High Exposures

To characterize high occupational exposures in King County, we reran Analysis 1 with a measure of high exposure. A job was defined as highly exposed if it was assigned a FWI score of 5, which is equivalent to a medium level of exposure for 40 or more hours per week or a high level of exposure for eight or more hours per week. The probability of high exposure was calculated by dividing the number of jobs with an FWI ≥ 5 by the total number of jobs for each industry-agent combination, as demonstrated in Equation 6.

$$p_{i,h} = \frac{j_{i,FWI\geq5}}{j_i}, \tag{6}$$

where $p_{i,h}$ = industry-specific probability of high exposure, $j_{i,FWI>5}$ = number of jobs in the industry with FWI≥5, and j_i = total number of jobs in the industry.

Estimates of high exposures by agent category are included in **Appendix B: Estimates of High Exposure**.

Sensitivity Analysis

We conducted a sensitivity analysis to determine how exposure estimates were affected when using more stringent parameters in the CANJEM data related to minimum sample sizes and confidence ratings of expert assessors.

As noted above, the probability of exposure in our primary analysis was calculated for industry-agent combinations when the sample size was based on at least five subjects and 10 jobs. Those with less than five subjects and 10 jobs were excluded in the primary analysis due to potential unreliability of small sample sizes. Additionally, exposed jobs with any confidence rating—including possible, probably, or definite—were included in the primary analysis. For comparison, we performed a more stringent analysis in which a) the probability of exposure was based on a sample size with at least 10 subjects and 10 jobs for each industry-agent combination, and b) only exposed jobs that were rated as "definite" were included in exposure probability calculations (jobs with "possible" and "probable" ratings were considered unexposed).

To understand how the sample size and confidence rating parameters affected the interpretation of our findings, we examined the extent to which exposure estimates for all and BIPOC workers decreased when using more stringent parameters. We further compared the relative ranking of each agent in terms of the number of exposed employees. Lastly, we examined whether the more stringent criteria of exposure affected the number of agents that disproportionately burdened each of the racial/ethnic groups.

Full results for the sensitivity analyses are included in **Appendix C: Sensitivity Analysis**.

Results

Coverage Analysis

The industries and employees in King County covered by the CANJEM data are shown in Table 3. Although exposure information is available in CANJEM for less than half of the 279 King County industry groups examined in the analysis, these industries account for over 73% of all employees (1,040,900) and over 72% of BIPOC employees (372,100) in King County. This represents good coverage of the King County working population and is similar to prior studies (Sauvé et al., 2018).

Table 3. Summary of King County industries and employees with exposure information.

Indicator	Number of Industry Groups (%)	Number of Employees[a] (%)	Number of BIPOC Employees[a] (%)
Total workforce	285 (100%)	1,413,400 (100%)	511,200 (100%)
Have exposure information	136 (47.7%)	1,040,900 (73.6%)	372,100 (72.8%)
No exposure information	149 (52.3%)	372,500 (26.4%)	139,100 (27.2%)

[a] Employee counts are rounded to the nearest hundred.

To better understand the impact of imperfect coverage of the CANJEM data across King County industries, we examined the largest industries with no exposure information, shown in Table 4. The largest industry groups excluded from our analysis tended to be white collar industries in which hazardous exposures are less likely (e.g., Software Publishers and Management of Companies and Enterprises). However, workers in some of the excluded industry groups likely do experience relevant hazardous exposures (e.g., Support Activities for Air Transportation). It is therefore important to consider that some industries not included in our analysis may both contribute to occupational exposure burden in King County and be amenable to toxics reduction interventions to prevent worker exposures and environmental contamination.

See **Appendix A, Table A-1** for the full list of industries without exposure information.

Table 4. Summary of top 10 King County industries with no exposure information.

NAICS	Industry	Number of Total Employees[a]	Number of BIPOC Employees[a]
5112	Software Publishers	73,200	33,400
5511	Management of Companies and Enterprises	35,500	11,100
4541	Electronic Shopping and Mail-Order Houses	34,100	17,800
9211	Executive, Legislative, and Other General Government Support	15,900	4,900
5417	Scientific Research and Development Services	12,600	3,900
4251	Wholesale Electronic Markets and Agents and Brokers	10,900	2,800
5182	Data Processing, Hosting, and Related Services	10,400	3,100
5311	Lessors of Real Estate	9,700	3,400
9221	Justice, Public Order, and Safety Activities	8,700	2,900
4881	Support Activities for Air Transportation	6,200	3,400

[a] Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000

Analysis 1: Estimates of Occupational Exposure Burden in King County

Exposure Estimates for All and BIPOC Workers

The 25 most prevalent occupational exposures in King County workplaces are shown in Table 5. Hazardous agents with the highest estimated prevalence of occupational exposure among all employees were cleaning agents (208,500 total workers; 14.8% of total workforce), organic solvents (156,900; 11.1%), biocides (144,200; 10.2%), aliphatic aldehydes (123,800; 8.8%), and engine emissions (123,500; 8.7%). Agents with the highest estimated prevalence of exposure among BIPOC employees were cleaning agents (87,900 BIPOC workers; 17.2% of total BIPOC workforce), biocides (59,300; 11.6%), organic solvents (55,900; 10.9%), aliphatic aldehydes (52,100; 10.2%), and cooking fumes (51,500; 10.1%). We estimated that BIPOC workers were disproportionately exposed to 10 of the 25 most prevalent occupational exposures (i.e., the estimated prevalence of exposure among BIPOC workers was larger than the prevalence of exposure among the total workforce), including for cleaning agents, biocides, aliphatic aldehydes, and cooking fumes.

Table 5. Top 25 most common occupational exposures among all employees in King County, 2019.

	Number of Employees Exposed[a,b] (%)	
CANJEM Chemical Agent Category	**All**	**BIPOC**
Cleaning agents	208,500 (14.8%)	87,900 (17.2%)
Organic solvents[c]	156,900 (11.1%)	55,900 (10.9%)
Biocides	144,200 (10.2%)	59,300 (11.6%)
Aliphatic aldehydes[e]	123,800 (8.8%)	52,100 (10.2%)
Engine emissions	123,500 (8.7%)	41,200 (8.1%)
Cooking fumes	114,100 (8.1%)	51,500 (10.1%)
Formaldehyde[e]	103,300 (7.3%)	44,200 (8.6%)
PAHs from any source	99,600 (7%)	33,800 (6.6%)
Aliphatic alcohols[c,d]	97,100 (6.9%)	38,900 (7.6%)
Ozone	84,700 (6%)	28,700 (5.6%)
Alkanes (C5-C17)	75,200 (5.3%)	25,700 (5%)
Isopropanol[c,d]	75,000 (5.3%)	31,800 (6.2%)
Calcium carbonate	63,100 (4.5%)	18,200 (3.6%)
Mononuclear aromatic hydrocarbons[c]	59,400 (4.2%)	19,700 (3.8%)
Abrasives dust	59,100 (4.2%)	20,700 (4%)
Ammonia	58,500 (4.1%)	24,000 (4.7%)
Alkanes (C18+)	56,800 (4%)	18,100 (3.5%)
Diesel engine emissions	56,400 (4%)	17,900 (3.5%)
Carbon monoxide	54,500 (3.9%)	17,500 (3.4%)
Metallic dust	51,700 (3.7%)	15,500 (3%)
Iron	49,600 (3.5%)	14,800 (2.9%)
Natural gas combustion products	49,400 (3.5%)	22,400 (4.4%)
Wood dust	48,500 (3.4%)	14,300 (2.8%)
Mineral spirits post 1970[c]	47,400 (3.4%)	16,300 (3.2%)
Cellulose	44,500 (3.1%)	16,300 (3.2%)

[a] Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000
[b] Values highlighted in red indicate agent categories in which BIPOC employees are disproportionately exposed.
[c] Aliphatic alcohols, isopropanol, mononuclear aromatic hydrocarbons, and mineral spirits post 1970 are also coded under organic solvents
[d] Isopropanol is also coded under aliphatic alcohols
[e] Formaldehyde is also coded under aliphatic aldehydes

Exposure Estimates by Disaggregated Race/Ethnicity

Table 6 presents the top 25 most prevalent occupational exposures among all employees in King County by disaggregated race and ethnicity groups. Exposures varied by race/ethnicity, with specific hazardous agents affecting certain groups more than others. Thus, prevalence of exposure among BIPOC workers as an aggregated group does not necessarily correspond to prevalence of exposure among the individual race and ethnicity groups, demonstrating the value of disaggregated demographic data to identify heterogeneity of exposure experience across groups. While BIPOC workers were estimated to be disproportionately exposed to 10 of the top 25 most common occupational agents, Table 6 shows that at least one race/ethnicity group within the larger BIPOC category was disproportionately exposed to all 25 of these agents. For example, although only 10.9% of BIPOC workers were estimated to experience workplace exposure to organic solvents (compared to 11.1% of all workers), we estimated that 13.5% of Hispanic workers were exposed. These results also indicate that some racial/ethnic groups were more burdened by the most common occupational exposures than others; notably, Hispanic workers were disproportionately exposed to 22 of the 25 most prevalent agents and American Indian/Alaskan Native workers were disproportionately exposed to 20 of 25.

Results for all 245 agents are provided in **Appendix A, Table A-2** and can be viewed, sorted, and downloaded via an interactive webtool at: https://king-county-haz-waste.shinyapps.io/KingCountyExposureReportSupplement/.

Table 6. Top 25 most common occupational exposures among all employees in King County by disaggregated race and ethnicity groups, 2019.

	Number of Employees Exposed[a,b] (% of Demographic Group)						
CANJEM Chemical Agent Category	**Hispanic**	**AIAN**	**Asian**	**Black**	**Multi-racial**	**NHPI**	**White**
Cleaning agents	25,500 (19.7%)	2,400 (16.8%)	36,000 (15.6%)	17,400 (18.9%)	9,700 (16.6%)	1,700 (14.9%)	120,600 (13.4%)
Organic solvents[c]	17,400 (13.5%)	1,600 (11.6%)	23,000 (10%)	9,300 (10.1%)	6,400 (10.9%)	1,200 (10.6%)	101,100 (11.2%)
Biocides	15,800 (12.2%)	1,500 (10.3%)	25,500 (11%)	12,100 (13.1%)	6,300 (10.8%)	1,200 (10%)	85,000 (9.4%)
Aliphatic aldehydes[e]	17,200 (13.3%)	1,600 (11.2%)	21,000 (9.1%)	8,100 (8.8%)	6,400 (11.1%)	1,000 (8.7%)	71,700 (7.9%)
Engine emissions	12,100 (9.4%)	1,300 (9.2%)	15,400 (6.7%)	8,300 (9%)	5,100 (8.8%)	1,200 (10.7%)	82,300 (9.1%)
Cooking fumes	17,000 (13.1%)	1,500 (10.8%)	19,800 (8.6%)	9,300 (10.1%)	6,100 (10.4%)	1,000 (8.6%)	62,600 (6.9%)
Formaldehyde[e]	14,700 (11.3%)	1,300 (9.5%)	18,000 (7.8%)	6,600 (7.2%)	5,400 (9.3%)	850 (7.4%)	59,100 (6.5%)
PAHs from any source	10,400 (8%)	1,100 (7.9%)	12,800 (5.5%)	6,300 (6.8%)	4,200 (7.2%)	910 (7.9%)	65,800 (7.3%)
Aliphatic alcohols[c,d]	10,300 (8%)	970 (6.8%)	17,100 (7.4%)	7,500 (8.2%)	4,200 (7.2%)	710 (6.2%)	58,200 (6.4%)
Ozone	6,900 (5.3%)	810 (5.7%)	12,500 (5.4%)	5,700 (6.2%)	3,400 (5.8%)	720 (6.3%)	56,000 (6.2%)
Alkanes (C5-C17)	8,800 (6.8%)	860 (6%)	9,400 (4.1%)	4,500 (4.9%)	2,900 (5%)	700 (6.1%)	49,500 (5.5%)
Isopropanol[c,d]	8,500 (6.6%)	780 (5.5%)	14,000 (6.1%)	6,300 (6.8%)	3,300 (5.7%)	590 (5.1%)	43,200 (4.8%)
Calcium carbonate	6,100 (4.7%)	630 (4.4%)	6,300 (2.7%)	3,500 (3.8%)	2,400 (4.1%)	360 (3.1%)	44,900 (5%)
Mononuclear aromatic hydrocarbons[c]	6,900 (5.3%)	670 (4.7%)	7,000 (3.1%)	3,400 (3.7%)	2,300 (3.9%)	530 (4.6%)	39,700 (4.4%)
Abrasives dust	7,000 (5.4%)	650 (4.6%)	7,700 (3.3%)	3,800 (4.1%)	2,300 (3.9%)	480 (4.1%)	38,400 (4.3%)
Ammonia	7,300 (5.7%)	660 (4.7%)	10,200 (4.4%)	4,100 (4.5%)	2,600 (4.5%)	440 (3.8%)	34,600 (3.8%)
Alkanes (C18+)	5,600 (4.3%)	620 (4.4%)	7,000 (3.1%)	3,100 (3.4%)	2,200 (3.7%)	500 (4.4%)	38,700 (4.3%)
Diesel engine emissions	6,100 (4.7%)	720 (5.1%)	5,200 (2.3%)	4,000 (4.4%)	2,300 (4%)	690 (6%)	38,400 (4.3%)
Carbon monoxide	5,900 (4.6%)	640 (4.5%)	6,000 (2.6%)	3,300 (3.6%)	2,200 (3.8%)	510 (4.4%)	36,900 (4.1%)
Metallic dust	4,500 (3.5%)	500 (3.6%)	6,400 (2.8%)	2,500 (2.8%)	2,000 (3.4%)	410 (3.6%)	36,200 (4%)
Iron	4,700 (3.6%)	520 (3.7%)	5,700 (2.5%)	2,500 (2.7%)	1,800 (3.2%)	380 (3.3%)	34,800 (3.9%)
Natural gas combustion products	7,700 (5.9%)	670 (4.7%)	8,900 (3.8%)	3,500 (3.8%)	2,700 (4.6%)	420 (3.6%)	27,000 (3%)
Wood dust	6,300 (4.9%)	650 (4.6%)	3,700 (1.6%)	2,400 (2.6%)	1,900 (3.3%)	430 (3.7%)	34,200 (3.8%)
Mineral spirits post 1970[c]	5,500 (4.2%)	510 (3.6%)	6,300 (2.7%)	2,800 (3%)	1,800 (3.1%)	420 (3.6%)	31,000 (3.4%)
Cellulose	3,500 (2.7%)	360 (2.6%)	8,600 (3.7%)	2,400 (2.6%)	1,800 (3.1%)	350 (3.1%)	28,200 (3.1%)

[a] Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000
[b] Values highlighted in red indicate agents in which employees of the demographic group are disproportionately exposed.
[c] Aliphatic alcohols, isopropanol, mononuclear aromatic hydrocarbons, and mineral spirits post 1970 are also coded under organic solvents
[d] Isopropanol is also coded under aliphatic alcohols
[e] Formaldehyde is also coded under aliphatic aldehydes

Online Interactive Tool Allows for Further Examination of Hazardous Exposure of Industries by Agent or Agents by Industry

Merging occupational exposure and worker demographic data by industry provides a rich matrix of information that can be explored in many ways to inform and prioritize pollution prevention or occupational health actions. To facilitate access to this information, we developed an interactive report to compliment this technical report, which allows for additional exploration of these exposure estimates: https://king-county-haz-waste.shinyapps.io/KingCountyExposureReportSupplement/

Within the interactive report, one can examine, for example, which hazardous exposures were most prevalent within a specific industry, which industries contribute the most occupational exposure to a specific agent, or either scenario while focusing on a specific race/ethnicity group. Table 7 and 8 demonstrate two examples of ways to use the interactive report. In Table 7, we present the top five industries with the greatest exposures to cleaning agents. In Table 8, we present the top five most common exposures in the industry group Services to Buildings and Dwellings (NAICS: 5617).

Table 1. Top five industries with the highest number of estimated workers exposed to cleaning agents in King County, 2019.

	Number of workers exposed[a]								
Industry	**All**	**BIPOC**	**Hispanic**	**AIAN**	**Asian**	**Black**	**NHPI**	**Multi-racial**	**White**
7225 - Restaurants and Other Eating Places	53,000	24,100	8,900	770	9,300	3,300	400	3,100	28,800
6221 - General Medical and Surgical Hospitals	24,000	9,200	1,500	150	4,900	1,900	170	880	14,900
5617 - Services to Buildings and Dwellings	11,300	5,600	2,800	200	1,200	1,200	100	420	5,700
6233 - Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	8,900	5,300	1,000	90	2,100	1,800	120	320	3,700
8121 - Personal Care Services	8,300	4,100	730	100	2,600	300	30	440	4,300

[a]Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000

Table 2. Top five most common exposures among workers in NAICS 5617 – Services to Buildings and Dwellings in King County, 2019.

	Number of workers exposed[a]								
CANJEM Chemical Agent Category	**All**	**BIPOC**	**Hispanic**	**AIAN**	**Asian**	**Black**	**NHPI**	**Multi-racial**	**White**
Cleaning agents	11,300	5,600	2,800	200	1,200	1,200	100	420	5,700
Organic solvents	8,700	4,300	2,200	150	930	940	80	330	4,400
Ammonia	8,200	4,000	2,100	140	880	890	80	310	4,100
Aliphatic alcohols	7,900	3,900	2,000	140	850	860	70	300	4,000
Isopropanol	7,700	3,800	1,900	140	830	840	70	290	3,900

[a]Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000

Analysis 2: Estimates of Disproportionate Exposure by Race/Ethnicity

In Analysis 2, we attempted to quantify the extent of disproportionate exposure burden experienced by workers of color in King County. Table 9 shows the 25 occupational agents that we estimated most disproportionately burdened BIPOC employees in King County; that is, the agents with the highest number of excess BIPOC workers exposed above what we would expect if race and ethnicity were evenly distributed across all industries in King County. The estimates are provided as both number and percent excess exposed employees, and by disaggregated race and ethnicity groups.

The top five agents in terms of excess BIPOC workers exposed were cleaning agents (12,400 more BIPOC workers exposed than expected), cooking fumes (10,200), aliphatic aldehydes (7,300), biocides (7,100), and formaldehyde (6,800) (Table 9). From a proportional overrepresentation perspective, the top five agents with the greatest percent excess exposure for BIPOC employees were nitrates (73.1%), phosgene (44.9%), animal/vegetable glues (37.0%), leather dust (33.8%), and hair dust (32.7%).

As noted above, patterns of exposure tended to vary across individual race and ethnicity groups. Table 10 shows the agents that most disproportionately impacted each race/ethnicity group. It is particularly notable how different the exposure patterns of non-Hispanic white workers were from workers in BIPOC race/ethnicity categories, which is consistent with King County industries being highly segregated by race and ethnicity. The BIPOC categories shared significant overlap in the agents contributing the most disproportionate exposure, especially cleaning agents, cooking fumes, aliphatic aldehydes, and biocides. However, none of these agents were in the top 15 most disproportionate exposures of non-Hispanic white workers, and many of the agents contributing the most excess exposure among white workers were not present in the top 15 for BIPOC groups (e.g., calcium carbonate, metallic dust, iron).

Figure 2 shows the number of agents for which each of the race/ethnicity groups was disproportionately exposed; that is, we determined how many of the 245 evaluated chemicals for which each race/ethnicity group experienced at least one excess exposure. We found that non-Hispanic white workers had the most instances of excess exposure (160 agents), followed by Hispanic (149 agents) and American Indian/Alaskan Native (118 agents) workers.

Estimates of excess exposure for all 245 agents are provided in **Appendix A, Table A-3** by disaggregated race/ethnicity and can be viewed, sorted, and downloaded via an interactive webtool at:
https://king-county-haz-waste.shinyapps.io/KingCountyExposureReportSupplement/.

Table 9. Top 25 agents with the highest estimated number of excess BIPOC employees exposed in King County by disaggregated race and ethnicity groups, 2019.

	# Excess Employees Exposed (% of Demographic Group Disproportionately Exposed)[a,b]							
CANJEM Chemical Agent Category	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
Cleaning agents	12,400 (16.5%)	6,400 (33.8%)	280 (13.6%)	1,900 (5.7%)	3,800 (27.9%)	1,100 (12.8%)	20 (1.2%)	-12,400 (-9.3%)
Cooking fumes	10,200 (24.8%)	6,600 (62.9%)	390 (33.8%)	1,200 (6.5%)	1,900 (24.9%)	1,400 (29.4%)	70 (7.1%)	-10,200 (-14.1%)
Aliphatic aldehydes*	7,300 (16.4%)	5,900 (51.6%)	350 (28.3%)	800 (4%)	60 (0.8%)	1,300 (26.5%)	-10 (-0.5%)	-7,300 (-9.3%)
Biocides	7,100 (13.6%)	2,600 (19.7%)	10 (1%)	1,900 (8.3%)	2,700 (28.2%)	360 (6.1%)	-20 (-1.6%)	-7,100 (-7.7%)
Formaldehyde*	6,800 (18.3%)	5,200 (55.3%)	310 (30%)	1,200 (7.1%)	-120 (-1.7%)	1200 (27.3%)	10 (1.4%)	-6,800 (-10.3%)
Isopropanol**	4,700 (17.3%)	1,600 (23.9%)	30 (3.8%)	1,700 (14.1%)	1,400 (28.7%)	210 (6.8%)	-20 (-3.8%)	-4,700 (-9.8%)
Natural gas combustion products	4,500 (25.4%)	3,100 (69.3%)	170 (34.7%)	820 (10.1%)	320 (10.1%)	650 (32.3%)	20 (4%)	-4,500 (-14.4%)
Ashes	3,900 (24.4%)	3,100 (77.5%)	170 (37.9%)	80 (1.2%)	540 (18.7%)	510 (28.1%)	0 (0.9%)	-3,900 (-13.8%)
Aliphatic alcohols**	3,800 (10.8%)	1,400 (15.9%)	0 (-0.3%)	1,300 (8.2%)	1,200 (19.1%)	180 (4.5%)	-80 (-10%)	-3,800 (-6.1%)
Ammonia	2,800 (13.2%)	2,000 (36.5%)	80 (12.8%)	620 (6.5%)	290 (7.6%)	210 (8.6%)	-40 (-8.6%)	-2,800 (-7.5%)
Hypochlorites	2,700 (20.6%)	1,300 (37.9%)	50 (12.4%)	360 (6%)	1,100 (44.9%)	180 (11.7%)	10 (4.7%)	-2,700 (-11.6%)
Flour dust	1,700 (21.6%)	1,200 (59.6%)	80 (38%)	130 (3.7%)	250 (17.3%)	240 (26.2%)	30 (18.3%)	-1,700 (-12.2%)
Starch dust	1,600 (26.1%)	950 (60.3%)	50 (29.9%)	390 (13.8%)	210 (18.4%)	170 (24.2%)	30 (19.8%)	-1,600 (-14.8%)
Sugar dust	1,600 (24.4%)	970 (59.2%)	60 (35.5%)	260 (9%)	240 (20.4%)	190 (26.4%)	30 (19.9%)	-1,600 (-13.8%)
Cotton dust	1,600 (20.5%)	300 (15.1%)	-10 (-4.2%)	760 (21.1%)	590 (41.2%)	20 (2.2%)	30 (16.4%)	-1,600 (-11.6%)
Cosmetic talc	1,600 (16.9%)	-220 (-9.5%)	-40 (-14.9%)	910 (21.6%)	920 (55.1%)	10 (0.9%)	-20 (-11.5%)	-1,600 (-9.6%)
Fabric dust	1,600 (13.5%)	590 (19.7%)	10 (2.5%)	390 (7.2%)	600 (28.2%)	80 (6%)	40 (16.8%)	-1,600 (-7.6%)
Propellant gases	1,500 (19.6%)	420 (22.1%)	20 (11.4%)	980 (29.1%)	50 (3.4%)	110 (13.5%)	-30 (-19.5%)	-1,500 (-11.1%)
Hair dust	910 (32.7%)	-30 (-4.1%)	10 (13.8%)	1,100 (88.1%)	-210 (-42.4%)	90 (27.4%)	-30 (-52.4%)	-910 (-18.5%)
Bleaches	870 (22.1%)	120 (11.6%)	10 (6.9%)	550 (31.3%)	180 (25.1%)	50 (11.2%)	-10 (-9.9%)	-870 (-12.5%)
Ethanol**	860 (17.7%)	10 (0.6%)	0 (0.1%)	980 (44.5%)	-170 (-19.4%)	90 (17%)	-30 (-28.7%)	-860 (-10%)
Hydrogen peroxide	600 (17.2%)	-30 (-3.9%)	0 (-4.3%)	780 (49.9%)	-160 (-26.1%)	50 (13.9%)	-30 (-40%)	-600 (-9.8%)
Fluorocarbons	540 (17.7%)	-70 (-9.1%)	0 (1.9%)	780 (56.6%)	-200 (-36.8%)	50 (15.1%)	-20 (-26.2%)	-540 (-10%)
Vinyl chloride	530 (25.6%)	10 (2.5%)	10 (9.2%)	620 (66.1%)	-120 (-33.3%)	40 (15.7%)	-10 (-18.1%)	-530 (-14.5%)
Organic dyes and pigments	530 (9.4%)	870 (61.4%)	40 (25.8%)	-30 (-1.4%)	-250 (-24.7%)	0 (0.1%)	10 (7.9%)	-530 (-5.3%)

[a] Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000
[b] Values highlighted in red indicate agents in which employees of the demographic group are disproportionately exposed.
* Formaldehyde is also coded under aliphatic aldehydes
**Isopropanol and ethanol are also coded under aliphatic alcohols

Table 10. Top 15 agents with the greatest number of excess workers exposed by disaggregated race/ethnicity groups.

	# Excess Workers Exposed (% of Group Disproportionately Exposed)[a]							
Agent Rank	BIPOC	Hispanic	AIAN	Asian	Black	Multiracial	NHPI	White
Agent 1	Cleaning agents 12400 (16.5%)	Cooking fumes 6600 (62.9%)	Cooking fumes 390 (33.8%)	Biocides 1900 (8.3%)	Cleaning agents 3800 (27.9%)	Cooking fumes 1400 (29.4%)	Diesel engine emissions 240 (50.9%)	Calcium carbonate 4600 (11.5%)
Agent 2	Cooking fumes 10200 (24.8%)	Cleaning agents 6400 (33.8%)	Aliphatic aldehydes 350 (28.3%)	Cleaning agents 1900 (5.7%)	Biocides 2700 (28.2%)	Aliphatic aldehydes 1300 (26.5%)	Engine emissions 230 (22.5%)	Engine emissions 3400 (4.4%)
Agent 3	Aliphatic aldehydes 7300 (16.4%)	Aliphatic aldehydes 5900 (51.6%)	Formaldehyde 310 (30.0%)	Isopropanol 1700 (14.1%)	Cooking fumes 1900 (24.9%)	Formaldehyde 1200 (27.3%)	Propane engine emissions 110 (80.8%)	Wood dust 3200 (10.4%)
Agent 4	Biocides 7100 (13.6%)	Formaldehyde 5200 (55.3%)	Cleaning agents 280 (13.6%)	Cellulose 1300 (17.7%)	Isopropanol 1400 (28.7%)	Cleaning agents 1100 (12.8%)	PAHs from any source 100 (11.7%)	Metallic dust 3200 (9.6%)
Agent 5	Formaldehyde 6800 (18.3%)	Ashes 3100 (77.5%)	Ashes 170 (37.9%)	Aliphatic alcohols 1300 (8.2%)	Aliphatic alcohols 1200 (19.1%)	Natural gas combustion products 660 (32.3%)	Alkanes (C5-C17) 90 (14.5%)	Iron 3100 (9.8%)
Agent 6	Isopropanol 4700 (17.3%)	Natural gas combustion products 3100 (69.3%)	Natural gas combustion products 170 (34.7%)	Formaldehyde 1200 (7.1%)	Hypochlorites 1100 (44.9%)	Ashes 510 (28.1%)	Cooking fumes 70 (7.1%)	Concrete dust 3000 (17.5%)
Agent 7	Natural gas combustion products 4500 (25.4%)	Organic solvents 3100 (21.3%)	Wood dust 160 (33.1%)	Cooking fumes 1200 (6.5%)	Cosmetic talc 920 (55.1%)	Biocides 360 (6.1%)	Carbon monoxide 60 (14.5%)	Inorganic insulation dust 2900 (16.1%)
Agent 8	Ashes 3900 (24.4%)	Biocides 2600 (19.7%)	Diesel engine emissions 160 (28.2%)	Hair dust 1100 (88.1%)	Fabric dust 600 (28.2%)	Flour dust 240 (26.2%)	Diesel oil 50 (97.1%)	Calcium sulphate 2900 (13.1%)
Agent 9	Aliphatic alcohols 3800 (10.8%)	Ammonia 2000 (36.5%)	Crystalline silica 120 (32.1%)	Ethanol 980 (44.5%)	Cotton dust 590 (41.2%)	Ammonia 210 (8.6%)	Lubricating oils and greases 50 (29.9%)	Diesel engine emissions 2500 (6.8%)
Agent 10	Ammonia 2800 (13.2%)	Wood dust 1900 (42.4%)	PAHs from any source 120 (12.1%)	Propellant gases 980 (29.1%)	Ashes 540 (18.7%)	Isopropanol 210 (6.8%)	Lead 50 (16.4%)	Alkanes (C18+) 2500 (6.8%)
Agent 11	Hypochlorites 2700 (20.6%)	Alkanes (C5-C17) 1900 (27.4%)	Concrete dust 100 (36.5%)	Cosmetic talc 910 (21.6%)	Diesel engine emissions 350 (9.6%)	Sugar dust 190 (26.4%)	Mononuclear aromatic hydrocarbons 50 (10.3%)	Mineral wool fibres 2300 (17.3%)
Agent 12	Flour dust 1700 (21.6%)	Crystalline silica 1800 (52.0%)	Calcium sulphate 100 (29.4%)	Natural gas combustion products 820 (10.1%)	Natural gas combustion products 320 (10.1%)	Hypochlorites 180 (11.7%)	Hydraulic fluid 40 (67.6%)	Mild steel dust 2200 (11.8%)
Agent 13	Starch dust 1600 (26.1%)	Abrasives dust 1600 (29.9%)	Alkanes (C5-C17) 100 (13.6%)	Aliphatic aldehydes 800 (4.0%)	Sodium carbonate 300 (51.6%)	Aliphatic alcohols 180 (4.5%)	Plastics pyrolysis fumes 40 (42.7%)	Carbon monoxide 2200 (6.2%)
Agent 14	Sugar dust 1600 (24.4%)	Isopropanol 1600 (23.9%)	Carbon monoxide 90 (16.7%)	Fluorocarbons 780 (56.6%)	Ammonia 290 (7.6%)	Starch dust 170 (24.2%)	Inorganic pigments 40 (17.8%)	PAHs from any source 2200 (3.5%)
Agent 15	Cotton dust 1600 (20.5%)	Inorganic pigments 1500 (64.2%)	Flour dust 80 (38.0%)	Hydrogen peroxide 780 (49.9%)	Engine emissions 270 (3.4%)	Propellant gases 110 (13.5%)	Fabric dust 40 (16.8%)	Aluminum 2000 (7.5%)

[a] Employee counts are rounded to the nearest ten if <1000, and to the nearest hundred if >1000.

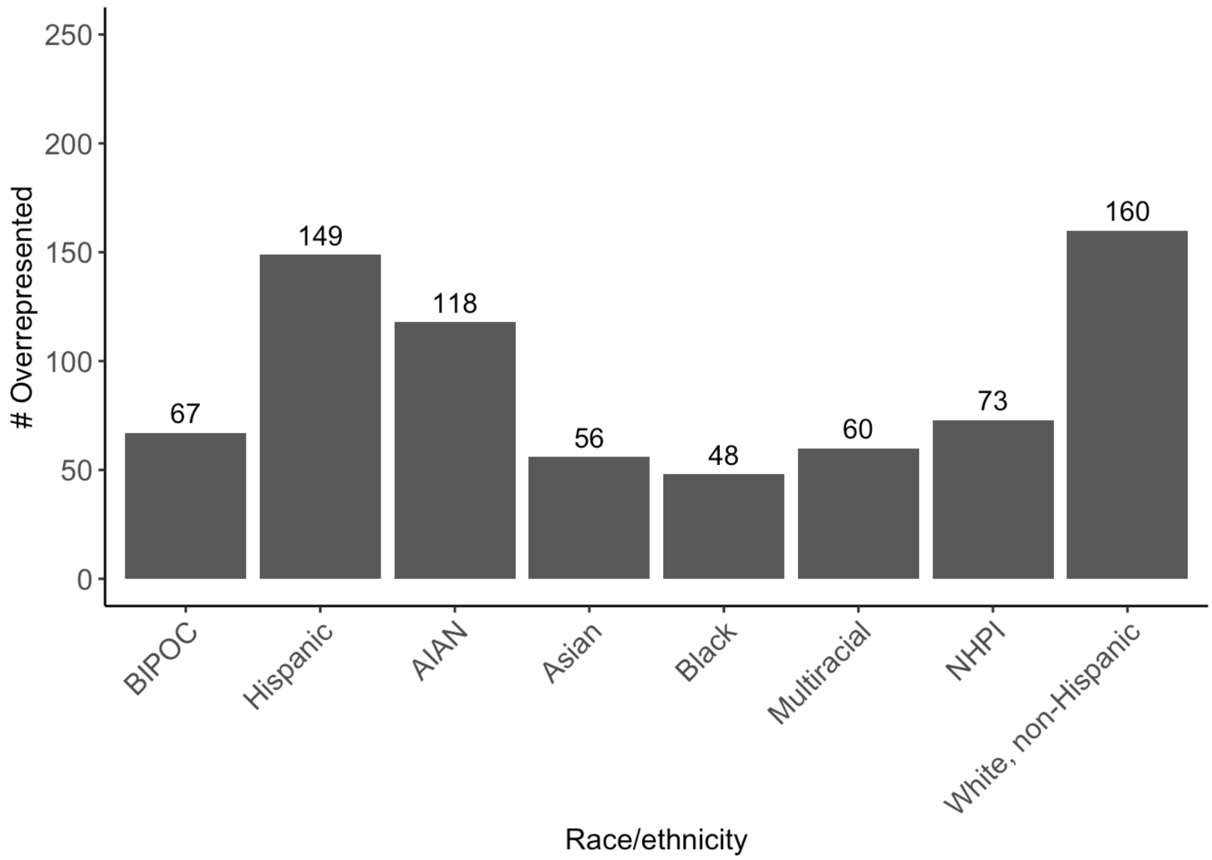

Figure 2. Number of agents for which each race/ethnicity group is disproportionately exposed.

Analysis 3: Time Trend Analysis

Table 11 shows how King County employment by race/ethnicity changed from 2009 to 2019. The overall workforce grew from 1.1 million to 1.4 million workers, an increase of about 25%. The growth varied, however, across race/ethnicity groups with a general trend toward an increasingly diverse King County workforce. For example, while the non-Hispanic white workforce only grew by 11%, the BIPOC workforce grew by 59%.

Table 12 shows how King County employment by industry sector changed from 2009 to 2019. All sectors demonstrated growth, except for the Finance and Insurance (NAICS: 22) sector, which decreased by 8%. Many of the industry sectors that experienced the most growth were white collar industries in which we generally expect less exposure to hazardous materials, including the Professional, Scientific, and Technical Services (NAICS: 54; grew by 43%) and Information (NAICS: 51; 43%) sectors. However, several industry sectors in which occupational exposures are common also increased over this period, including the Accommodation and Food Services (NAICS: 72; 35%), Construction (NAICS: 23; 33%), Health Care and Social Assistance (NAICS: 62; 32%), and Administrative and Support and Waste Management and Remediation Services (NAICS: 56; 24%) sectors.

Table 11. Summary of changes in average King County employment estimates by race/ethnicity from 2009 to 2019.

Category	Race/Ethnicity[a]	2009 Employee Count[b] (%)	2019 Employee Count[b] (%)	Percent change (%)
Race	American Indian and Alaska Native	10,400 (0.9)	14,200 (1.0)	36.3
	Asian	147,400 (13.0)	230,700 (16.3)	56.4
	Black or African American	61,200 (5.4)	92,200 (6.5)	50.7
	Multiracial	36,100 (3.2)	58,100 (4.1)	60.9
	Native Hawaiian or Other Pacific Islander	7,800 (0.7)	11,500 (0.8)	47.3
	Non-Hispanic White	810,700 (71.6)	902,300 (63.8)	11.3
	Hispanic White	59,100 (5.2)	104,700 (7.4)	77.2
Ethnicity	Hispanic or Latino	74,100 (6.5)	129,400 (9.2)	74.7
	Not Hispanic or Latino	1,058,600 (93.5)	1,284,100 (90.8)	21.3
BIPOC[c]		322,000 (28.4)	511,300 (36.2)	58.8
Total		1,132,700 (100.0)	1,413,500 (100.0)	24.8

Source: U.S. Census Bureau Quarterly Workforce Indicators, annual average over four quarters in 2009 and 2019.
[a] Except for the Hispanic white and non-Hispanic white race/ethnicity groups, race categories include persons of any ethnicity. Persons of Hispanic or Latino ethnicity are of any race and are also counted in their preferred race category.
[b] Employee counts are rounded to the nearest hundred
[c] Black, Indigenous, and People of Color (BIPOC) category includes all workers except those identifying as non-Hispanic white.

Table 12. Changes to average King County employment estimates by industry sector from 2009 to 2019.

NAICS Sector Code[a]	Industry Sector	2009 Employee Count[b]	2019 Employee Count[b]	Percent change (%)
11	Agriculture, Forestry, Fishing and Hunting	2,800	2,900	2.2
21	Mining, Quarrying, and Oil and Gas Extraction	420	450	5.4
22	Utilities	5,000	5,600	12.2
23	Construction	56,500	75,000	32.7
31-33	Manufacturing	99,700	103,300	3.7
42	Wholesale Trade	61,600	66,400	7.7
44-45	Retail Trade	111,400	151,500	35.9
48-49	Transportation and Warehousing	51,500	65,100	26.3
51	Information	88,200	125,700	42.5
52	Finance and Insurance	47,600	44,100	-7.5
53	Real Estate and Rental and Leasing	25,600	30,600	19.5
54	Professional, Scientific, and Technical Services	93,500	133,400	42.7
55	Management of Companies and Enterprises	27,500	35,500	28.8
56	Administrative and Support and Waste Management and Remediation Services	63,600	79,000	24.3
61	Educational Services	82,400	97,800	18.6
62	Health Care and Social Assistance	128,800	170,100	32.1
71	Arts, Entertainment, and Recreation	24,600	31,500	28.1
72	Accommodation and Food Services	84,900	114,600	35.0
81	Other Services (except Public Administration)	45,500	49,000	7.7
92	Public Administration	31,300	32,000	2.1
0000	All Sectors	1,132,700	1,413,500	24.8

Source: U.S. Census Bureau Quarterly Workforce Indicators, annual average over four quarters in 2009 and 2019.
[a] NAICS: North American Industrial Classification System
[b] Employee counts are rounded to the nearest ten if <1000, and to the nearest hundred if >1000.

The next series of figures present how the number, prevalence, and distribution of King County workers exposed to the five most common hazardous exposures—cleaning agents, organic solvents, biocides, aliphatic aldehydes, and engine emissions—have changed between 2009 to 2019. Figure 3 presents the number of all workers exposed over the 10-year period. This shows that the absolute number of workers exposed to these agents has steadily increased, which is expected given the overall growth of the King County workforce.

Figure 4 shows trends in the prevalence of exposure by all, BIPOC, and non-Hispanic white workers to the five most common exposures, which appear to have been very stable over this period. For all five agents, the demographic group with the highest prevalence of exposure remained so throughout the years examined: BIPOC workers had the highest likelihood of exposure to cleaning agents, biocides, and aliphatic aldehydes, while non-Hispanic white had a higher exposure prevalence for engine emissions and organic solvents.

Figure 5 shows trends in the percent of excess exposure by BIPOC and non-Hispanic white workers from 2009 to 2019. These results indicate that the proportional overrepresentation of exposure among BIPOC workers has decreased in this period for some of the most common exposures, including cleaning agents, aliphatic aldehydes, and biocides.

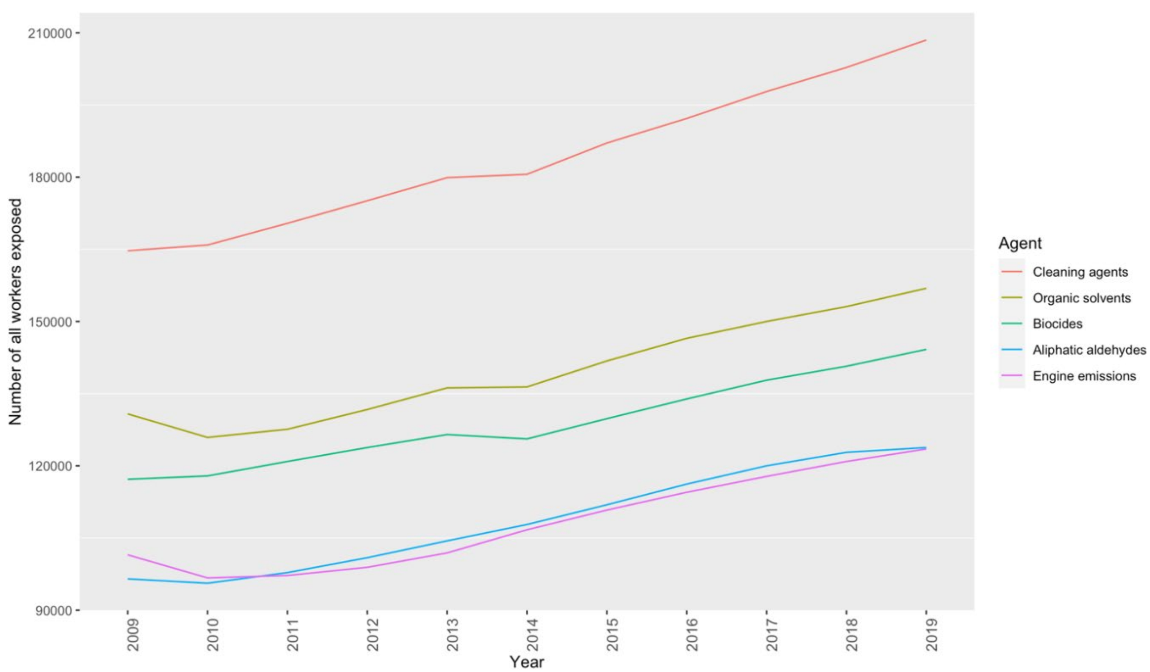

Figure 3. Number of all King County workers exposed to cleaning agents, organic solvents, biocides, aliphatic aldehydes, and engine emissions between 2009 and 2019.

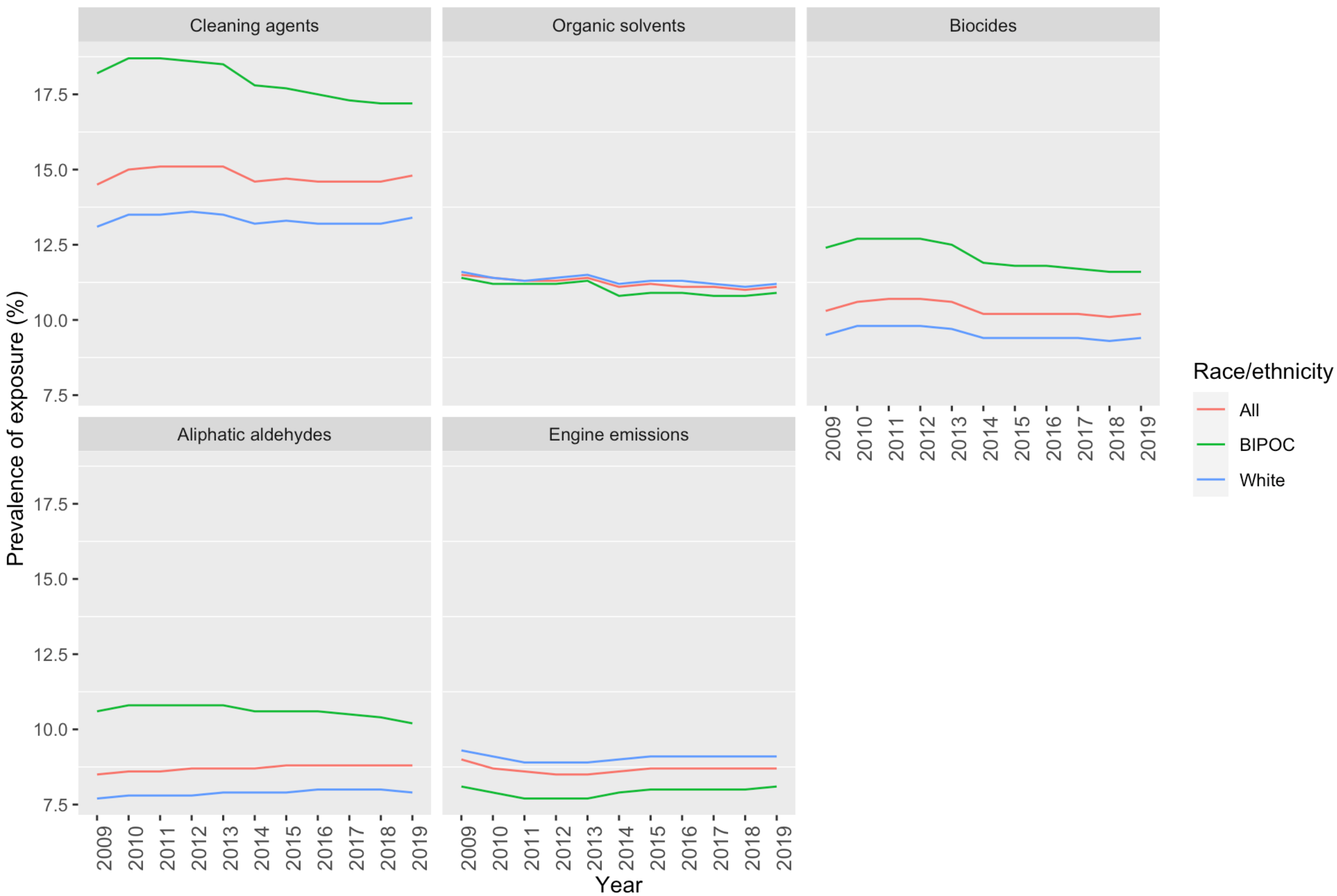

Figure 4. Prevalence of King County workers exposed to cleaning agents, organic solvents, biocides, aliphatic aldehydes, and engine emissions by race/ethnicity over time, 2009 to 2019.

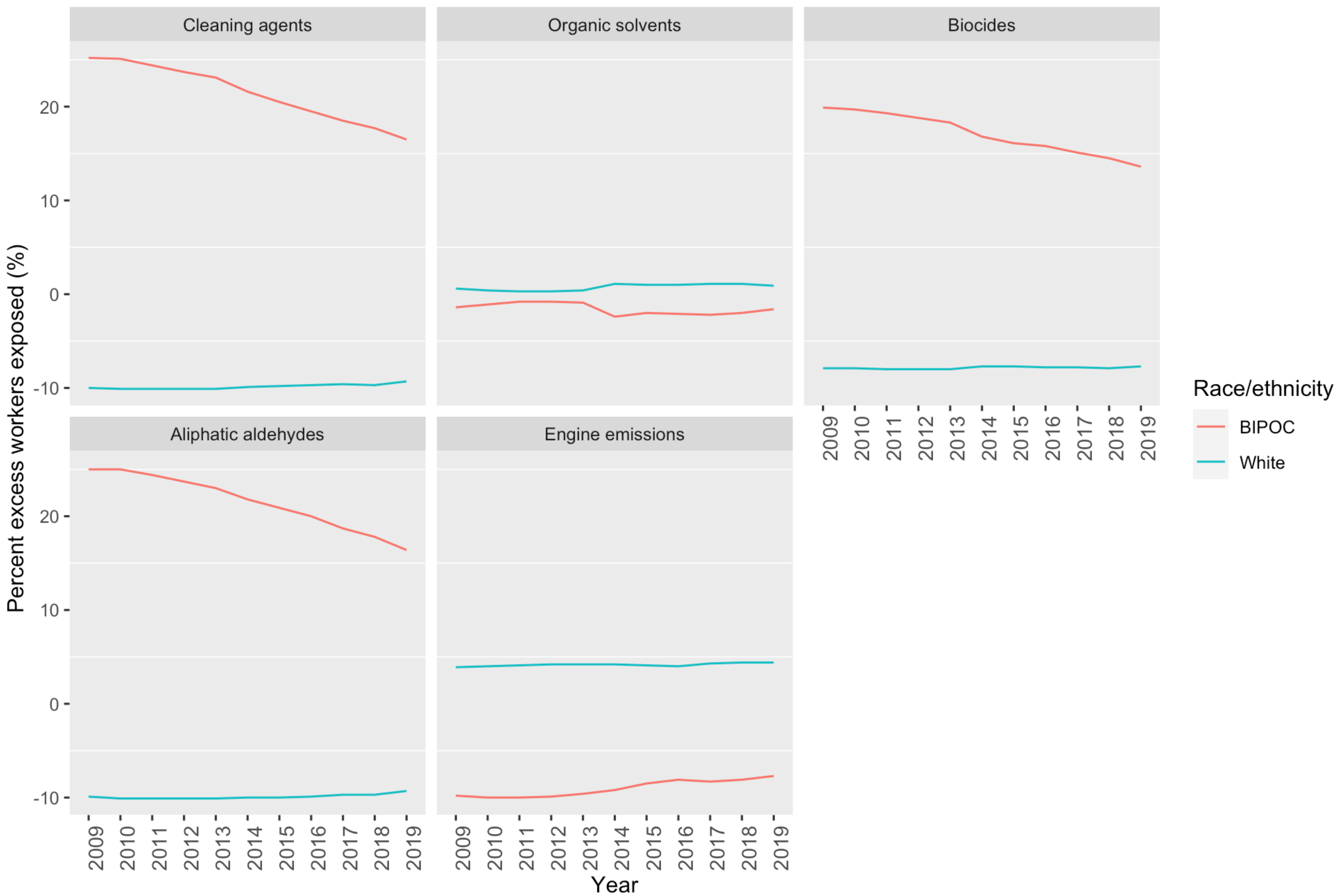

Figure 5. Percent excess workers exposed in King County to cleaning agents, organic solvents, biocides, aliphatic aldehydes, and engine emissions by race/ethnicity over time, 2009 to 2019.

Analysis 4: Development of Exposure Prevention Index to Prioritize Industries

In Analysis 4, we developed an EPI to identify industries to prioritize for efforts to reduce workplace exposures to hazardous materials. As explained above, the EPI ranks industries for each agent based on a combination of likelihood of exposure (i.e., probability of exposure) and the extent of exposure (i.e., estimated number of exposed workers).

Tables 13–15 present King County industries with the highest exposure burdens to the three most common exposures: cleaning agents, biocides, and organic solvents, respectively. These tables also include information on whether industries are overrepresented by BIPOC employees or are considered low wage, which can provide further context by which to consider when prioritizing industries for pollution prevention efforts from an equity perspective. It is notable that two industry groups are among the top five industries in terms of highest EPI rank for all three agents, suggesting these workforces might be particularly worthy of attention: Personal Care Services (NAICS: 8121), which includes nail and beauty salons; and Services to Buildings and Dwellings (NAICS: 5617), which includes janitorial, pest control, and landscaping services.

Results for all 245 agents can be viewed, sorted, and downloaded via an interactive report at: https://king-county-haz-waste.shinyapps.io/KingCountyExposureReportSupplement/

Table 13. Top 20 industries with highest burdens of occupational exposure to cleaning agents in King County, based on the Exposure Prevention Index (EPI).

Industry group	EPI rank	EPI score	Exposure likelihood rank	Extent of exposure rank	Overrepresented by BIPOC employees	Low-wage industry
5617 - Services to Buildings and Dwellings	1	2.5	2	3	yes	yes
8121 - Personal Care Services	2	3	1	5	yes	yes
6233 - Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	3	3.5	3	4	yes	yes
7225 - Restaurants and Other Eating Places	4	4	7	1	yes	yes
6221 - General Medical and Surgical Hospitals	5	7.5	13	2	yes	no
6244 - Child Day Care Services	6	9.5	9	10	yes	yes
6216 - Home Health Care Services	7	11	4	18	yes	no
8141 - Private Households	7	11	6	16	no	no
7211 - Traveler Accommodation	9	13	18	8	yes	yes
5313 - Activities Related to Real Estate	10	13.5	16	11	no	no
6232 - Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities	10	13.5	5	22	yes	yes
4451 - Grocery Stores	12	14	22	6	yes	yes
6241 - Individual and Family Services	13	15.5	24	7	yes	yes
7224 - Drinking Places (Alcoholic Beverages)	14	16	8	24	no	yes
6214 - Outpatient Care Centers	15	17	21	13	yes	no
7223 - Special Food Services	15	17	19	15	yes	yes
4461 - Health and Personal Care Stores	17	18	17	19	yes	no
5191 - Other Information Services	18	21.5	31	12	yes	no
6211 - Offices of Physicians	19	22	30	14	no	no
6212 - Offices of Dentists	20	22.5	25	20	no	no

Table 14. Top 20 industries with highest burdens of occupational exposure to biocides in King County, based on the Exposure Prevention Index (EPI).

Industry group	EPI rank	EPI	Exposure likelihood rank	Extent of exposure rank	Overrepresented by BIPOC employees	Low-wage industry
8121 - Personal Care Services	1	2.5	1	4	yes	yes
6221 - General Medical and Surgical Hospitals	2	3.5	6	1	yes	no
6233 - Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	3	5.5	5	6	yes	yes
5617 - Services to Buildings and Dwellings	4	7	9	5	yes	yes
6212 - Offices of Dentists	5	7.5	7	8	no	no
6211 - Offices of Physicians	6	8	13	3	no	no
6214 - Outpatient Care Centers	7	8.5	10	7	yes	no
6216 - Home Health Care Services	7	8.5	2	15	yes	no
6244 - Child Day Care Services	9	11	11	11	yes	yes
6232 - Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities	10	11.5	4	19	yes	yes
7225 - Restaurants and Other Eating Places	11	12.5	23	2	yes	yes
7211 - Traveler Accommodation	12	14	18	10	yes	yes
8141 - Private Households	13	15.5	14	17	no	no
4451 - Grocery Stores	14	16.5	24	9	yes	yes
5313 - Activities Related to Real Estate	15	17	20	14	no	no
6213 - Offices of Other Health Practitioners	16	19	22	16	no	yes
3231 - Printing and Related Support Activities	17	20	16	24	yes	no
4452 - Specialty Food Stores	18	21.5	15	28	yes	yes
3116 - Animal Slaughtering and Processing	19	23	12	34	yes	no
3364 - Aerospace Product and Parts Manufacturing	20	24	36	12	no	no

Table 15. Top 20 industries with highest burdens of occupational exposure to <u>organic solvents</u> in King County, based on the Exposure Prevention Index (EPI).

Industry group	EPI rank	EPI	Exposure likelihood rank	Extent of exposure rank	Overrepresented by BIPOC employees	Low-wage industry
2383 - Building Finishing Contractors	1	2	2	2	yes	no
3364 - Aerospace Product and Parts Manufacturing	2	7.5	14	1	no	no
5617 - Services to Buildings and Dwellings	3	8	12	4	yes	yes
8111 - Automotive Repair and Maintenance	4	8.5	6	11	no	no
8121 - Personal Care Services	4	8.5	9	8	yes	yes
2361 - Residential Building Construction	6	11	13	9	no	no
3231 - Printing and Related Support Activities	7	11.5	5	18	yes	no
5191 - Other Information Services	8	14	23	5	yes	no
2382 - Building Equipment Contractors	9	17	27	7	no	no
8123 - Drycleaning and Laundry Services	10	21	7	35	yes	yes
4411 - Automobile Dealers	11	22	25	19	no	no
7211 - Traveler Accommodation	11	22	32	12	yes	yes
4461 - Health and Personal Care Stores	13	22.5	23	22	yes	no
3345 - Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	14	24.5	22	27	yes	no
2381 - Foundation, Structure, and Building Exterior Contractors	15	25	30	20	yes	no
2362 - Nonresidential Building Construction	16	25.5	37	14	no	no
6213 - Offices of Other Health Practitioners	16	25.5	35	16	no	yes
4483 - Jewelry, Luggage, and Leather Goods Stores	18	26.5	8	45	yes	no
6111 - Elementary and Secondary Schools	19	28	53	3	no	no
6233 - Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	20	28.5	42	15	yes	yes

Additional Analyses and Tables

High Exposures

Estimates of high exposures are presented in **Appendix B: Estimates of High Exposure** and estimates for all 245 agents can be viewed, sorted, and downloaded via an interactive report at: https://king-county-haz-waste.shinyapps.io/KingCountyExposureReportSupplement/

Sensitivity Analysis

Results of the sensitivity analysis are presented in **Appendix C: Sensitivity Analysis**. Overall, applying more stringent criteria lowered the overall exposure estimates, as expected, but had only a minor effect on rankings of the agent categories in terms of most prevalent exposures in King County, especially among the most common occupational hazards.

Sensitivity analysis results for all 245 agents can be viewed, sorted, and downloaded via an interactive report at:
https://king-county-haz-waste.shinyapps.io/KingCountyExposureReportSupplement/

Discussion

Main Findings

Many King County workers are exposed to hazardous materials on the job

The main objective of this study was to characterize the extent of exposure occurring in King County workplace settings, an important venue for hazardous exposures that may be amenable to intervention from the Haz Waste Program's technical assistance to small businesses. We estimated that hundreds of thousands of workers in King County are exposed to hazardous materials on the job, and that the most common exposures were to cleaning agents (208,500 total workers exposed; 14.8% of the total workforce exposed), organic solvents (156,900; 11.1%), biocides (144,200; 10.2%), aliphatic aldehydes (123,810; 8.8%), and engine emissions (123,500; 8.7%).

Not surprisingly, the most common exposures identified in our analysis are groups, or categories, of agents (rather than individual chemicals) and are commonly used in wide range of work settings and tasks (rather than specific industries or industrial processes), which likely contributes to higher overall estimates of workers exposed. For 20 of the CANJEM agent categories, we estimated that at least 50,000 workers are exposed across King County, and we estimated that at least 20,000 workers are exposed to 58 individual agent categories. However, many of the agent categories included in the CANJEM database are relatively rare exposures in King County; for example, we estimated that less than 14,500 of King County workers (approximately 1% of the total workforce) are exposed to 156 of the 245 agents examined.

Overall, our analysis suggests that a substantial proportion of workers in King County experience at least some exposures to hazardous agents, underscoring the importance of considering the workplace setting in efforts to reduce exposures and protect public health from hazardous materials. These results provide useful information about what hazardous exposures are most widely experienced in King County, which the Haz Waste Program can use to guide their work planning and issue development. It is important to note that the Haz Waste Program has a rich tradition of programing and technical assistance related to some of the exposures that we estimate are the most common in King County, including cleaning agents and organic solvents; our analysis suggests continued efforts focused on these hazardous materials are warranted.

BIPOC workers are disproportionately exposed to many hazardous materials at work

Our second objective was to examine patterns of occupational exposure by race/ethnicity. Consistent with the Haz Waste Program's Racial Equity Strategy, this analysis can improve our understanding of potential racial/ethnic inequities and help shape policies, practices, and tools for the Program to address such inequities. We found that the most common exposures among BIPOC workers were to cleaning agents (87,900 total BIPOC workers exposed; 17.2% of the BIPOC workforce exposed), biocides (59,300; 11.6%), organic solvents (55,900; 10.9%), aliphatic aldehydes (52,100; 10.2%), and cooking fumes (51,500; 10.1%). We also attempted to characterize the extent that occupational exposures disproportionately burdened workers of color in King County due to racial/ethnic segregation of the workforce. We estimated that BIPOC workers are disproportionately exposed to many of the most common occupational exposures occurring in King County, including three of the four most common exposures.

In terms of quantifying the extent of disproportionate exposures, we estimated that thousands more BIPOC workers are exposed to hazardous agents beyond what we would expect based on their proportional representation in the King County workforce. The top five agents that most disproportionately burdened BIPOC workers included cleaning agents (12,400 more BIPOC workers exposed than expected), cooking fumes (10,200), aliphatic aldehydes (7,300), biocides (7,100), and formaldehyde (6,800). From a proportional overrepresentation perspective, the top five agents with the greatest percent excess exposure for BIPOC workers were nitrates (73.1% more BIPOC workers exposed than expected), phosgene (44.9%), animal/vegetable glues (37.0%), leather dust (33.8%), and hair dust (32.7%). It should be noted that agents with the greatest percentage of excess exposure tended to be rare exposures, affecting a relatively small number of BIPOC workers and which were found in a limited set of small industries.

Overall, we found that many BIPOC workers are exposed to hazardous materials in occupational settings, and, in many cases, BIPOC workers experience a greater burden of these exposures compared to non-Hispanic white workers. Consequently, these results suggest the existence of racial inequities in occupational exposures to hazardous materials due to occupational segregation of BIPOC workers into industries with a higher likelihood of exposure to hazardous materials. This study therefore provides support for applying a racial equity-based approach to pollution prevention and technical assistance to small businesses from a worker health perspective. More directly, this information offers an opportunity for the Haz Waste Program to incorporate racial equity into this work by focusing on specific industries, exposures, or working populations where inequities are greatest, including when setting priorities for resource allocation or evaluating service delivery.

Patterns of occupational exposure varied by race/ethnicity

Our results show that exposure patterns varied by specific race and ethnicity groups, suggesting that the segregation of different working populations across the King County labor market contributes to distinct experiences with respect to exposures in the workplace. For example, while we estimated that BIPOC workers as a whole were not disproportionately exposed to organic solvents (10.9% exposure prevalence, compared to 11.1% of all workers), we found that Hispanic (13.5%) and AIAN (11.6%) workers were more likely to be exposed than the overall workforce. In another example, BIPOC workers were estimated to be disproportionately exposed to cleaning agents (17.2% exposure prevalence, compared to 14.8% of all workers), but certain groups were estimated to have particularly high exposure burdens, including Hispanic (19.7%) and Black (18.9%) workers. More generally, our analysis suggests that Hispanic and AIAN workers tended to bear the highest levels of exposure burden; for example, Hispanic workers were disproportionately exposed to 22 out of 25 of the most common agents and AIAN workers experienced excess exposure to 20 out of 25 of these agents.

We also found different patterns when we examined which agents contributed the most excess exposures within each race/ethnicity group. It is particularly notable how different the exposure patterns of non-Hispanic white workers were from workers in BIPOC race/ethnicity categories, which, again, is consistent with King County industries being highly segregated by race and ethnicity. Although race/ethnicity groups within the larger BIPOC category each had a somewhat unique overall exposure pattern, there was also significant overlap in the agents contributing the most disproportionate exposure—especially cleaning agents, cooking fumes, aliphatic aldehydes, and biocides which each ranked highly in terms of excess exposures for all BIPOC subgroups. However, none of these agents were in the top 15 most disproportionate exposures of non-Hispanic white workers, and many of the agents contributing the most excess exposure among white workers were not present in the top 15 for any other race/ethnicity group (e.g., calcium carbonate, metallic dust, or iron).

When we examined the total number of agents that disproportionately burdened each race/ethnicity group in the entire dataset, we found that non-Hispanic white workers, followed by Hispanic and AIAN workers, had the most instances of excess exposures by agent categories included in the CANJEM data. This finding is contrary to what we would suspect based on prior studies, which generally found workers of color carrying the greatest burden of occupational morbidity and mortality (Baron et al., 2013; Marsh et al., 2013). It is possible that non-Hispanic white workers were found to be disproportionately burdened by the greatest number of occupational agents due to exposure misclassification associated with the use of an industry-based JEM, rather than an occupation-based JEM. That is, it is likely that certain occupations within a given industry classification may simultaneously be more likely to be exposed to a given hazardous material and be overrepresented by BIPOC workers, which would not be captured by our industry-level data and could therefore bias our estimates (see the Limitations section for further discussion).

Overall, our findings of distinct patterns of occupational exposures within the specific race/ethnicity categories highlights the importance of disaggregating demographic data when possible. Quantifying which agents were contributing to excess exposures within each race/ethnicity group could highlight where intervention efforts may have the greatest impact to reduce exposure and health disparities.

The King County workforce is growing, becoming more diverse, and inequities in occupational exposures have been persistent

Our third objective in this study was to examine the extent and racial/ethnic distribution of occupational exposures over time. Employment data show that the King County workforce grew by 25% between 2009 and 2019. Importantly, this workforce has become increasingly racially diverse; while the number of non-Hispanic white workers has grown by 11% over this period, the number of BIPOC workers grew by 59%. Individual race/ethnicity groups have also grown faster than the overall workforce, including those identifying as Hispanic (75%), multiracial (61%), Asian (56%), and Black (51%).

We characterized trends in occupational exposures between 2009 and 2019 and examined whether disproportionality in exposures across race/ethnicity has changed in this period. We found that for many chemical agents the number of all and BIPOC workers in King County that are exposed on the job has increased steadily over this decade, likely due to the overall growth of the workforce. Additionally, disproportionate exposure burdens experienced by BIPOC workers for many chemical agents were persistent across this period; that is, for many agents, the likelihood of exposure among BIPOC race/ethnicity groups were consistently higher than non-Hispanic white workers during this period.

Overall, our findings related to the time trend analysis suggest that more and more King County workers are being exposed to hazardous materials at their workplaces—which is generally reflective of the growth of the overall workforce during this time—and that the inequitable distribution of these exposures has largely persisted over time.

Our novel Exposure Prevention Index identifies industries that may particularly benefit from pollution prevention interventions

Our fourth objective was to develop an index measure to identify industries that have both a large extent (i.e., many exposed workers) and high likelihood (i.e., high exposure probability) of exposure and may therefore particularly benefit from public health and pollution prevention intervention efforts. Our results suggest that some industries ranked highly by our EPI measure across many of the most common occupational exposures in King County. In particular, we found that two industry groups were among the top five industries in terms of highest EPI rank for cleaning agents, biocides, and organic solvents: Personal Care Services (NAICS: 8121), which includes nail and beauty salons; and Services to Buildings and Dwellings (NAICS: 5617), which includes janitorial, pest control, and landscaping services. These industry groups were also considered low-wage and overrepresented by BIPOC employees. Thus, prioritizing these identified industries may contribute to reducing racial and socioeconomic health inequities, in addition to reducing other negative impacts of hazardous materials.

It is also notable that, because the EPI accounts for both likelihood and extent of exposure, industries that had low ranks across either dimension did not rank as highly in the EPI calculation. For example, the Restaurants and Other Eating Places industry group generally includes low probabilities of exposure to hazardous agents but high estimates of number of exposed workers because it was the largest industry in King County. As a result, the restaurant industry did not score among industries with the highest exposure burdens based on EPI. The EPI approach might therefore make sense for the purposes of identifying workplaces for interventions: although many workers in the restaurant industries are exposed to hazardous agents like cleaning agents or organic solvents, the likelihood of exposure for the average worker in these industries is relatively low.

Overall, the EPI analysis results provide potentially useful information for programmatic decision making—particularly once a specific agent or groups of agents has been decided is a priority—allowing for identifying industries to focus on for technical assistance outreach.

Comparison to Other Studies

Our results are largely consistent with two recent population-based studies that applied JEM data to examine occupational exposures. One study also used the CANJEM data and likewise identified the same set of occupational hazards as the most common facing workers in Federal Region 10 (AK, ID, OR, and WA), although with a slightly different ranking of the top exposures (Doubleday et al., 2018). Another study used different JEM data to examine trends for six occupational exposures among the Swedish workforce (Gustavsson et al., 2022). Table

16 compares occupation exposure prevalence estimates from these studies with those from the present study. Most prevalence estimates from our analysis were within ~33% of the other studies. However, we estimated a significantly smaller fraction of workers were exposed to welding fumes in King County compared to Doubleday's estimates of workers in all of Region 10. On the other hand, we estimated the prevalence of occupational exposure to lead was nearly twice as high in King County as in Sweden. Variation in these estimates across studies could be related to differences in the industrial composition of businesses operating in these geographies as well as differences in business practices or chemical regulatory policies. Additionally, differences may arise from distinct data types/sources (e.g., using exposure information by industry vs. occupation). Overall, however, these comparisons provide some external validity that our estimates are plausible, at least in comparison to studies using a similar JEM-based approach to characterize occupational exposures at the population-level.

Table 16: Comparison of selected occupational exposure prevalence estimates from two recent JEM-based studies

	Present study Exposure data: CANJEM, by industry Year: 2019 estimates Population: King County	**Doubleday et al. 2018** Exposure data: CANJEM, by occupation Year: 2014 estimates Population: USA Region 10		**Gustavsson et al. 2022** Exposure data: FINJEM, by occupation Year: 2013 estimates Population: Sweden	
Chemical agent categories	**Exposure prevalence**	**Exposure prevalence**	**% Difference from present study**	**Exposure prevalence**	**% Difference from present study**
aliphatic aldehydes	8.8%	7.8%	11%	--	--
biocides	10.2%	6.9%	32%	--	--
cleaning agents	14.8%	11.3%	24%	--	--
diesel exhaust	4.0%	4.9%	-23%	2.7%	31%
lead	2.5%	2.6%	-4%	0.2%	90%
organic solvents	11.1%	9.0%	19%	--	--
silica	2.7%	1.8%	33%	2.6%	4%
welding fumes	1.9%	4.0%	-111%	1.6%	14%
wood dust	3.4%	3.4%	0%	2.3%	33%

Our results are somewhat similar to another recent analysis that used a different JEM-based approach to characterize occupational exposures (Beckman et al., 2022), although this study is not as directly comparable to the present analysis. The analysis by Beckman and colleagues was focused specifically on estimating exposures linked to breast cancer among working women in California; thus, the agents they examined were primarily endocrine disrupters, developmental toxicants, and mammary gland carcinogens, rather than a larger set of occupational exposures more relevant to a general population-based study. The authors also developed their own qualitative JEM based primarily on expert assessments of whether a given occupation had probable, possible, or unlikely exposure to each agent category. While this is a common and acceptable approach, it differs from how the CANJEM databases was constructed, the latter of which is considered semi-quantitative and was based on compiling information from thousands of interviews and worker-specific determinations of exposure. Despite these differences, these researchers similarly found that cleaning products, antimicrobials (a category similar to biocides), combustion byproducts (a category similar to engine emissions), and solvents were among the most common exposures affecting working women in California. However, exposure to other agents that are not included or were grouped differently in the CANJEM data were also prominent in the Beckman et al. analysis. For example, the two most common exposures identified were fragrance ingredients and phthalates. While fragrance ingredients as a group was not included in the CANJEM database, phthalates are included in CANJEM but with estimates of exposure that are very low. Accordingly, our analysis yielded very low estimates of workers exposed to phthalates on the job. However, given the more recent evidence suggesting exposure to phthalates are extensive and pervasive, it is not unreasonable to expect that estimates of exposure to phthalates might increase if CANJEM was reconstructed with more contemporary data.

Overall, comparing our results to similar studies using JEM data provides some support for the plausibility of our exposure estimates. However, variation across these studies also highlights that such studies will depend largely on underlying JEM data, which have some inherent limitations.

Limitations and Future Directions

This study has several limitations which are important to understand when interpreting the results. First, it is important to acknowledge that CANJEM does not provide coverage of all workers, industries, or exposures in King County. CANJEM does not contain exposure information for many important chemical agents or other potentially important work-related hazards. Additionally, probabilities of exposure in these data are based on jobs held by the Canadian population between 1985 to 2005, which is a different population and geographical and industrial context than King County and does not account for how industry working conditions may have changed since that time. The static nature of CANJEM further limits our ability to measure trends in the magnitude and extent of exposure over time. Any trends seen over time are merely a factor of changes in the composition of the workforce and the distribution of demographics by industry, rather than actual fluctuations in exposure due to, for example, changes in business practices. Despite these limitations, to our knowledge CANJEM is the best available JEM to estimate occupational exposure burdens in King County, covering a wide range of industries and agents for a North American population. Given the potential value of JEM data to characterize occupational exposures at the population-level, future efforts should be aimed at developing more contemporary JEM data in the US context.

As with any JEM, one of the most significant limitations is exposure misclassification. In this analysis, we assumed that exposure information from individuals included in the CANJEM database applied to the entire industry group. Thus, we were unable to account for exposure differences of individuals or occupations within a single industry, potentially leading to exposure misclassification. A critical issue is that exposure estimates based on industry rather than occupation may include many workers that are not actually exposed to a particular agent (i.e., they are misclassified as exposed). For example, national estimates from the Bureau of Labor Statistics (U.S. Bureau of Labor Statistics, 2021) show that approximately 55% of employees in the aerospace industry are in occupations that are unlikely to have substantial exposure to hazardous materials, including those in management, business/financial operations, computer/mathematics, architecture/engineering, legal, sales, and office/administrative support occupations. While some of these white-collar workers will experience workplace exposures, using JEM data that classifies exposure at the industry-level likely dilutes the exposure probability for blue collar workers in this industry working in production, installation, maintenance, and construction jobs, which account for less than half the total jobs in the aerospace industry. We used exposure data by industry because that is often helpful for pollution prevention activities that target specific agents and industrial processes for intervention and technical assistance; that is, businesses in the same or similar industries have shared characteristics that allow for the development of interventions that apply to many businesses. However, future studies should further compare such results to analyses using occupation-based exposure data, which may allow for more precision when examining demographic differences in workplace exposures.

Additionally, there is ample evidence that workers in different sociodemographic groups experience differential exposure to occupational hazards within the same job or industry due to differences in assigned tasks and other occupational inequities (Frumkin et al., 1999; Messing et al., 1994; Quinn, 2011; Quinn et al., 2007; Roelofs et al., 2017), which is likewise not accounted for when using a general population JEM like CANJEM. An analysis of the CANJEM data by Lacourt et al. (Lacourt et al., 2013) found important sex-mediated differences in exposure for some agents, while a separate analysis by Xu et al. (Xu et al., 2022) found that CANJEM's ability to ascertain exposures among females performed well for some agents, but not for others. While these studies focused on sex, we can suspect that CANJEM's reliability in estimating exposures may also vary by race/ethnicity, and that there may be important within-industry differences in exposure among racial/ethnic groups that are not captured in our study. This form of misclassification could result in underestimation of exposures for some combinations of agents and racial/ethnic groups and the overestimation of exposure for others. In addition, any identified exposure disparities across race/ethnicity in our analysis can only be attributed to the distribution of workers across occupations and industries, i.e., occupational segregation. Some misclassification may have also been introduced into the study from the use of crosswalks needed to merge the data sources by a common industry/occupation classification system (Peters, 2020). Additional research is needed to better understand the impact of using general population JEM data to characterize racial disparities in occupational exposures.

Regarding the QWI employee demographic data, it is important to note that the U.S. Census Bureau suppresses or alters some data to protect the confidentiality of employees and employers, usually when industries have very small numbers of employees/firms and there is either risk that specific persons/businesses can be identified, or the estimate is unreliable. Therefore, employees from smaller demographic populations, such as Native Hawaiian and Pacific Islander and American Indian/Alaska Native populations, are more likely to be under-counted within the QWI data compared to non-Hispanic white employees. Additionally, the racial/ethnic information available in the QWI is limited to a small number of broad categories and may hinder our ability to identify exposure disparities among more specific racial/ethnic groups. The collection of more detailed demographic data may be useful in better identifying and addressing occupational health disparities (Montoya-Barthelemy et al., 2022). The QWI data also do not allow for a thorough examination of exposures across multiple intersectional identities. The application of an intersectional approach has been useful in highlighting important occupational and social inequities and should be considered in future studies (Andrea et al., 2021).

Lastly, this analysis uses employment data from before the COVID-19 pandemic, which dramatically altered the labor market in King County and beyond. Although many sectors have largely recovered in terms of employment levels, it is possible that the current and future King County labor market may differ from pre-pandemic trends in important ways that could affect some of the conclusions of our analysis.

Recommendations

The Haz Waste Program can integrate the results of this analysis into their work related to pollution prevention among small businesses, including when providing technical assistance or planning and evaluating processes.

When conducting technical assistance to small businesses:

- ***Seek opportunities to reduce worker exposures.*** Our results suggest that workplaces are an important aspect of exposure to hazardous materials in King County. The Haz Waste Program should promote pollution prevention and technical assistance efforts that reduce or eliminate workers' exposures, especially transitioning businesses to safer alternatives.
- ***Account for racial equity in our work with small businesses.*** Our results identify the existence of racial disparities in occupational exposures due to segregation of BIPOC workers into industries with higher probabilities of exposure. Characterizing the distribution of occupational exposure by demographic groups can identify where OH interventions have the greatest impact to reduce and eliminate exposure disparities.

When applying research and data analysis to support work planning and performance evaluation:

- ***Continue to research and advocate for quality OH surveillance data.*** JEM-based research approaches can help address the pressing need for OH surveillance to move "upstream" to characterize exposures rather than only health outcomes. However, JEMs have inherent limitations, including potential exposure misclassification (e.g., unaccounted for exposure variability within industries or across demographic groups) and the static nature of the data. Additional work is needed to improve OH surveillance in King County and elsewhere.
- ***Disaggregate data by race/ethnicity.*** Our findings of distinct patterns in exposures within specific race/ethnicity categories highlight the importance of disaggregating demographic data when possible.

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Appendix A: Full Tables

Industries with No Exposure Information

Table A-1. King County industries with no exposure information.

NAICS	Industry	Number of Total Employees[a,b]	Number of BIPOC Employees[a]
5112	Software Publishers	73200	33400
5511	Management of Companies and Enterprises	35500	11100
4541	Electronic Shopping and Mail-Order Houses	34100	17800
9211	Executive, Legislative, and Other General Government Support	15900	4900
5417	Scientific Research and Development Services	12600	3900
4251	Wholesale Electronic Markets and Agents and Brokers	10900	2800
5182	Data Processing, Hosting, and Related Services	10400	3100
5311	Lessors of Real Estate	9700	3400
9221	Justice, Public Order, and Safety Activities	8700	2900
4881	Support Activities for Air Transportation	6200	3400
6231	Nursing Care Facilities (Skilled Nursing Facilities)	5700	3300
8129	Other Personal Services	5700	2500
9231	Administration of Human Resource Programs	5300	2000
4831	Deep Sea, Coastal, and Great Lakes Water Transportation	5000	1000
5239	Other Financial Investment Activities	4800	1100
5222	Nondepository Credit Intermediation	4600	1100
4236	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers	4500	1400
3117	Seafood Product Preparation and Packaging	3700	2300
7121	Museums, Historical Sites, and Similar Institutions	3700	1100
4248	Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers	3300	750
3339	Other General Purpose Machinery Manufacturing	3200	1300
7112	Spectator Sports	3200	940
4231	Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers	3100	800
2371	Utility System Construction	2900	590
5619	Other Support Services	2800	680
6215	Medical and Diagnostic Laboratories	2800	1100
4413	Automotive Parts, Accessories, and Tire Stores	2700	750
4533	Used Merchandise Stores	2600	1000
3391	Medical Equipment and Supplies Manufacturing	2500	1000
8132	Grantmaking and Giving Services	2500	740
2213	Water, Sewage and Other Systems	2400	750
6219	Other Ambulatory Health Care Services	2400	680
4239	Miscellaneous Durable Goods Merchant Wholesalers	2300	710
5611	Office Administrative Services	2200	630
6242	Community Food and Housing, and Emergency and Other Relief Services	2200	840
6243	Vocational Rehabilitation Services	2200	940
4242	Drugs and Druggists' Sundries Merchant Wholesalers	2000	620
7113	Promoters of Performing Arts, Sports, and Similar Events	2000	480

5414	Specialized Design Services	1900	410
4232	Furniture and Home Furnishing Merchant Wholesalers	1800	590
6117	Educational Support Services	1800	540
3344	Semiconductor and Other Electronic Component Manufacturing	1700	1100
4922	Local Messengers and Local Delivery	1700	780
4859	Other Transit and Ground Passenger Transportation	1600	780
5324	Commercial and Industrial Machinery and Equipment Rental and Leasing	1600	370
9261	Administration of Economic Programs	1600	290
3272	Glass and Glass Product Manufacturing	1500	680
4235	Metal and Mineral (except Petroleum) Merchant Wholesalers	1500	470
5223	Activities Related to Credit Intermediation	1500	540
3328	Coating, Engraving, Heat Treating, and Allied Activities	1400	750
4241	Paper and Paper Product Merchant Wholesalers	1400	370
4249	Miscellaneous Nondurable Goods Merchant Wholesalers	1400	380
5621	Waste Collection	1400	550
6115	Technical and Trade Schools	1400	340
3327	Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	1300	320
3361	Motor Vehicle Manufacturing	1300	380
4246	Chemical and Allied Products Merchant Wholesalers	1300	310
4852	Interurban and Rural Bus Transportation	1200	400
5629	Remediation and Other Waste Management Services	1200	460
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	1100	780
4412	Other Motor Vehicle Dealers	1100	210
4482	Shoe Stores	1100	540
5622	Waste Treatment and Disposal	1100	400
8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	1100	300
4442	Lawn and Garden Equipment and Supplies Stores	1000	160
3115	Dairy Product Manufacturing	970	310
6114	Business Schools and Computer and Management Training	960	290
1141	Fishing	950	510
3366	Ship and Boat Building	940	270
4855	Charter Bus Industry	940	390
5322	Consumer Goods Rental	880	290
4512	Book Stores and News Dealers	870	220
4884	Support Activities for Road Transportation	830	290
3363	Motor Vehicle Parts Manufacturing	790	390
3335	Metalworking Machinery Manufacturing	780	230
8114	Personal and Household Goods Repair and Maintenance	770	170
4543	Direct Selling Establishments	760	200
1114	Greenhouse, Nursery, and Floriculture Production	680	210
4453	Beer, Wine, and Liquor Stores	680	170
3332	Industrial Machinery Manufacturing	660	220
8112	Electronic and Precision Equipment Repair and Maintenance	660	150

4882	Support Activities for Rail Transportation	590	240
7131	Amusement Parks and Arcades	590	260
2372	Land Subdivision	500	160
3312	Steel Product Manufacturing from Purchased Steel	460	150
3352	Household Appliance Manufacturing	440	170
2123	Nonmetallic Mineral Mining and Quarrying	400	60
3279	Other Nonmetallic Mineral Product Manufacturing	400	140
4872	Scenic and Sightseeing Transportation, Water	390	80
3333	Commercial and Service Industry Machinery Manufacturing	380	110
7115	Independent Artists, Writers, and Performers	370	60
9241	Administration of Environmental Quality Programs	370	60
5179	Other Telecommunications	360	70
4531	Florists	330	80
5612	Facilities Support Services	330	230
4542	Vending Machine Operators	300	80
3274	Lime and Gypsum Product Manufacturing	280	120
4812	Nonscheduled Air Transportation	260	50
5122	Sound Recording Industries	260	50
1112	Vegetable and Melon Farming	250	60
5323	General Rental Centers	240	60
9251	Administration of Housing Programs, Urban Planning, and Community Development	230	110
3331	Agriculture, Construction, and Mining Machinery Manufacturing	220	70
3353	Electrical Equipment Manufacturing	220	50
5331	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	220	60
3111	Animal Food Manufacturing	210	70
1119	Other Crop Farming	200	130
1152	Support Activities for Animal Production	180	50
3211	Sawmills and Wood Preservation	170	40
3343	Audio and Video Equipment Manufacturing	170	40
1121	Cattle Ranching and Farming	160	60
3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	160	40
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	130	30
5211	Monetary Authorities-Central Bank	130	60
1151	Support Activities for Crop Production	110	70
3351	Electric Lighting Equipment Manufacturing	110	30
4869	Other Pipeline Transportation	110	20
3362	Motor Vehicle Body and Trailer Manufacturing	100	30
4871	Scenic and Sightseeing Transportation, Land	100	10
7213	Rooming and Boarding Houses, Dormitories, and Workers' Camps	100	20
1133	Logging	90	20
7212	RV (Recreational Vehicle) Parks and Recreational Camps	90	20
3325	Hardware Manufacturing	80	30
3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	80	30

1153	Support Activities for Forestry	70	20
3259	Other Chemical Product and Preparation Manufacturing	70	20
3262	Rubber Product Manufacturing	70	40
1113	Fruit and Tree Nut Farming	60	30
2212	Natural Gas Distribution	60	10
3169	Other Leather and Allied Product Manufacturing	60	40
3322	Cutlery and Handtool Manufacturing	60	20
4832	Inland Water Transportation	60	10
4889	Other Support Activities for Transportation	50	10
5259	Other Investment Pools and Funds	50	20
7114	Agents and Managers for Artists, Athletes, Entertainers, and Other Public Figures	50	20
1125	Aquaculture	40	10
1129	Other Animal Production	40	10
5174	Satellite Telecommunications	40	10
2131	Support Activities for Mining	30	10
3326	Spring and Wire Product Manufacturing	30	10
3346	Manufacturing and Reproducing Magnetic and Optical Media	30	10
3369	Other Transportation Equipment Manufacturing	20	0
4245	Farm Product Raw Material Merchant Wholesalers	20	10
4879	Scenic and Sightseeing Transportation, Other	20	10
1111	Oilseed and Grain Farming	10	0
3159	Apparel Accessories and Other Apparel Manufacturing	10	0
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	10	0
3271	Clay Product and Refractory Manufacturing	10	0
5251	Insurance and Employee Benefit Funds	0	0

[a] Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000
[b] Table is sorted by industries with the highest number of total employees

Analysis 1: Exposure Estimates – All Agent Categories

Table A-2. Estimated prevalence of exposure to all CANJEM agents in King County by race and ethnicity, 2019.

		# of Employees Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
140	1,1,1-Trichlorethane	4700 (0.3%)	1400 (0.3%)	310 (0.2%)	40 (0.3%)	590 (0.3%)	270 (0.3%)	180 (0.3%)	70 (0.6%)	3300 (0.4%)
15	Abrasives dust	59100 (4.2%)	20700 (4%)	7000 (5.4%)	650 (4.6%)	7700 (3.3%)	3800 (4.1%)	2300 (3.9%)	480 (4.1%)	38400 (4.3%)
217	Acetate fibres	550 (0%)	260 (0.1%)	60 (0%)	10 (0%)	140 (0.1%)	30 (0%)	30 (0%)	10 (0%)	290 (0%)
80	Acetic acid	14700 (1%)	5500 (1.1%)	1700 (1.3%)	150 (1.1%)	2400 (1%)	820 (0.9%)	670 (1.2%)	110 (1%)	9100 (1%)
96	Acetone	11000 (0.8%)	4100 (0.8%)	930 (0.7%)	100 (0.7%)	2100 (0.9%)	560 (0.6%)	460 (0.8%)	80 (0.7%)	6900 (0.8%)
162	Acetylene	2900 (0.2%)	830 (0.2%)	240 (0.2%)	40 (0.2%)	310 (0.1%)	150 (0.2%)	110 (0.2%)	20 (0.2%)	2100 (0.2%)
172	Acrylic fibres	2200 (0.2%)	780 (0.2%)	220 (0.2%)	20 (0.2%)	350 (0.2%)	110 (0.1%)	100 (0.2%)	20 (0.1%)	1400 (0.2%)
9	Aliphatic alcohols	97100 (6.9%)	38900 (7.6%)	10300 (8%)	970 (6.8%)	17100 (7.4%)	7500 (8.2%)	4200 (7.2%)	710 (6.2%)	58200 (6.4%)
4	Aliphatic aldehydes	123800 (8.8%)	52100 (10.2%)	17200 (13.3%)	1600 (11.2%)	21000 (9.1%)	8100 (8.8%)	6400 (11.1%)	1000 (8.7%)	71700 (7.9%)
137	Aliphatic esters	5000 (0.4%)	1600 (0.3%)	510 (0.4%)	40 (0.3%)	700 (0.3%)	230 (0.2%)	210 (0.4%)	30 (0.3%)	3400 (0.4%)
62	Aliphatic ketones	18900 (1.3%)	6600 (1.3%)	1900 (1.5%)	190 (1.3%)	3000 (1.3%)	970 (1.1%)	780 (1.3%)	140 (1.2%)	12300 (1.4%)
70	Alkanes (C1-C4)	17800 (1.3%)	6400 (1.2%)	2200 (1.7%)	230 (1.6%)	2300 (1%)	1100 (1.2%)	790 (1.4%)	140 (1.2%)	11400 (1.3%)
17	Alkanes (C18+)	56800 (4%)	18100 (3.5%)	5600 (4.3%)	620 (4.4%)	7000 (3.1%)	3100 (3.4%)	2200 (3.7%)	500 (4.4%)	38700 (4.3%)
11	Alkanes (C5-C17)	75200 (5.3%)	25700 (5%)	8800 (6.8%)	860 (6%)	9400 (4.1%)	4500 (4.9%)	2900 (5%)	700 (6.1%)	49500 (5.5%)
110	Alkyds	8400 (0.6%)	2800 (0.5%)	1400 (1.1%)	110 (0.8%)	690 (0.3%)	380 (0.4%)	310 (0.5%)	80 (0.7%)	5700 (0.6%)
38	Alumina	28500 (2%)	9000 (1.8%)	2900 (2.2%)	290 (2%)	3700 (1.6%)	1400 (1.5%)	1000 (1.8%)	210 (1.8%)	19500 (2.2%)
27	Aluminium	40900 (2.9%)	12800 (2.5%)	4000 (3.1%)	410 (2.9%)	5300 (2.3%)	2000 (2.2%)	1500 (2.6%)	340 (2.9%)	28100 (3.1%)
121	Aluminium fumes	7300 (0.5%)	2300 (0.5%)	590 (0.5%)	70 (0.5%)	1100 (0.5%)	390 (0.4%)	260 (0.4%)	60 (0.6%)	5000 (0.6%)
16	Ammonia	58500 (4.1%)	24000 (4.7%)	7300 (5.7%)	660 (4.7%)	10200 (4.4%)	4100 (4.5%)	2600 (4.5%)	440 (3.8%)	34600 (3.8%)
85	Anaesthetic gases	14000 (1%)	5100 (1%)	1100 (0.9%)	100 (0.7%)	2600 (1.1%)	850 (0.9%)	550 (0.9%)	80 (0.7%)	8900 (1%)
223	Animal, vegetable glues	350 (0%)	170 (0%)	50 (0%)	0 (0%)	80 (0%)	30 (0%)	10 (0%)	10 (0%)	180 (0%)
219	Antimony	440 (0%)	150 (0%)	30 (0%)	0 (0%)	80 (0%)	20 (0%)	20 (0%)	10 (0%)	290 (0%)
113	Aromatic alcohols	8100 (0.6%)	3100 (0.6%)	720 (0.6%)	80 (0.5%)	1700 (0.7%)	370 (0.4%)	340 (0.6%)	40 (0.4%)	5000 (0.6%)
92	Aromatic amines	12000 (0.9%)	4700 (0.9%)	1700 (1.3%)	150 (1%)	1900 (0.8%)	600 (0.7%)	500 (0.9%)	100 (0.9%)	7300 (0.8%)
235	Arsenic	60 (0%)	20 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	40 (0%)
49	Asbestos	22700 (1.6%)	6400 (1.3%)	2400 (1.9%)	290 (2%)	1800 (0.8%)	1200 (1.3%)	920 (1.6%)	210 (1.8%)	16300 (1.8%)
26	Ashes	44100 (3.1%)	19800 (3.9%)	7200 (5.5%)	610 (4.3%)	7300 (3.2%)	3400 (3.7%)	2300 (4%)	360 (3.2%)	24300 (2.7%)

		# of Employees Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
126	Asphalt	6100 (0.4%)	1800 (0.4%)	930 (0.7%)	100 (0.7%)	380 (0.2%)	270 (0.3%)	220 (0.4%)	60 (0.5%)	4300 (0.5%)
204	Aviation gasoline	1100 (0.1%)	350 (0.1%)	70 (0.1%)	10 (0.1%)	160 (0.1%)	70 (0.1%)	40 (0.1%)	20 (0.2%)	750 (0.1%)
215	Basic lead carbonate	570 (0%)	220 (0%)	140 (0.1%)	10 (0.1%)	30 (0%)	30 (0%)	20 (0%)	10 (0.1%)	350 (0%)
83	Benzene	14200 (1%)	4800 (0.9%)	1900 (1.5%)	180 (1.3%)	1400 (0.6%)	900 (1%)	570 (1%)	140 (1.2%)	9400 (1%)
58	Benzo[a]pyrene	20100 (1.4%)	6700 (1.3%)	2300 (1.8%)	240 (1.7%)	2400 (1.1%)	1100 (1.2%)	800 (1.4%)	160 (1.4%)	13400 (1.5%)
245	Beryllium	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
3	Biocides	144200 (10.2%)	59300 (11.6%)	15800 (12.2%)	1500 (10.3%)	25500 (11%)	12100 (13.1%)	6300 (10.8%)	1200 (10%)	85000 (9.4%)
97	Bleaches	10900 (0.8%)	4800 (0.9%)	1100 (0.9%)	120 (0.8%)	2300 (1%)	890 (1%)	500 (0.9%)	80 (0.7%)	6100 (0.7%)
178	Brass dust	2100 (0.2%)	750 (0.1%)	160 (0.1%)	20 (0.1%)	310 (0.1%)	200 (0.2%)	80 (0.1%)	10 (0.1%)	1400 (0.2%)
115	Brick dust	7900 (0.6%)	2200 (0.4%)	1200 (0.9%)	120 (0.8%)	410 (0.2%)	310 (0.3%)	290 (0.5%)	60 (0.5%)	5700 (0.6%)
158	Bronze dust	3300 (0.2%)	1100 (0.2%)	230 (0.2%)	30 (0.2%)	560 (0.2%)	160 (0.2%)	110 (0.2%)	20 (0.2%)	2200 (0.2%)
134	Cadmium	5200 (0.4%)	1900 (0.4%)	960 (0.7%)	70 (0.5%)	480 (0.2%)	270 (0.3%)	190 (0.3%)	60 (0.5%)	3300 (0.4%)
233	Cadmium fumes	60 (0%)	20 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	40 (0%)
13	Calcium carbonate	63100 (4.5%)	18200 (3.6%)	6100 (4.7%)	630 (4.4%)	6300 (2.7%)	3500 (3.8%)	2400 (4.1%)	360 (3.1%)	44900 (5%)
102	Calcium oxide	9900 (0.7%)	3600 (0.7%)	1500 (1.1%)	140 (1%)	1100 (0.5%)	680 (0.7%)	390 (0.7%)	100 (0.8%)	6300 (0.7%)
196	Calcium oxide fumes	1400 (0.1%)	420 (0.1%)	110 (0.1%)	20 (0.1%)	170 (0.1%)	70 (0.1%)	50 (0.1%)	10 (0.1%)	1000 (0.1%)
33	Calcium sulphate	34300 (2.4%)	9500 (1.9%)	4200 (3.3%)	450 (3.1%)	2400 (1.1%)	1500 (1.7%)	1300 (2.3%)	280 (2.4%)	24800 (2.7%)
146	Carbon black	4000 (0.3%)	1300 (0.3%)	290 (0.2%)	30 (0.2%)	630 (0.3%)	230 (0.2%)	150 (0.3%)	30 (0.3%)	2700 (0.3%)
236	Carbon disulphide	20 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
19	Carbon monoxide	54500 (3.9%)	17500 (3.4%)	5900 (4.6%)	640 (4.5%)	6000 (2.6%)	3300 (3.6%)	2200 (3.8%)	510 (4.4%)	36900 (4.1%)
180	Carbon tetrachloride	2000 (0.1%)	680 (0.1%)	170 (0.1%)	20 (0.1%)	310 (0.1%)	120 (0.1%)	80 (0.1%)	10 (0.1%)	1300 (0.1%)
54	Caustic alkali solutions	21300 (1.5%)	7700 (1.5%)	2300 (1.8%)	210 (1.5%)	3200 (1.4%)	1400 (1.5%)	910 (1.6%)	140 (1.2%)	13600 (1.5%)
25	Cellulose	44500 (3.1%)	16300 (3.2%)	3500 (2.7%)	360 (2.6%)	8600 (3.7%)	2400 (2.6%)	1800 (3.1%)	350 (3.1%)	28200 (3.1%)
229	Cellulose acetate	190 (0%)	50 (0%)	20 (0%)	0 (0%)	20 (0%)	10 (0%)	10 (0%)	0 (0%)	140 (0%)
221	Cellulose nitrate	390 (0%)	110 (0%)	40 (0%)	0 (0%)	30 (0%)	20 (0%)	20 (0%)	0 (0%)	280 (0%)
67	Chlorinated alkanes	18100 (1.3%)	6600 (1.3%)	1600 (1.2%)	170 (1.2%)	3300 (1.4%)	920 (1%)	750 (1.3%)	160 (1.4%)	11600 (1.3%)
74	Chlorinated alkenes	16900 (1.2%)	6500 (1.3%)	1400 (1%)	150 (1.1%)	3500 (1.5%)	910 (1%)	670 (1.1%)	150 (1.3%)	10400 (1.2%)
183	Chlorine	1800 (0.1%)	680 (0.1%)	180 (0.1%)	20 (0.2%)	210 (0.1%)	210 (0.2%)	70 (0.1%)	10 (0.1%)	1100 (0.1%)
203	Chlorine dioxide	1100 (0.1%)	520 (0.1%)	130 (0.1%)	20 (0.1%)	160 (0.1%)	180 (0.2%)	40 (0.1%)	10 (0.1%)	610 (0.1%)
188	Chloroform	1600 (0.1%)	510 (0.1%)	100 (0.1%)	10 (0.1%)	260 (0.1%)	80 (0.1%)	60 (0.1%)	10 (0.1%)	1100 (0.1%)

Agent Rank[b]	CANJEM Chemical Agent Category[c]	# of Employees Exposed[a] (% of Demographic Group) All	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
41	Chromium	27800 (2%)	8900 (1.7%)	2500 (1.9%)	250 (1.8%)	4000 (1.8%)	1300 (1.5%)	980 (1.7%)	200 (1.7%)	18900 (2.1%)
105	Chromium (VI)	9400 (0.7%)	3100 (0.6%)	1200 (0.9%)	110 (0.7%)	1100 (0.5%)	470 (0.5%)	350 (0.6%)	80 (0.7%)	6300 (0.7%)
112	Chromium fumes	8200 (0.6%)	2500 (0.5%)	600 (0.5%)	70 (0.5%)	1300 (0.5%)	380 (0.4%)	290 (0.5%)	50 (0.5%)	5600 (0.6%)
157	Clay dust	3300 (0.2%)	1100 (0.2%)	580 (0.4%)	50 (0.3%)	220 (0.1%)	150 (0.2%)	120 (0.2%)	30 (0.3%)	2300 (0.2%)
1	Cleaning agents	208500 (14.8%)	87900 (17.2%)	25500 (19.7%)	2400 (16.8%)	36000 (15.6%)	17400 (18.9%)	9700 (16.6%)	1700 (14.9%)	120600 (13.4%)
155	Coal combustion products	3400 (0.2%)	1200 (0.2%)	420 (0.3%)	40 (0.3%)	480 (0.2%)	190 (0.2%)	170 (0.3%)	20 (0.2%)	2200 (0.2%)
187	Coal dust	1600 (0.1%)	500 (0.1%)	160 (0.1%)	20 (0.1%)	170 (0.1%)	90 (0.1%)	80 (0.1%)	10 (0.1%)	1100 (0.1%)
179	Coal tar and pitch	2100 (0.1%)	660 (0.1%)	370 (0.3%)	40 (0.3%)	120 (0.1%)	90 (0.1%)	80 (0.1%)	20 (0.1%)	1400 (0.2%)
163	Cobalt	2800 (0.2%)	900 (0.2%)	200 (0.2%)	20 (0.1%)	480 (0.2%)	130 (0.1%)	100 (0.2%)	20 (0.1%)	1900 (0.2%)
242	Coke combustion products	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
240	Coke dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
43	Concrete dust	26900 (1.9%)	6700 (1.3%)	3200 (2.5%)	370 (2.6%)	1400 (0.6%)	1000 (1.1%)	1000 (1.7%)	210 (1.8%)	20100 (2.2%)
6	Cooking fumes	114100 (8.1%)	51500 (10.1%)	17000 (13.1%)	1500 (10.8%)	19800 (8.6%)	9300 (10.1%)	6100 (10.4%)	1000 (8.6%)	62600 (6.9%)
79	Copper	15400 (1.1%)	4800 (0.9%)	1100 (0.9%)	130 (0.9%)	2200 (1%)	880 (1%)	560 (1%)	120 (1.1%)	10600 (1.2%)
133	Copper fumes	5300 (0.4%)	1600 (0.3%)	420 (0.3%)	50 (0.4%)	650 (0.3%)	290 (0.3%)	200 (0.3%)	60 (0.5%)	3700 (0.4%)
232	Cork dust	80 (0%)	30 (0%)	10 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	0 (0%)	50 (0%)
45	Cosmetic talc	25700 (1.8%)	10900 (2.1%)	2100 (1.6%)	220 (1.5%)	5100 (2.2%)	2600 (2.8%)	1100 (1.8%)	190 (1.6%)	14800 (1.6%)
52	Cotton dust	22000 (1.6%)	9600 (1.9%)	2300 (1.8%)	210 (1.5%)	4300 (1.9%)	2000 (2.2%)	920 (1.6%)	210 (1.8%)	12400 (1.4%)
192	Creosote	1500 (0.1%)	490 (0.1%)	290 (0.2%)	30 (0.2%)	80 (0%)	70 (0.1%)	50 (0.1%)	10 (0.1%)	980 (0.1%)
28	Cristalline silica	38400 (2.7%)	13300 (2.6%)	5300 (4.1%)	510 (3.6%)	3900 (1.7%)	2500 (2.7%)	1500 (2.5%)	340 (2.9%)	25100 (2.8%)
222	Crude petroleum	360 (0%)	100 (0%)	40 (0%)	10 (0%)	30 (0%)	10 (0%)	10 (0%)	0 (0%)	270 (0%)
71	Cutting fluids post-1955	17700 (1.3%)	5200 (1%)	1200 (0.9%)	140 (1%)	2600 (1.1%)	800 (0.9%)	600 (1%)	110 (0.9%)	12500 (1.4%)
205	Cyanides	1000 (0.1%)	360 (0.1%)	100 (0.1%)	10 (0.1%)	160 (0.1%)	50 (0.1%)	40 (0.1%)	10 (0.1%)	650 (0.1%)
18	Diesel engine emissions	56400 (4%)	17900 (3.5%)	6100 (4.7%)	720 (5.1%)	5200 (2.3%)	4000 (4.4%)	2300 (4%)	690 (6%)	38400 (4.3%)
129	Diesel oil	6000 (0.4%)	2000 (0.4%)	610 (0.5%)	80 (0.6%)	610 (0.3%)	500 (0.5%)	240 (0.4%)	100 (0.8%)	4000 (0.4%)
161	Diethyl ether	3100 (0.2%)	1100 (0.2%)	190 (0.1%)	20 (0.1%)	570 (0.2%)	210 (0.2%)	110 (0.2%)	20 (0.2%)	2000 (0.2%)
5	Engine emissions	123500 (8.7%)	41200 (8.1%)	12100 (9.4%)	1300 (9.2%)	15400 (6.7%)	8300 (9%)	5100 (8.8%)	1200 (10.7%)	82300 (9.1%)
147	Epoxies	3800 (0.3%)	1300 (0.3%)	610 (0.5%)	50 (0.4%)	340 (0.1%)	190 (0.2%)	150 (0.3%)	40 (0.3%)	2500 (0.3%)
87	Ethanol	13500 (1%)	5700 (1.1%)	1200 (1%)	140 (1%)	3200 (1.4%)	710 (0.8%)	650 (1.1%)	80 (0.7%)	7700 (0.9%)
148	Ethylene glycol	3800 (0.3%)	1300 (0.3%)	330 (0.3%)	40 (0.3%)	620 (0.3%)	210 (0.2%)	160 (0.3%)	30 (0.2%)	2400 (0.3%)

		# of Employees Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
143	Ethylene oxide	4400 (0.3%)	1500 (0.3%)	310 (0.2%)	30 (0.2%)	790 (0.3%)	270 (0.3%)	170 (0.3%)	20 (0.2%)	2800 (0.3%)
86	Extenders	13700 (1%)	4700 (0.9%)	2100 (1.6%)	180 (1.2%)	1300 (0.6%)	800 (0.9%)	540 (0.9%)	130 (1.2%)	9000 (1%)
34	Fabric dust	32800 (2.3%)	13500 (2.6%)	3600 (2.8%)	340 (2.4%)	5700 (2.5%)	2700 (3%)	1400 (2.5%)	310 (2.7%)	19400 (2.1%)
220	Felt dust	400 (0%)	100 (0%)	30 (0%)	0 (0%)	30 (0%)	10 (0%)	20 (0%)	0 (0%)	300 (0%)
177	Fertilizers	2200 (0.2%)	740 (0.1%)	320 (0.2%)	30 (0.2%)	160 (0.1%)	160 (0.2%)	100 (0.2%)	20 (0.2%)	1400 (0.2%)
181	Flax fibres	1900 (0.1%)	760 (0.1%)	190 (0.1%)	20 (0.1%)	360 (0.2%)	130 (0.1%)	90 (0.1%)	20 (0.2%)	1100 (0.1%)
53	Flour dust	21900 (1.6%)	9700 (1.9%)	3200 (2.5%)	300 (2.1%)	3700 (1.6%)	1700 (1.8%)	1100 (2%)	210 (1.8%)	12300 (1.4%)
150	Fluorides	3700 (0.3%)	1100 (0.2%)	290 (0.2%)	40 (0.3%)	490 (0.2%)	210 (0.2%)	140 (0.2%)	30 (0.3%)	2500 (0.3%)
109	Fluorocarbons	8500 (0.6%)	3600 (0.7%)	710 (0.5%)	90 (0.6%)	2200 (0.9%)	350 (0.4%)	400 (0.7%)	50 (0.4%)	4900 (0.5%)
7	Formaldehyde	103300 (7.3%)	44200 (8.6%)	14700 (11.3%)	1300 (9.5%)	18000 (7.8%)	6600 (7.2%)	5400 (9.3%)	850 (7.4%)	59100 (6.5%)
243	Formic acid	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
195	Fur dust	1400 (0.1%)	430 (0.1%)	110 (0.1%)	10 (0.1%)	180 (0.1%)	80 (0.1%)	60 (0.1%)	10 (0.1%)	950 (0.1%)
189	Glass dust	1500 (0.1%)	460 (0.1%)	200 (0.2%)	20 (0.1%)	130 (0.1%)	70 (0.1%)	60 (0.1%)	10 (0.1%)	1100 (0.1%)
94	Glass fibres	11100 (0.8%)	3000 (0.6%)	1200 (1%)	140 (1%)	840 (0.4%)	480 (0.5%)	420 (0.7%)	80 (0.7%)	8100 (0.9%)
139	Glycol ethers	4800 (0.3%)	1800 (0.3%)	540 (0.4%)	50 (0.4%)	750 (0.3%)	270 (0.3%)	220 (0.4%)	30 (0.3%)	3100 (0.3%)
138	Grain dust	4900 (0.3%)	1300 (0.3%)	410 (0.3%)	70 (0.5%)	340 (0.1%)	320 (0.3%)	220 (0.4%)	50 (0.4%)	3600 (0.4%)
199	Graphite dust	1300 (0.1%)	420 (0.1%)	110 (0.1%)	10 (0.1%)	100 (0%)	150 (0.2%)	60 (0.1%)	10 (0.1%)	910 (0.1%)
119	Hair dust	7700 (0.5%)	3700 (0.7%)	680 (0.5%)	90 (0.6%)	2400 (1%)	290 (0.3%)	400 (0.7%)	30 (0.3%)	4000 (0.4%)
176	Heating oil	2200 (0.2%)	730 (0.1%)	360 (0.3%)	30 (0.2%)	160 (0.1%)	120 (0.1%)	80 (0.1%)	20 (0.2%)	1500 (0.2%)
118	Hydraulic fluid	7800 (0.5%)	2300 (0.5%)	770 (0.6%)	100 (0.7%)	730 (0.3%)	470 (0.5%)	320 (0.6%)	110 (0.9%)	5400 (0.6%)
202	Hydrogen	1100 (0.1%)	280 (0.1%)	80 (0.1%)	10 (0.1%)	110 (0%)	40 (0%)	40 (0.1%)	10 (0.1%)	860 (0.1%)
47	Hydrogen chloride	25000 (1.8%)	7700 (1.5%)	2500 (1.9%)	260 (1.8%)	3000 (1.3%)	1300 (1.4%)	960 (1.6%)	190 (1.6%)	17300 (1.9%)
210	Hydrogen cyanide	850 (0.1%)	300 (0.1%)	90 (0.1%)	10 (0.1%)	130 (0.1%)	40 (0%)	40 (0.1%)	10 (0.1%)	540 (0.1%)
160	Hydrogen fluoride	3100 (0.2%)	970 (0.2%)	260 (0.2%)	40 (0.3%)	390 (0.2%)	180 (0.2%)	120 (0.2%)	30 (0.2%)	2100 (0.2%)
104	Hydrogen peroxide	9600 (0.7%)	4100 (0.8%)	850 (0.7%)	90 (0.7%)	2400 (1%)	460 (0.5%)	450 (0.8%)	50 (0.4%)	5500 (0.6%)
149	Hydrogen sulphide	3700 (0.3%)	970 (0.2%)	330 (0.3%)	50 (0.3%)	240 (0.1%)	230 (0.2%)	150 (0.3%)	30 (0.2%)	2800 (0.3%)
29	Hypochlorites	36500 (2.6%)	15900 (3.1%)	4600 (3.6%)	410 (2.9%)	6300 (2.7%)	3400 (3.7%)	1700 (2.9%)	310 (2.7%)	20600 (2.3%)
142	Industrial talc	4400 (0.3%)	1500 (0.3%)	680 (0.5%)	60 (0.4%)	440 (0.2%)	250 (0.3%)	160 (0.3%)	50 (0.4%)	2900 (0.3%)
89	Inks	12800 (0.9%)	3900 (0.8%)	930 (0.7%)	100 (0.7%)	1800 (0.8%)	640 (0.7%)	470 (0.8%)	90 (0.8%)	8900 (1%)
35	Inorganic acid solutions	31300 (2.2%)	10000 (2%)	3000 (2.4%)	300 (2.1%)	4200 (1.8%)	1600 (1.8%)	1200 (2.1%)	220 (1.9%)	21300 (2.4%)

Agent Rank[b]	CANJEM Chemical Agent Category[c]	# of Employees Exposed[a] (% of Demographic Group) All	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
39	Inorganic insulation dust	28100 (2%)	7300 (1.4%)	3200 (2.5%)	360 (2.5%)	1900 (0.8%)	1100 (1.2%)	1000 (1.8%)	210 (1.8%)	20800 (2.3%)
44	Inorganic pigments	25900 (1.8%)	8700 (1.7%)	3900 (3%)	330 (2.3%)	2400 (1%)	1400 (1.6%)	990 (1.7%)	250 (2.2%)	17200 (1.9%)
21	Iron	49600 (3.5%)	14800 (2.9%)	4700 (3.6%)	520 (3.7%)	5700 (2.5%)	2500 (2.7%)	1800 (3.2%)	380 (3.3%)	34800 (3.9%)
76	Iron fumes	15900 (1.1%)	4800 (0.9%)	1400 (1.1%)	170 (1.2%)	1900 (0.8%)	820 (0.9%)	600 (1%)	130 (1.1%)	11200 (1.2%)
106	Iron oxides	9100 (0.6%)	3000 (0.6%)	1400 (1%)	120 (0.9%)	760 (0.3%)	540 (0.6%)	370 (0.6%)	90 (0.8%)	6100 (0.7%)
171	Isocyanates	2500 (0.2%)	920 (0.2%)	470 (0.4%)	40 (0.3%)	210 (0.1%)	150 (0.2%)	110 (0.2%)	20 (0.2%)	1600 (0.2%)
12	Isopropanol	75000 (5.3%)	31800 (6.2%)	8500 (6.6%)	780 (5.5%)	14000 (6.1%)	6300 (6.8%)	3300 (5.7%)	590 (5.1%)	43200 (4.8%)
175	Kerosene	2200 (0.2%)	830 (0.2%)	240 (0.2%)	20 (0.2%)	370 (0.2%)	150 (0.2%)	80 (0.1%)	20 (0.1%)	1400 (0.2%)
31	Lead	35800 (2.5%)	11500 (2.3%)	3700 (2.9%)	390 (2.7%)	4300 (1.9%)	2000 (2.2%)	1400 (2.4%)	340 (2.9%)	24200 (2.7%)
198	Lead chromate	1300 (0.1%)	480 (0.1%)	210 (0.2%)	20 (0.1%)	130 (0.1%)	90 (0.1%)	50 (0.1%)	10 (0.1%)	800 (0.1%)
46	Lead fumes	25300 (1.8%)	8000 (1.6%)	2500 (2%)	270 (1.9%)	3100 (1.3%)	1400 (1.5%)	970 (1.7%)	220 (2%)	17300 (1.9%)
206	Lead oxides	990 (0.1%)	340 (0.1%)	180 (0.1%)	10 (0.1%)	80 (0%)	40 (0%)	40 (0.1%)	10 (0.1%)	650 (0.1%)
125	Leaded gasoline	6200 (0.4%)	2200 (0.4%)	650 (0.5%)	80 (0.5%)	760 (0.3%)	460 (0.5%)	250 (0.4%)	70 (0.6%)	4000 (0.4%)
228	Leather dust	190 (0%)	90 (0%)	20 (0%)	0 (0%)	60 (0%)	10 (0%)	10 (0%)	0 (0%)	100 (0%)
123	Linseed oil	6500 (0.5%)	2300 (0.5%)	1200 (0.9%)	90 (0.6%)	580 (0.3%)	310 (0.3%)	240 (0.4%)	70 (0.6%)	4200 (0.5%)
124	Liquid fuel combustion products	6200 (0.4%)	1700 (0.3%)	790 (0.6%)	80 (0.6%)	440 (0.2%)	280 (0.3%)	230 (0.4%)	40 (0.4%)	4400 (0.5%)
50	Lubricating oils and greases	22400 (1.6%)	7300 (1.4%)	2200 (1.7%)	250 (1.8%)	2700 (1.1%)	1400 (1.5%)	930 (1.6%)	240 (2.1%)	15100 (1.7%)
201	Magnesium	1300 (0.1%)	400 (0.1%)	80 (0.1%)	10 (0.1%)	210 (0.1%)	60 (0.1%)	40 (0.1%)	10 (0.1%)	880 (0.1%)
59	Manganese	19900 (1.4%)	6300 (1.2%)	2000 (1.5%)	220 (1.6%)	2400 (1%)	1100 (1.2%)	760 (1.3%)	160 (1.4%)	13600 (1.5%)
64	Manganese fumes	18400 (1.3%)	5800 (1.1%)	1900 (1.5%)	210 (1.5%)	2200 (0.9%)	1000 (1.1%)	710 (1.2%)	150 (1.3%)	12600 (1.4%)
212	Melamine-formaldehyde	780 (0.1%)	210 (0%)	80 (0.1%)	10 (0.1%)	60 (0%)	40 (0%)	40 (0.1%)	10 (0.1%)	570 (0.1%)
135	Mercury	5200 (0.4%)	1700 (0.3%)	510 (0.4%)	40 (0.3%)	790 (0.3%)	240 (0.3%)	210 (0.4%)	30 (0.3%)	3500 (0.4%)
99	Metal coatings	10600 (0.8%)	3600 (0.7%)	1400 (1.1%)	130 (0.9%)	1000 (0.5%)	710 (0.8%)	430 (0.7%)	110 (1%)	7000 (0.8%)
40	Metal oxide fumes	28000 (2%)	8500 (1.7%)	2600 (2%)	300 (2.1%)	3300 (1.4%)	1500 (1.6%)	1100 (1.8%)	230 (2%)	19500 (2.2%)
20	Metallic dust	51700 (3.7%)	15500 (3%)	4500 (3.5%)	500 (3.6%)	6400 (2.8%)	2500 (2.8%)	2000 (3.4%)	410 (3.6%)	36200 (4%)
145	Methane	4100 (0.3%)	1700 (0.3%)	530 (0.4%)	50 (0.4%)	600 (0.3%)	330 (0.4%)	210 (0.4%)	40 (0.3%)	2500 (0.3%)
95	Methanol	11100 (0.8%)	3300 (0.7%)	810 (0.6%)	90 (0.6%)	1500 (0.6%)	660 (0.7%)	400 (0.7%)	60 (0.5%)	7800 (0.9%)
165	Methyl methacrylate	2700 (0.2%)	860 (0.2%)	240 (0.2%)	20 (0.1%)	400 (0.2%)	110 (0.1%)	120 (0.2%)	10 (0.1%)	1800 (0.2%)
117	Methylene chloride	7900 (0.6%)	3400 (0.7%)	870 (0.7%)	90 (0.6%)	1800 (0.8%)	340 (0.4%)	370 (0.6%)	50 (0.4%)	4500 (0.5%)
167	Mica	2500 (0.2%)	840 (0.2%)	420 (0.3%)	30 (0.2%)	210 (0.1%)	130 (0.1%)	90 (0.2%)	20 (0.2%)	1700 (0.2%)

		# of Employees Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
37	Mild steel dust	29700 (2.1%)	8500 (1.7%)	2600 (2%)	310 (2.2%)	3200 (1.4%)	1500 (1.6%)	1100 (1.9%)	220 (1.9%)	21200 (2.3%)
24	Mineral spirits post 1970	47400 (3.4%)	16300 (3.2%)	5500 (4.2%)	510 (3.6%)	6300 (2.7%)	2800 (3%)	1800 (3.1%)	420 (3.6%)	31000 (3.4%)
57	Mineral wool fibres	20700 (1.5%)	5200 (1%)	2400 (1.9%)	270 (1.9%)	1200 (0.5%)	790 (0.9%)	770 (1.3%)	160 (1.4%)	15500 (1.7%)
14	Mononuclear aromatic hydrocarbons	59400 (4.2%)	19700 (3.8%)	6900 (5.3%)	670 (4.7%)	7000 (3.1%)	3400 (3.7%)	2300 (3.9%)	530 (4.6%)	39700 (4.4%)
173	Natural gas	2200 (0.2%)	970 (0.2%)	340 (0.3%)	30 (0.2%)	390 (0.2%)	140 (0.1%)	120 (0.2%)	20 (0.1%)	1200 (0.1%)
22	Natural gas combustion products	49400 (3.5%)	22400 (4.4%)	7700 (5.9%)	670 (4.7%)	8900 (3.8%)	3500 (3.8%)	2700 (4.6%)	420 (3.6%)	27000 (3%)
190	Natural rubber	1500 (0.1%)	470 (0.1%)	140 (0.1%)	20 (0.1%)	150 (0.1%)	110 (0.1%)	60 (0.1%)	20 (0.1%)	1000 (0.1%)
55	Nickel	20900 (1.5%)	6500 (1.3%)	1400 (1.1%)	170 (1.2%)	3300 (1.4%)	1000 (1.1%)	730 (1.2%)	130 (1.1%)	14400 (1.6%)
116	Nickel fumes	7900 (0.6%)	2500 (0.5%)	590 (0.5%)	70 (0.5%)	1200 (0.5%)	410 (0.4%)	280 (0.5%)	50 (0.5%)	5400 (0.6%)
234	Nitrates	60 (0%)	40 (0%)	10 (0%)	0 (0%)	20 (0%)	10 (0%)	0 (0%)	0 (0%)	20 (0%)
153	Nitric acid	3500 (0.2%)	1000 (0.2%)	250 (0.2%)	20 (0.2%)	480 (0.2%)	160 (0.2%)	130 (0.2%)	20 (0.1%)	2500 (0.3%)
36	Nitrogen oxides	30500 (2.2%)	10000 (2%)	3600 (2.8%)	390 (2.7%)	3300 (1.4%)	1800 (1.9%)	1300 (2.2%)	260 (2.3%)	20500 (2.3%)
227	Nitroglycerine	240 (0%)	90 (0%)	20 (0%)	0 (0%)	40 (0%)	20 (0%)	10 (0%)	0 (0%)	160 (0%)
122	Nylon fibres	6600 (0.5%)	2400 (0.5%)	760 (0.6%)	70 (0.5%)	950 (0.4%)	350 (0.4%)	300 (0.5%)	60 (0.6%)	4200 (0.5%)
78	Organic dyes and pigments	15500 (1.1%)	6100 (1.2%)	2300 (1.8%)	200 (1.4%)	2500 (1.1%)	760 (0.8%)	640 (1.1%)	140 (1.2%)	9300 (1%)
2	Organic solvents	156900 (11.1%)	55900 (10.9%)	17400 (13.5%)	1600 (11.6%)	23000 (10%)	9300 (10.1%)	6400 (10.9%)	1200 (10.6%)	101100 (11.2%)
141	Other mineral oils	4700 (0.3%)	1700 (0.3%)	360 (0.3%)	40 (0.3%)	950 (0.4%)	210 (0.2%)	160 (0.3%)	40 (0.4%)	3000 (0.3%)
30	Other paints, varnishes	36200 (2.6%)	11800 (2.3%)	4700 (3.7%)	430 (3%)	3800 (1.6%)	1900 (2%)	1400 (2.4%)	320 (2.8%)	24500 (2.7%)
77	Other pyrolysis fumes	15800 (1.1%)	5100 (1%)	1500 (1.1%)	170 (1.2%)	2100 (0.9%)	870 (0.9%)	600 (1%)	120 (1.1%)	10700 (1.2%)
10	Ozone	84700 (6%)	28700 (5.6%)	6900 (5.3%)	810 (5.7%)	12500 (5.4%)	5700 (6.2%)	3400 (5.8%)	720 (6.3%)	56000 (6.2%)
8	PAHs from any source	99600 (7%)	33800 (6.6%)	10400 (8%)	1100 (7.9%)	12800 (5.5%)	6300 (6.8%)	4200 (7.2%)	910 (7.9%)	65800 (7.3%)
170	Perchloroethylene	2500 (0.2%)	1100 (0.2%)	340 (0.3%)	30 (0.2%)	520 (0.2%)	200 (0.2%)	90 (0.2%)	20 (0.2%)	1300 (0.1%)
151	Pesticides	3700 (0.3%)	1300 (0.3%)	440 (0.3%)	40 (0.3%)	410 (0.2%)	250 (0.3%)	190 (0.3%)	30 (0.3%)	2400 (0.3%)
208	Phenol	940 (0.1%)	300 (0.1%)	60 (0%)	10 (0.1%)	140 (0.1%)	60 (0.1%)	40 (0.1%)	10 (0.1%)	650 (0.1%)
211	Phenol-formaldehyde	780 (0.1%)	220 (0%)	120 (0.1%)	10 (0.1%)	40 (0%)	30 (0%)	30 (0.1%)	10 (0.1%)	560 (0.1%)
216	Phosgene	570 (0%)	300 (0.1%)	80 (0.1%)	10 (0%)	140 (0.1%)	70 (0.1%)	20 (0%)	10 (0%)	270 (0%)
169	Phosphoric acid	2500 (0.2%)	930 (0.2%)	250 (0.2%)	20 (0.2%)	460 (0.2%)	120 (0.1%)	90 (0.2%)	20 (0.2%)	1600 (0.2%)
194	Phthalates	1500 (0.1%)	470 (0.1%)	230 (0.2%)	20 (0.1%)	120 (0.1%)	70 (0.1%)	60 (0.1%)	10 (0.1%)	1000 (0.1%)
68	Plastic dusts	18000 (1.3%)	5500 (1.1%)	1900 (1.5%)	190 (1.3%)	2000 (0.9%)	820 (0.9%)	690 (1.2%)	160 (1.4%)	12500 (1.4%)
91	Plastics pyrolysis fumes	12000 (0.9%)	4400 (0.9%)	1200 (0.9%)	130 (0.9%)	1900 (0.8%)	730 (0.8%)	530 (0.9%)	140 (1.2%)	7600 (0.8%)

Agent Rank[b]	CANJEM Chemical Agent Category[c]	# of Employees Exposed[a] (% of Demographic Group) All	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
214	Plating solutions	660 (0%)	220 (0%)	50 (0%)	0 (0%)	130 (0.1%)	20 (0%)	20 (0%)	0 (0%)	440 (0%)
127	Poly(vinyl acetate)	6000 (0.4%)	2000 (0.4%)	1200 (0.9%)	90 (0.6%)	410 (0.2%)	270 (0.3%)	220 (0.4%)	60 (0.5%)	4000 (0.4%)
144	Poly(vinyl chloride)	4300 (0.3%)	1200 (0.2%)	350 (0.3%)	40 (0.3%)	470 (0.2%)	210 (0.2%)	170 (0.3%)	40 (0.4%)	3100 (0.3%)
111	Polyacrylates	8300 (0.6%)	2600 (0.5%)	940 (0.7%)	80 (0.6%)	960 (0.4%)	370 (0.4%)	320 (0.6%)	50 (0.5%)	5700 (0.6%)
239	Polyamides	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
193	Polychlorinated biphenyls or PCBs	1500 (0.1%)	390 (0.1%)	100 (0.1%)	10 (0.1%)	160 (0.1%)	70 (0.1%)	60 (0.1%)	10 (0.1%)	1100 (0.1%)
230	Polychloroprene	180 (0%)	70 (0%)	10 (0%)	0 (0%)	20 (0%)	30 (0%)	10 (0%)	0 (0%)	110 (0%)
103	Polyester fibres	9600 (0.7%)	4000 (0.8%)	1100 (0.8%)	100 (0.7%)	1800 (0.8%)	660 (0.7%)	440 (0.8%)	90 (0.7%)	5600 (0.6%)
168	Polyesters	2500 (0.2%)	820 (0.2%)	200 (0.2%)	20 (0.2%)	370 (0.2%)	150 (0.2%)	100 (0.2%)	20 (0.1%)	1700 (0.2%)
218	Polyethylene	450 (0%)	180 (0%)	50 (0%)	0 (0%)	80 (0%)	30 (0%)	20 (0%)	10 (0.1%)	270 (0%)
225	Polypropylene	270 (0%)	100 (0%)	30 (0%)	0 (0%)	50 (0%)	20 (0%)	10 (0%)	10 (0%)	160 (0%)
213	Polystyrene	700 (0%)	230 (0%)	100 (0.1%)	10 (0.1%)	70 (0%)	30 (0%)	30 (0%)	10 (0.1%)	470 (0.1%)
128	Polyurethanes	6000 (0.4%)	2100 (0.4%)	920 (0.7%)	70 (0.5%)	630 (0.3%)	300 (0.3%)	230 (0.4%)	70 (0.6%)	3900 (0.4%)
93	Portland cement	11500 (0.8%)	3200 (0.6%)	1600 (1.2%)	170 (1.2%)	600 (0.3%)	540 (0.6%)	420 (0.7%)	110 (0.9%)	8400 (0.9%)
132	Propane	5300 (0.4%)	1800 (0.4%)	660 (0.5%)	70 (0.5%)	550 (0.2%)	390 (0.4%)	220 (0.4%)	40 (0.4%)	3500 (0.4%)
72	Propane combustion products	17500 (1.2%)	6200 (1.2%)	2300 (1.8%)	230 (1.6%)	2200 (0.9%)	960 (1%)	800 (1.4%)	130 (1.1%)	11400 (1.3%)
75	Propane engine emissions	16600 (1.2%)	5200 (1%)	1400 (1.1%)	170 (1.2%)	1900 (0.8%)	1000 (1.1%)	680 (1.2%)	240 (2.1%)	11400 (1.3%)
56	Propellant gases	20800 (1.5%)	9000 (1.8%)	2300 (1.8%)	230 (1.6%)	4400 (1.9%)	1400 (1.5%)	970 (1.7%)	140 (1.2%)	11800 (1.3%)
184	Rayon fibres	1700 (0.1%)	730 (0.1%)	180 (0.1%)	20 (0.1%)	380 (0.2%)	100 (0.1%)	80 (0.1%)	10 (0.1%)	930 (0.1%)
226	RDX	270 (0%)	60 (0%)	10 (0%)	0 (0%)	10 (0%)	20 (0%)	10 (0%)	0 (0%)	210 (0%)
207	Refractory brick dust	980 (0.1%)	310 (0.1%)	170 (0.1%)	20 (0.1%)	60 (0%)	50 (0.1%)	30 (0.1%)	10 (0.1%)	670 (0.1%)
159	Rubber dust	3100 (0.2%)	1100 (0.2%)	340 (0.3%)	40 (0.3%)	330 (0.1%)	240 (0.3%)	130 (0.2%)	30 (0.2%)	2100 (0.2%)
185	Rubber pyrolysis fumes	1700 (0.1%)	540 (0.1%)	170 (0.1%)	20 (0.1%)	200 (0.1%)	100 (0.1%)	70 (0.1%)	20 (0.1%)	1200 (0.1%)
152	Selenium	3600 (0.3%)	1400 (0.3%)	780 (0.6%)	60 (0.4%)	260 (0.1%)	200 (0.2%)	140 (0.2%)	40 (0.4%)	2300 (0.2%)
51	Silicon carbide	22200 (1.6%)	6800 (1.3%)	2000 (1.5%)	210 (1.5%)	2900 (1.3%)	1100 (1.2%)	790 (1.4%)	160 (1.4%)	15500 (1.7%)
186	Silk fibres	1600 (0.1%)	720 (0.1%)	190 (0.1%)	20 (0.1%)	360 (0.2%)	110 (0.1%)	70 (0.1%)	20 (0.1%)	900 (0.1%)
114	Silver	8000 (0.6%)	2500 (0.5%)	660 (0.5%)	60 (0.4%)	1200 (0.5%)	330 (0.4%)	320 (0.6%)	40 (0.4%)	5500 (0.6%)
164	Silver fumes	2700 (0.2%)	770 (0.1%)	200 (0.2%)	20 (0.2%)	360 (0.2%)	100 (0.1%)	100 (0.2%)	10 (0.1%)	1900 (0.2%)
108	Sodium carbonate	8800 (0.6%)	3600 (0.7%)	1300 (1%)	110 (0.8%)	1200 (0.5%)	870 (0.9%)	360 (0.6%)	80 (0.7%)	5100 (0.6%)
209	Sodium hydrosulphite	920 (0.1%)	290 (0.1%)	80 (0.1%)	10 (0.1%)	120 (0.1%)	40 (0%)	40 (0.1%)	10 (0.1%)	630 (0.1%)

		# of Employees Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
60	Soldering fumes	19300 (1.4%)	5600 (1.1%)	1600 (1.2%)	180 (1.2%)	2400 (1.1%)	800 (0.9%)	710 (1.2%)	130 (1.1%)	13800 (1.5%)
130	Soot	5700 (0.4%)	1600 (0.3%)	520 (0.4%)	70 (0.5%)	460 (0.2%)	370 (0.4%)	230 (0.4%)	70 (0.6%)	4100 (0.5%)
63	Stainless steel dust	18700 (1.3%)	5700 (1.1%)	1200 (0.9%)	150 (1%)	2900 (1.3%)	870 (0.9%)	640 (1.1%)	110 (0.9%)	13000 (1.4%)
73	Starch dust	17100 (1.2%)	7800 (1.5%)	2500 (1.9%)	220 (1.6%)	3200 (1.4%)	1300 (1.4%)	870 (1.5%)	170 (1.5%)	9300 (1%)
174	Styrene	2200 (0.2%)	730 (0.1%)	180 (0.1%)	20 (0.1%)	320 (0.1%)	130 (0.1%)	90 (0.1%)	10 (0.1%)	1500 (0.2%)
191	Styrene-butadiene rubber	1500 (0.1%)	470 (0.1%)	140 (0.1%)	20 (0.1%)	150 (0.1%)	110 (0.1%)	60 (0.1%)	20 (0.1%)	1000 (0.1%)
69	Sugar dust	17900 (1.3%)	8000 (1.6%)	2600 (2%)	240 (1.7%)	3200 (1.4%)	1400 (1.5%)	930 (1.6%)	170 (1.5%)	9800 (1.1%)
224	Sulfur	270 (0%)	60 (0%)	20 (0%)	0 (0%)	10 (0%)	20 (0%)	10 (0%)	0 (0%)	210 (0%)
81	Sulphur dioxide	14500 (1%)	4800 (0.9%)	1900 (1.5%)	190 (1.3%)	1500 (0.6%)	870 (0.9%)	600 (1%)	110 (1%)	9600 (1.1%)
98	Sulphuric acid	10700 (0.8%)	3400 (0.7%)	860 (0.7%)	90 (0.6%)	1600 (0.7%)	510 (0.6%)	410 (0.7%)	60 (0.5%)	7300 (0.8%)
32	Synthetic adhesives	34900 (2.5%)	11300 (2.2%)	3900 (3%)	370 (2.6%)	4300 (1.9%)	1700 (1.9%)	1300 (2.3%)	320 (2.8%)	23600 (2.6%)
65	Synthetic fibres	18200 (1.3%)	7100 (1.4%)	2100 (1.6%)	190 (1.4%)	3000 (1.3%)	1200 (1.3%)	820 (1.4%)	170 (1.5%)	11100 (1.2%)
238	Tannic acid	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
61	Tin	19200 (1.4%)	5800 (1.1%)	1500 (1.2%)	170 (1.2%)	2800 (1.2%)	810 (0.9%)	690 (1.2%)	130 (1.1%)	13400 (1.5%)
84	Tin fumes	14100 (1%)	4100 (0.8%)	1100 (0.8%)	120 (0.9%)	1900 (0.8%)	590 (0.6%)	510 (0.9%)	100 (0.9%)	10000 (1.1%)
66	Titanium	18200 (1.3%)	6000 (1.2%)	2100 (1.6%)	200 (1.4%)	2400 (1%)	920 (1%)	640 (1.1%)	140 (1.2%)	12100 (1.3%)
120	Titanium dioxide	7600 (0.5%)	2600 (0.5%)	1500 (1.1%)	120 (0.8%)	520 (0.2%)	400 (0.4%)	290 (0.5%)	80 (0.7%)	4900 (0.5%)
241	Titanium dioxide fumes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
237	Tobacco dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
48	Toluene	24300 (1.7%)	8100 (1.6%)	3000 (2.3%)	270 (1.9%)	2800 (1.2%)	1400 (1.5%)	980 (1.7%)	210 (1.8%)	16200 (1.8%)
107	Trichloroethylene	9000 (0.6%)	2900 (0.6%)	550 (0.4%)	70 (0.5%)	1500 (0.6%)	480 (0.5%)	320 (0.5%)	90 (0.8%)	6200 (0.7%)
244	Trinitrotoluene	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
166	Tungsten compounds	2700 (0.2%)	760 (0.1%)	160 (0.1%)	20 (0.2%)	380 (0.2%)	120 (0.1%)	90 (0.2%)	20 (0.1%)	2000 (0.2%)
156	Turpentine	3400 (0.2%)	1100 (0.2%)	590 (0.5%)	50 (0.4%)	230 (0.1%)	200 (0.2%)	130 (0.2%)	40 (0.4%)	2300 (0.3%)
154	Unsaturated aliphatic hydrocarbons	3500 (0.3%)	1100 (0.2%)	310 (0.2%)	40 (0.3%)	390 (0.2%)	220 (0.2%)	140 (0.2%)	30 (0.3%)	2500 (0.3%)
182	Urea-formaldehyde	1800 (0.1%)	600 (0.1%)	350 (0.3%)	30 (0.2%)	120 (0.1%)	80 (0.1%)	60 (0.1%)	20 (0.2%)	1200 (0.1%)
231	Vanadium	110 (0%)	40 (0%)	10 (0%)	0 (0%)	20 (0%)	10 (0%)	0 (0%)	0 (0%)	70 (0%)
131	Vinyl chloride	5700 (0.4%)	2600 (0.5%)	530 (0.4%)	60 (0.4%)	1500 (0.7%)	250 (0.3%)	270 (0.5%)	40 (0.3%)	3100 (0.3%)
88	Waxes, polishes	13500 (1%)	5100 (1%)	1800 (1.4%)	150 (1.1%)	1800 (0.8%)	1000 (1.1%)	530 (0.9%)	100 (0.9%)	8400 (0.9%)
42	Welding fumes	27000 (1.9%)	8100 (1.6%)	2500 (1.9%)	290 (2.1%)	3100 (1.4%)	1400 (1.5%)	1000 (1.8%)	240 (2%)	18800 (2.1%)

Agent Rank[b]	CANJEM Chemical Agent Category[c]	# of Employees Exposed[a] (% of Demographic Group) All	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
200	Wood combustion products	1300 (0.1%)	510 (0.1%)	180 (0.1%)	20 (0.1%)	210 (0.1%)	60 (0.1%)	60 (0.1%)	10 (0.1%)	790 (0.1%)
23	Wood dust	48500 (3.4%)	14300 (2.8%)	6300 (4.9%)	650 (4.6%)	3700 (1.6%)	2400 (2.6%)	1900 (3.3%)	430 (3.7%)	34200 (3.8%)
101	Wood varnishes, stains and paints	10000 (0.7%)	3500 (0.7%)	1900 (1.4%)	150 (1%)	760 (0.3%)	520 (0.6%)	390 (0.7%)	100 (0.9%)	6500 (0.7%)
136	Wool fibres	5100 (0.4%)	2200 (0.4%)	630 (0.5%)	60 (0.4%)	970 (0.4%)	360 (0.4%)	230 (0.4%)	40 (0.4%)	2900 (0.3%)
90	Xylene	12200 (0.9%)	4100 (0.8%)	1700 (1.3%)	150 (1.1%)	1200 (0.5%)	730 (0.8%)	480 (0.8%)	110 (0.9%)	8200 (0.9%)
82	Zinc	14500 (1%)	4200 (0.8%)	1200 (0.9%)	140 (1%)	1800 (0.8%)	710 (0.8%)	540 (0.9%)	110 (1%)	10200 (1.1%)
100	Zinc fumes	10200 (0.7%)	2800 (0.5%)	780 (0.6%)	100 (0.7%)	1200 (0.5%)	400 (0.4%)	370 (0.6%)	80 (0.7%)	7400 (0.8%)
197	Zinc oxide	1300 (0.1%)	470 (0.1%)	180 (0.1%)	10 (0.1%)	190 (0.1%)	50 (0.1%)	50 (0.1%)	10 (0.1%)	870 (0.1%)

[a] Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000
[b] Agents are ranked by estimated number of exposed employees
[c] Table is sorted in alphabetical order by agent

Analysis 2: Estimates of Disproportionate Exposure – All Agents

Table A-3. Estimated number and percent of excess workers exposed to all CANJEM agents in King County by race and ethnicity, 2019.

		# Excess Employees Exposed (% of Demographic Group Disproportionately Exposed)							
Agent Rank[b]	CANJEM Chemical Agent Category[c]	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
167	1,1,1-Trichlorethane	-290 (-17.1%)	-120 (-28.1%)	-10 (-18.6%)	-170 (-21.8%)	-30 (-10%)	-10 (-6.8%)	30 (82.7%)	290 (9.7%)
193	Abrasives dust	-710 (-3.3%)	1600 (29.9%)	60 (9.5%)	-2000 (-20.6%)	-80 (-2.1%)	-150 (-6.2%)	0 (-0.8%)	710 (1.9%)
46	Acetate fibres	60 (29.5%)	10 (20%)	0 (0.1%)	50 (54.5%)	0 (-5.3%)	0 (12.5%)	0 (27.2%)	-60 (-16.7%)
35	Acetic acid	240 (4.5%)	400 (29.5%)	10 (3.8%)	-20 (-0.9%)	-140 (-14.5%)	70 (11.6%)	-10 (-6.4%)	-240 (-2.6%)
43	Acetone	100 (2.6%)	-80 (-7.9%)	-10 (-9.8%)	330 (18.6%)	-150 (-21.4%)	10 (2.6%)	-10 (-11.8%)	-100 (-1.4%)
159	Acetylene	-230 (-21.9%)	-20 (-9.1%)	10 (19.7%)	-170 (-35%)	-40 (-23.4%)	-10 (-6.9%)	0 (-0.9%)	230 (12.4%)
72	Acrylic fibres	0 (-0.5%)	20 (10%)	0 (4.5%)	0 (-0.1%)	-30 (-23%)	20 (17.2%)	0 (-10.5%)	0 (0.3%)
9	Aliphatic alcohols	3800 (10.8%)	1400 (15.9%)	0 (-0.3%)	1300 (8.2%)	1200 (19.1%)	180 (4.5%)	-80 (-10%)	-3800 (-6.1%)
3	Aliphatic aldehydes	7300 (16.4%)	5900 (51.6%)	350 (28.3%)	800 (4%)	60 (0.8%)	1300 (26.5%)	-10 (-0.5%)	-7300 (-9.3%)
155	Aliphatic esters	-190 (-10.3%)	50 (11.6%)	-10 (-11.3%)	-130 (-15.3%)	-100 (-30.5%)	0 (0%)	-10 (-20.7%)	190 (5.9%)
161	Aliphatic ketones	-240 (-3.6%)	160 (9.5%)	0 (-1.9%)	-120 (-4%)	-260 (-21.1%)	0 (0.6%)	-20 (-10.3%)	240 (2%)
114	Alkanes (C1-C4)	-60 (-0.9%)	590 (36.3%)	50 (30.5%)	-620 (-21.3%)	-60 (-5.1%)	60 (8.1%)	0 (-3.2%)	60 (0.5%)
237	Alkanes (C18+)	-2500 (-12.1%)	380 (7.4%)	50 (9%)	-2200 (-23.9%)	-580 (-15.7%)	-160 (-7%)	40 (8.6%)	2500 (6.8%)
225	Alkanes (C5-C17)	-1500 (-5.5%)	1900 (27.4%)	100 (13.6%)	-2800 (-23%)	-370 (-7.5%)	-200 (-6.6%)	90 (14.5%)	1500 (3.1%)
166	Alkyds	-280 (-9.4%)	640 (82.7%)	30 (35.1%)	-680 (-49.6%)	-170 (-31.3%)	-40 (-10.6%)	10 (10.8%)	280 (5.3%)
220	Alumina	-1300 (-13%)	290 (10.9%)	0 (1.5%)	-1000 (-21.5%)	-470 (-25.4%)	-130 (-11.3%)	-30 (-11.3%)	1300 (7.3%)
231	Aluminium	-2000 (-13.2%)	260 (6.9%)	0 (-0.8%)	-1400 (-20.5%)	-680 (-25.3%)	-190 (-11.4%)	0 (1.1%)	2000 (7.5%)
169	Aluminium fumes	-320 (-11.9%)	-90 (-12.9%)	-10 (-8.4%)	-120 (-9.7%)	-90 (-19.5%)	-40 (-13.5%)	0 (7%)	320 (6.8%)
10	Ammonia	2800 (13.2%)	2000 (36.5%)	80 (12.8%)	620 (6.5%)	290 (7.6%)	210 (8.6%)	-40 (-8.6%)	-2800 (-7.5%)
70	Anaesthetic gases	0 (0%)	-180 (-13.9%)	-40 (-29.6%)	310 (13.4%)	-60 (-6.4%)	-30 (-4.9%)	-30 (-27.3%)	0 (0%)
47	Animal, vegetable glues	50 (37%)	20 (57%)	0 (16.7%)	20 (34.6%)	10 (38.9%)	0 (-5.3%)	0 (82.2%)	-50 (-21%)
88	Antimony	-10 (-4.6%)	-10 (-15.3%)	0 (-26.4%)	10 (9.5%)	-10 (-27.9%)	0 (-15.4%)	0 (51.4%)	10 (2.6%)
39	Aromatic alcohols	160 (5.6%)	-10 (-1.9%)	0 (-3.9%)	340 (25.9%)	-150 (-28.8%)	10 (4%)	-20 (-36.8%)	-160 (-3.1%)
31	Aromatic amines	340 (7.8%)	630 (57.6%)	30 (22.1%)	-70 (-3.7%)	-180 (-23.2%)	10 (1.7%)	10 (6%)	-340 (-4.4%)
75	Arsenic	0 (-9.9%)	0 (-27.1%)	0 (-66.8%)	0 (27.7%)	0 (-59.3%)	0 (-38.1%)	0 (-18%)	0 (5.6%)
229	Asbestos	-1800 (-22.2%)	340 (16.6%)	60 (26.5%)	-1900 (-52.2%)	-290 (-19.5%)	-10 (-1.4%)	20 (13.2%)	1800 (12.6%)
8	Ashes	3900 (24.4%)	3100 (77.5%)	170 (37.9%)	80 (1.2%)	540 (18.7%)	510 (28.1%)	0 (0.9%)	-3900 (-13.8%)
177	Asphalt	-390 (-17.9%)	370 (66.6%)	30 (57.4%)	-610 (-61.8%)	-130 (-32.6%)	-30 (-12.5%)	10 (14.1%)	390 (10.1%)

		# Excess Employees Exposed (% of Demographic Group Disproportionately Exposed)							
Agent Rank[b]	CANJEM Chemical Agent Category[c]	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
112	Aviation gasoline	-50 (-11.9%)	-30 (-31.5%)	0 (-25.2%)	-20 (-10.1%)	-10 (-9%)	0 (-8.3%)	10 (124.2%)	50 (6.7%)
65	Basic lead carbonate	10 (5.6%)	80 (160.9%)	0 (62.8%)	-60 (-63.2%)	-10 (-20.9%)	0 (-6.7%)	0 (46.4%)	-10 (-3.2%)
171	Benzene	-360 (-7%)	610 (46.6%)	40 (25.7%)	-930 (-40%)	-20 (-2.5%)	-10 (-2.3%)	20 (20.4%)	360 (4%)
187	Benzo[a]pyrene	-560 (-7.7%)	500 (27%)	40 (21.4%)	-840 (-25.6%)	-180 (-13.8%)	-30 (-3.5%)	0 (-2%)	560 (4.4%)
85	Beryllium	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)
4	Biocides	7100 (13.6%)	2600 (19.7%)	10 (1%)	1900 (8.3%)	2700 (28.2%)	360 (6.1%)	-20 (-1.6%)	-7100 (-7.7%)
20	Bleaches	870 (22.1%)	120 (11.6%)	10 (6.9%)	550 (31.3%)	180 (25.1%)	50 (11.2%)	-10 (-9.9%)	-870 (-12.5%)
91	Brass dust	-20 (-2.4%)	-40 (-19.1%)	0 (-17.3%)	-30 (-10.1%)	60 (42.9%)	0 (-5.2%)	0 (-15.1%)	20 (1.3%)
191	Brick dust	-680 (-23.9%)	440 (60.7%)	40 (50.1%)	-870 (-67.9%)	-210 (-40.1%)	-40 (-11.1%)	0 (-7.3%)	680 (13.6%)
144	Bronze dust	-120 (-10.1%)	-60 (-21.4%)	-10 (-21.4%)	30 (5.3%)	-60 (-26.1%)	-30 (-20.1%)	-10 (-28.6%)	120 (5.7%)
66	Cadmium	10 (0.6%)	490 (102.4%)	20 (38.4%)	-370 (-43.7%)	-70 (-19.6%)	-20 (-10.2%)	20 (41.9%)	-10 (-0.4%)
76	Cadmium fumes	0 (-12.6%)	0 (-20.5%)	0 (-34%)	0 (5%)	0 (-43.8%)	0 (-8.5%)	0 (-78.1%)	0 (7.2%)
245	Calcium carbonate	-4600 (-20.3%)	280 (4.9%)	-10 (-1%)	-4000 (-39%)	-620 (-15%)	-220 (-8.4%)	-150 (-29.7%)	4600 (11.5%)
61	Calcium oxide	20 (0.5%)	570 (63.4%)	40 (40%)	-560 (-34.8%)	30 (5.1%)	-20 (-4%)	20 (19.4%)	-20 (-0.3%)
139	Calcium oxide fumes	-100 (-19%)	-20 (-12.3%)	0 (14.5%)	-60 (-26.4%)	-20 (-23.2%)	-10 (-10.2%)	0 (-1.8%)	100 (10.8%)
238	Calcium sulphate	-2900 (-23.1%)	1100 (34.7%)	100 (29.4%)	-3200 (-56.7%)	-700 (-31.3%)	-90 (-6.4%)	0 (-0.8%)	2900 (13.1%)
150	Carbon black	-150 (-10.6%)	-80 (-21%)	-10 (-25.7%)	-30 (-4.5%)	-40 (-13.6%)	-20 (-12.3%)	0 (5.7%)	150 (6%)
74	Carbon disulphide	0 (-9.7%)	0 (-57.1%)	0 (-100%)	0 (27.4%)	0 (-38.2%)	0 (-2.6%)	0 (-100%)	0 (5.5%)
233	Carbon monoxide	-2200 (-10.9%)	950 (19%)	90 (16.7%)	-2900 (-32.5%)	-270 (-7.5%)	-20 (-1%)	60 (14.5%)	2200 (6.2%)
98	Carbon tetrachloride	-30 (-4.6%)	-10 (-4.4%)	0 (-17.9%)	-10 (-3.3%)	-10 (-5.1%)	0 (-4.3%)	0 (-14.9%)	30 (2.6%)
86	Caustic alkali solutions	-10 (-0.1%)	360 (18.6%)	0 (0.3%)	-310 (-8.9%)	-30 (-1.9%)	40 (4.4%)	-30 (-17.4%)	10 (0.1%)
36	Cellulose	200 (1.2%)	-580 (-14.3%)	-80 (-18.6%)	1300 (17.7%)	-480 (-16.5%)	-40 (-2.2%)	-10 (-2.3%)	-200 (-0.7%)
96	Cellulose acetate	-20 (-22.2%)	0 (24.9%)	0 (0.3%)	-10 (-42.7%)	0 (-38.9%)	0 (-15.9%)	0 (-6%)	20 (12.6%)
99	Cellulose nitrate	-30 (-23.3%)	10 (21.3%)	0 (-3.1%)	-30 (-52.6%)	-10 (-28.2%)	0 (6.5%)	0 (-16.1%)	30 (13.2%)
53	Chlorinated alkanes	30 (0.5%)	-90 (-5.2%)	-10 (-6.8%)	370 (12.4%)	-260 (-22.2%)	10 (0.7%)	10 (5.7%)	-30 (-0.3%)
30	Chlorinated alkenes	360 (5.9%)	-200 (-12.9%)	-20 (-11.6%)	770 (28%)	-200 (-17.8%)	-30 (-4.2%)	10 (9.3%)	-360 (-3.4%)
51	Chlorine	30 (4%)	10 (7.3%)	0 (27.1%)	-80 (-27.2%)	100 (82.5%)	-10 (-7.6%)	0 (-6.7%)	-30 (-2.3%)
42	Chlorine dioxide	110 (26.7%)	20 (23.4%)	10 (46.2%)	-20 (-11.7%)	110 (147.1%)	0 (-9.1%)	0 (11.2%)	-110 (-15.1%)
131	Chloroform	-80 (-14.1%)	-50 (-30.6%)	-10 (-42.5%)	0 (-1.6%)	-20 (-23.2%)	0 (-5.2%)	-10 (-47.7%)	80 (8%)
214	Chromium	-1200 (-11.5%)	-40 (-1.6%)	-20 (-8.7%)	-490 (-10.8%)	-470 (-25.8%)	-160 (-13.8%)	-30 (-13.7%)	1200 (6.5%)
164	Chromium (VI)	-270 (-7.9%)	320 (37.4%)	10 (11.2%)	-400 (-26.1%)	-150 (-23.7%)	-30 (-8.3%)	0 (1.5%)	270 (4.5%)

		# Excess Employees Exposed (% of Demographic Group Disproportionately Exposed)							
Agent Rank[b]	**CANJEM Chemical Agent Category**[c]	**BIPOC**	**Hispanic**	**AIAN**	**Asian**	**Black**	**Multi-racial**	**NHPI**	**White**
179	Chromium fumes	-420 (-14.1%)	-150 (-19.6%)	-10 (-11.4%)	-90 (-6.4%)	-150 (-28.3%)	-50 (-14%)	-10 (-18%)	420 (8%)
147	Clay dust	-140 (-11.3%)	270 (89.7%)	20 (45.2%)	-320 (-59.2%)	-60 (-29.3%)	-20 (-11.4%)	10 (20.4%)	140 (6.4%)
1	Cleaning agents	12400 (16.5%)	6400 (33.8%)	280 (13.6%)	1900 (5.7%)	3800 (27.9%)	1100 (12.8%)	20 (1.2%)	-12400 (-9.3%)
69	Coal combustion products	0 (0.1%)	110 (33.7%)	0 (13.3%)	-80 (-13.8%)	-40 (-16.8%)	30 (20.9%)	-10 (-20.9%)	0 (0%)
128	Coal dust	-70 (-13%)	20 (12.8%)	0 (13.5%)	-90 (-35.4%)	-10 (-11.4%)	10 (20.7%)	0 (-12.9%)	70 (7.3%)
138	Coal tar and pitch	-100 (-12.6%)	180 (94.4%)	10 (71.1%)	-220 (-63.8%)	-40 (-32.7%)	-10 (-10.9%)	0 (-4.2%)	100 (7.1%)
142	Cobalt	-110 (-10.7%)	-60 (-23.2%)	-10 (-30.6%)	20 (5%)	-60 (-31.1%)	-10 (-11.1%)	-10 (-26.5%)	110 (6.1%)
82	Coke combustion products	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)
80	Coke dust	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)
240	Concrete dust	-3000 (-30.8%)	720 (29.1%)	100 (36.5%)	-2900 (-67%)	-730 (-41.5%)	-100 (-9.2%)	-10 (-3.4%)	3000 (17.5%)
2	Cooking fumes	10200 (24.8%)	6600 (62.9%)	390 (33.8%)	1200 (6.5%)	1900 (24.9%)	1400 (29.4%)	70 (7.1%)	-10200 (-14.1%)
196	Copper	-760 (-13.6%)	-300 (-21.6%)	-20 (-13.2%)	-300 (-12%)	-120 (-12.2%)	-70 (-10.7%)	0 (-0.9%)	760 (7.7%)
168	Copper fumes	-310 (-16.5%)	-60 (-12.8%)	0 (-4%)	-210 (-24.6%)	-50 (-15.8%)	-20 (-7.8%)	20 (43.6%)	310 (9.3%)
62	Cork dust	10 (17.5%)	0 (26.5%)	0 (20.6%)	0 (0.3%)	0 (23.9%)	0 (-4%)	0 (280.1%)	-10 (-9.9%)
16	Cosmetic talc	1600 (16.9%)	-220 (-9.5%)	-40 (-14.9%)	910 (21.6%)	920 (55.1%)	10 (0.9%)	-20 (-11.5%)	-1600 (-9.6%)
15	Cotton dust	1600 (20.5%)	300 (15.1%)	-10 (-4.2%)	760 (21.1%)	590 (41.2%)	20 (2.2%)	30 (16.4%)	-1600 (-11.6%)
101	Creosote	-40 (-8.1%)	160 (117%)	10 (79.8%)	-160 (-66.7%)	-30 (-29.1%)	-10 (-11.1%)	0 (-4%)	40 (4.6%)
188	Cristalline silica	-620 (-4.5%)	1800 (52%)	120 (32.1%)	-2300 (-37.1%)	20 (0.9%)	-100 (-6.2%)	20 (7.7%)	620 (2.5%)
105	Crude petroleum	-40 (-27.1%)	0 (14.5%)	0 (39%)	-30 (-53.9%)	-10 (-39.4%)	0 (-14.8%)	0 (43.7%)	40 (15.3%)
216	Cutting fluids post-1955	-1200 (-18.6%)	-450 (-27.7%)	-40 (-20.2%)	-280 (-9.8%)	-360 (-30.8%)	-120 (-17%)	-40 (-24.5%)	1200 (10.5%)
87	Cyanides	-10 (-1.5%)	10 (11.3%)	0 (-3.9%)	-10 (-4.4%)	-10 (-20.7%)	0 (7.8%)	0 (31.9%)	10 (0.8%)
236	Diesel engine emissions	-2500 (-12%)	900 (17.4%)	160 (28.2%)	-4000 (-43.6%)	350 (9.6%)	20 (0.7%)	230 (50.9%)	2500 (6.8%)
149	Diesel oil	-150 (-6.9%)	60 (11.2%)	20 (37.4%)	-370 (-37.9%)	110 (27.4%)	-10 (-2.8%)	50 (97.1%)	150 (3.9%)
97	Diethyl ether	-30 (-2.7%)	-90 (-32.9%)	-10 (-37.2%)	70 (13.4%)	10 (6%)	-10 (-10.2%)	-10 (-29.3%)	30 (1.5%)
244	Engine emissions	-3400 (-7.7%)	830 (7.4%)	60 (5.1%)	-4800 (-23.8%)	270 (3.4%)	50 (1%)	230 (22.5%)	3400 (4.4%)
132	Epoxies	-90 (-6.5%)	270 (76.7%)	10 (36.6%)	-280 (-45.4%)	-60 (-22.5%)	-10 (-6%)	10 (19.5%)	90 (3.7%)
21	Ethanol	860 (17.7%)	10 (0.6%)	0 (0.1%)	980 (44.5%)	-170 (-19.4%)	90 (17%)	-30 (-28.7%)	-860 (-10%)
100	Ethylene glycol	-40 (-3.3%)	-10 (-2.8%)	0 (-0.7%)	10 (1.1%)	-40 (-15.9%)	0 (0.5%)	0 (-11.1%)	40 (1.9%)
108	Ethylene oxide	-50 (-3%)	-90 (-22.9%)	-10 (-33.2%)	80 (10.8%)	-10 (-4.5%)	-10 (-5.5%)	-10 (-30.2%)	50 (1.7%)
158	Extenders	-220 (-4.5%)	840 (67.3%)	40 (28.6%)	-920 (-41.1%)	-90 (-10.2%)	-20 (-4.2%)	20 (19.4%)	220 (2.6%)
17	Fabric dust	1600 (13.5%)	590 (19.7%)	10 (2.5%)	390 (7.2%)	600 (28.2%)	80 (6%)	40 (16.8%)	-1600 (-7.6%)

		# Excess Employees Exposed (% of Demographic Group Disproportionately Exposed)							
Agent Rank[b]	CANJEM Chemical Agent Category[c]	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
113	Felt dust	-50 (-31.6%)	0 (-13.1%)	0 (20%)	-30 (-48.9%)	-10 (-50.8%)	0 (28.2%)	0 (-46.2%)	50 (17.9%)
110	Fertilizers	-50 (-6.7%)	120 (58.4%)	10 (45.3%)	-190 (-54%)	20 (12.9%)	10 (7.5%)	0 (19.6%)	50 (3.8%)
45	Flax fibres	90 (14%)	20 (12.9%)	0 (1.9%)	60 (19.7%)	10 (5.2%)	10 (12.1%)	0 (18.9%)	-90 (-7.9%)
12	Flour dust	1700 (21.6%)	1200 (59.6%)	80 (38%)	130 (3.7%)	250 (17.3%)	240 (26.2%)	30 (18.3%)	-1700 (-12.2%)
154	Fluorides	-170 (-13.1%)	-40 (-11.9%)	0 (11.8%)	-100 (-17.6%)	-30 (-12.5%)	-10 (-8.2%)	0 (3.6%)	170 (7.4%)
23	Fluorocarbons	540 (17.7%)	-70 (-9.1%)	0 (1.9%)	780 (56.6%)	-200 (-36.8%)	50 (15.1%)	-20 (-26.2%)	-540 (-10%)
5	Formaldehyde	6800 (18.3%)	5200 (55.3%)	310 (30%)	1200 (7.1%)	-120 (-1.7%)	1200 (27.3%)	10 (1.4%)	-6800 (-10.3%)
83	Formic acid	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)
129	Fur dust	-70 (-14.3%)	-20 (-12.7%)	0 (2.1%)	-50 (-20.3%)	-10 (-14.4%)	0 (7.8%)	0 (-39.2%)	70 (8.1%)
134	Glass dust	-90 (-16.4%)	60 (44.9%)	0 (25.8%)	-120 (-49.5%)	-30 (-25.7%)	0 (-1%)	0 (-11%)	90 (9.3%)
210	Glass fibres	-1000 (-25.7%)	220 (21.5%)	20 (21.3%)	-980 (-53.9%)	-250 (-33.8%)	-30 (-7.4%)	-10 (-12.1%)	1000 (14.6%)
60	Glycol ethers	20 (1.2%)	100 (22.2%)	0 (4.7%)	-30 (-4.4%)	-50 (-14.6%)	20 (10.5%)	-10 (-14.3%)	-20 (-0.7%)
182	Grain dust	-450 (-25.3%)	-40 (-8.9%)	20 (44.9%)	-460 (-57.8%)	0 (-0.3%)	20 (10.2%)	10 (20.9%)	450 (14.3%)
118	Graphite dust	-60 (-12.6%)	-10 (-8.6%)	0 (8.4%)	-120 (-56%)	70 (75.4%)	0 (8%)	0 (2.4%)	60 (7.1%)
19	Hair dust	910 (32.7%)	-30 (-4.1%)	10 (13.8%)	1100 (88.1%)	-210 (-42.4%)	90 (27.4%)	-30 (-52.4%)	-910 (-18.5%)
117	Heating oil	-60 (-7.9%)	160 (81.8%)	10 (56.2%)	-190 (-54.4%)	-20 (-14.4%)	-10 (-10.5%)	0 (8.9%)	60 (4.5%)
183	Hydraulic fluid	-460 (-16.4%)	50 (7.5%)	20 (22.6%)	-540 (-42.5%)	-30 (-6.4%)	0 (0.7%)	40 (67.6%)	460 (9.3%)
146	Hydrogen	-130 (-31.8%)	-20 (-19.3%)	0 (-7.6%)	-80 (-41.5%)	-30 (-43%)	0 (-5.8%)	0 (-35.7%)	130 (18%)
221	Hydrogen chloride	-1300 (-14.5%)	210 (9.2%)	10 (2.2%)	-1100 (-26.6%)	-360 (-22.2%)	-70 (-6.9%)	-20 (-8.6%)	1300 (8.2%)
71	Hydrogen cyanide	0 (-0.4%)	10 (15.7%)	0 (-0.3%)	-10 (-4.4%)	-10 (-19.3%)	0 (11.3%)	0 (12.4%)	0 (0.2%)
151	Hydrogen fluoride	-150 (-13.5%)	-20 (-7.1%)	10 (20%)	-120 (-23.1%)	-20 (-10.3%)	-10 (-6.1%)	0 (10.7%)	150 (7.6%)
22	Hydrogen peroxide	600 (17.2%)	-30 (-3.9%)	0 (-4.3%)	780 (49.9%)	-160 (-26.1%)	50 (13.9%)	-30 (-40%)	-600 (-9.8%)
175	Hydrogen sulphide	-380 (-28.3%)	-20 (-4.5%)	10 (21.5%)	-370 (-60.1%)	-10 (-5.8%)	0 (0.5%)	0 (-8.8%)	380 (16%)
11	Hypochlorites	2700 (20.6%)	1300 (37.9%)	50 (12.4%)	360 (6%)	1100 (44.9%)	180 (11.7%)	10 (4.7%)	-2700 (-11.6%)
122	Industrial talc	-70 (-4.2%)	270 (68.1%)	10 (32.3%)	-280 (-39.1%)	-40 (-13.8%)	-20 (-9.5%)	10 (31.7%)	70 (2.4%)
195	Inks	-710 (-15.4%)	-240 (-20.7%)	-30 (-23%)	-240 (-11.5%)	-190 (-22.9%)	-60 (-11.2%)	-10 (-12.3%)	710 (8.7%)
219	Inorganic acid solutions	-1300 (-11.6%)	170 (6%)	-10 (-4%)	-960 (-18.8%)	-410 (-20.1%)	-80 (-6.2%)	-40 (-15.1%)	1300 (6.6%)
239	Inorganic insulation dust	-2900 (-28.4%)	610 (23.9%)	80 (27.6%)	-2700 (-59.1%)	-710 (-39%)	-110 (-9.6%)	-20 (-8.3%)	2900 (16.1%)
190	Inorganic pigments	-660 (-7.1%)	1500 (64.2%)	70 (28%)	-1800 (-42.8%)	-260 (-15.1%)	-70 (-6.8%)	40 (17.8%)	660 (4%)
241	Iron	-3100 (-17.3%)	170 (3.7%)	30 (5.3%)	-2400 (-29.2%)	-770 (-23.7%)	-190 (-9.3%)	-30 (-7%)	3100 (9.8%)
205	Iron fumes	-980 (-16.9%)	-20 (-1.5%)	10 (8.6%)	-720 (-27.6%)	-220 (-21.4%)	-60 (-8.8%)	0 (1.6%)	980 (9.6%)

		# Excess Employees Exposed (% of Demographic Group Disproportionately Exposed)							
Agent Rank[b]	CANJEM Chemical Agent Category[c]	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
165	Iron oxides	-280 (-8.6%)	520 (62.3%)	30 (35.7%)	-730 (-49.2%)	-60 (-9.6%)	0 (-0.7%)	10 (18.5%)	280 (4.9%)
58	Isocyanates	20 (2.2%)	240 (106.4%)	10 (44.9%)	-200 (-49.4%)	-10 (-6.5%)	0 (3.6%)	0 (21.6%)	-20 (-1.2%)
6	Isopropanol	4700 (17.3%)	1600 (23.9%)	30 (3.8%)	1700 (14.1%)	1400 (28.7%)	210 (6.8%)	-20 (-3.8%)	-4700 (-9.8%)
52	Kerosene	30 (3.2%)	30 (16.2%)	0 (2.6%)	10 (1.8%)	0 (1.8%)	-10 (-14%)	0 (-15.9%)	-30 (-1.8%)
223	Lead	-1400 (-11%)	420 (12.8%)	30 (7.7%)	-1500 (-25.8%)	-300 (-12.7%)	-90 (-5.9%)	50 (16.4%)	1400 (6.2%)
57	Lead chromate	20 (3.5%)	100 (83.2%)	0 (36.4%)	-80 (-39.6%)	10 (6.6%)	0 (0.3%)	0 (29.6%)	-20 (-2%)
211	Lead fumes	-1100 (-12.4%)	210 (8.9%)	10 (5.7%)	-1000 (-25.4%)	-250 (-15.2%)	-70 (-6.9%)	20 (8.8%)	1100 (7%)
93	Lead oxides	-20 (-5.4%)	90 (103.1%)	0 (40.9%)	-80 (-52.1%)	-20 (-30.8%)	-10 (-12.4%)	0 (31.2%)	20 (3.1%)
121	Leaded gasoline	-70 (-3.2%)	90 (15.9%)	10 (22.9%)	-240 (-24%)	60 (15.7%)	-10 (-2.8%)	20 (46.2%)	70 (1.8%)
55	Leather dust	20 (33.8%)	0 (6%)	0 (-24.5%)	20 (74.5%)	0 (-10.5%)	0 (-29.4%)	0 (13.2%)	-20 (-19.1%)
89	Linseed oil	-20 (-0.9%)	620 (104.9%)	30 (38.8%)	-480 (-44.9%)	-120 (-27.3%)	-30 (-11%)	20 (36.5%)	20 (0.5%)
184	Liquid fuel combustion products	-490 (-21.9%)	230 (40%)	20 (35.2%)	-570 (-56.4%)	-120 (-30.4%)	-20 (-9.3%)	-10 (-10.8%)	490 (12.4%)
199	Lubricating oils and greases	-820 (-10.1%)	170 (8.4%)	30 (11.9%)	-1000 (-27.6%)	-50 (-3.6%)	10 (1.1%)	50 (29.9%)	820 (5.7%)
119	Magnesium	-60 (-13.6%)	-40 (-32.4%)	0 (-33.4%)	10 (3.2%)	-20 (-27.1%)	-10 (-16.8%)	0 (-34%)	60 (7.7%)
201	Manganese	-880 (-12.3%)	180 (9.9%)	20 (10.8%)	-830 (-25.6%)	-200 (-15.4%)	-60 (-7.3%)	0 (1.1%)	880 (7%)
198	Manganese fumes	-810 (-12.2%)	230 (13.4%)	30 (15%)	-840 (-28.1%)	-170 (-14%)	-50 (-6.6%)	0 (2.9%)	810 (6.9%)
130	Melamine-formaldehyde	-70 (-24.3%)	10 (10.7%)	0 (2.7%)	-60 (-50.9%)	-20 (-31.2%)	10 (16.9%)	0 (-8.2%)	70 (13.8%)
153	Mercury	-160 (-8.4%)	30 (6.6%)	-10 (-17.9%)	-70 (-7.7%)	-100 (-30.7%)	0 (-1.6%)	-10 (-26.9%)	160 (4.8%)
163	Metal coatings	-260 (-6.7%)	440 (45.1%)	20 (21.5%)	-690 (-39.8%)	10 (1.8%)	-10 (-2.7%)	20 (27.5%)	260 (3.8%)
226	Metal oxide fumes	-1600 (-15.8%)	80 (3.2%)	20 (7.9%)	-1300 (-28.5%)	-350 (-18.9%)	-90 (-7.4%)	0 (0.5%)	1600 (8.9%)
242	Metallic dust	-3200 (-17%)	-230 (-4.9%)	-20 (-2.9%)	-2000 (-23.9%)	-830 (-24.5%)	-170 (-7.9%)	-10 (-2.4%)	3200 (9.6%)
38	Methane	160 (10.9%)	150 (39.7%)	10 (26.9%)	-80 (-11.4%)	60 (22.4%)	40 (26%)	0 (9.7%)	-160 (-6.2%)
192	Methanol	-700 (-17.3%)	-210 (-20.2%)	-20 (-20.5%)	-350 (-19.5%)	-70 (-9.9%)	-60 (-12.8%)	-30 (-38.1%)	700 (9.8%)
143	Methyl methacrylate	-110 (-11.8%)	-10 (-3.2%)	-10 (-27.3%)	-40 (-8.6%)	-60 (-35.5%)	10 (5.5%)	-10 (-36.3%)	110 (6.7%)
27	Methylene chloride	520 (18.3%)	140 (19.6%)	10 (15.2%)	540 (42%)	-170 (-33.3%)	40 (13.7%)	-20 (-26.1%)	-520 (-10.4%)
115	Mica	-60 (-6.8%)	190 (82%)	10 (37%)	-190 (-47.7%)	-40 (-22.2%)	-10 (-7.6%)	0 (1.3%)	60 (3.9%)
234	Mild steel dust	-2200 (-20.7%)	-90 (-3.1%)	10 (4.1%)	-1600 (-33.2%)	-480 (-24.6%)	-90 (-7.6%)	-30 (-10.9%)	2200 (11.8%)
197	Mineral spirits post 1970	-790 (-4.6%)	1100 (26%)	40 (7.8%)	-1400 (-18.7%)	-280 (-9.1%)	-160 (-8.4%)	30 (8%)	790 (2.6%)
235	Mineral wool fibres	-2300 (-30.6%)	510 (26.7%)	60 (30%)	-2200 (-64.7%)	-560 (-41.2%)	-80 (-9.1%)	-10 (-7.8%)	2300 (17.3%)
228	Mononuclear aromatic hydrocarbons	-1800 (-8.5%)	1400 (26.3%)	80 (12.7%)	-2700 (-27.4%)	-460 (-11.8%)	-160 (-6.4%)	50 (10.3%)	1800 (4.8%)
37	Natural gas	190 (24.1%)	150 (73.7%)	10 (38.2%)	30 (9.5%)	0 (-2.2%)	30 (36.8%)	0 (-7.4%)	-190 (-13.7%)

		# Excess Employees Exposed (% of Demographic Group Disproportionately Exposed)							
Agent Rank[b]	CANJEM Chemical Agent Category[c]	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
7	Natural gas combustion products	4500 (25.4%)	3100 (69.3%)	170 (34.7%)	820 (10.1%)	320 (10.1%)	650 (32.3%)	20 (4%)	-4500 (-14.4%)
125	Natural rubber	-70 (-12.3%)	10 (4.7%)	10 (36.5%)	-100 (-40.4%)	20 (15.4%)	0 (3.3%)	0 (30.1%)	70 (7%)
212	Nickel	-1100 (-13.9%)	-490 (-25.7%)	-40 (-19.3%)	-110 (-3.1%)	-340 (-24.9%)	-130 (-15.5%)	-40 (-25.8%)	1100 (7.9%)
173	Nickel fumes	-380 (-13.2%)	-130 (-17.5%)	-10 (-9%)	-120 (-9.3%)	-110 (-20.6%)	-40 (-12.3%)	-10 (-14.6%)	380 (7.5%)
54	Nitrates	20 (73.1%)	0 (12.2%)	0 (42.9%)	10 (119%)	0 (40.6%)	0 (-30.2%)	0 (550.5%)	-20 (-41.4%)
162	Nitric acid	-250 (-20%)	-70 (-22.7%)	-10 (-31.7%)	-90 (-15.7%)	-70 (-30%)	-10 (-10%)	-10 (-44.5%)	250 (11.3%)
206	Nitrogen oxides	-1000 (-9.1%)	850 (30.6%)	80 (26%)	-1600 (-32.8%)	-230 (-11.7%)	0 (0.2%)	10 (5.5%)	1000 (5.2%)
73	Nitroglycerine	0 (-2.5%)	-10 (-28.2%)	0 (-18.1%)	0 (7.6%)	0 (11.5%)	0 (-7%)	0 (-17.7%)	0 (1.4%)
90	Nylon fibres	-20 (-1%)	160 (26.4%)	0 (4.6%)	-120 (-11.5%)	-80 (-18.2%)	30 (11.2%)	10 (20.7%)	20 (0.6%)
25	Organic dyes and pigments	530 (9.4%)	870 (61.4%)	40 (25.8%)	-30 (-1.4%)	-250 (-24.7%)	0 (0.1%)	10 (7.9%)	-530 (-5.3%)
202	Organic solvents	-890 (-1.6%)	3100 (21.3%)	70 (4.6%)	-2600 (-10.1%)	-950 (-9.3%)	-90 (-1.4%)	-60 (-4.7%)	890 (0.9%)
67	Other mineral oils	10 (0.4%)	-70 (-15.6%)	-10 (-20.6%)	190 (25.4%)	-90 (-31.2%)	-30 (-17.2%)	0 (6.5%)	-10 (-0.2%)
217	Other paints, varnishes	-1300 (-10.3%)	1400 (43.2%)	70 (18.5%)	-2100 (-36.2%)	-500 (-21.4%)	-90 (-5.8%)	30 (9.1%)	1300 (5.8%)
189	Other pyrolysis fumes	-640 (-11.3%)	10 (0.5%)	10 (5.2%)	-460 (-17.8%)	-160 (-15.9%)	-50 (-7.8%)	-10 (-4.6%)	640 (6.4%)
230	Ozone	-1900 (-6.3%)	-880 (-11.3%)	-40 (-5.1%)	-1300 (-9.4%)	210 (3.8%)	-110 (-3.1%)	30 (4.4%)	1900 (3.6%)
232	PAHs from any source	-2200 (-6.2%)	1300 (14%)	120 (12.1%)	-3500 (-21.3%)	-200 (-3.2%)	90 (2.2%)	100 (11.7%)	2200 (3.5%)
33	Perchloroethylene	240 (27.5%)	110 (49.4%)	0 (12.7%)	120 (29.4%)	40 (27.5%)	-10 (-11.7%)	0 (3.7%)	-240 (-15.6%)
109	Pesticides	-50 (-3.6%)	100 (30.9%)	0 (2.1%)	-190 (-31.4%)	10 (5%)	40 (26.9%)	0 (-3%)	50 (2.1%)
104	Phenol	-40 (-13.2%)	-20 (-24.9%)	0 (-21.1%)	-20 (-10.2%)	0 (-8.1%)	0 (-8.2%)	0 (-23%)	40 (7.5%)
120	Phenol-formaldehyde	-60 (-22.4%)	50 (63.8%)	0 (35%)	-80 (-65.9%)	-20 (-41%)	0 (-9%)	0 (8.3%)	60 (12.7%)
44	Phosgene	90 (44.9%)	30 (50.4%)	0 (10.4%)	40 (44.7%)	30 (81.4%)	0 (-2.2%)	0 (18.3%)	-90 (-25.5%)
59	Phosphoric acid	20 (2.1%)	20 (9.8%)	0 (-6%)	50 (12.3%)	-50 (-29.1%)	-10 (-8.5%)	0 (20.3%)	-20 (-1.2%)
127	Phthalates	-70 (-12.4%)	90 (67.5%)	10 (34%)	-120 (-50.2%)	-30 (-29.9%)	0 (-3.4%)	0 (-5.4%)	70 (7%)
207	Plastic dusts	-1000 (-15.9%)	240 (14.8%)	10 (4.6%)	-900 (-30.8%)	-350 (-29.7%)	-50 (-6.4%)	10 (8.7%)	1000 (9%)
50	Plastics pyrolysis fumes	40 (0.9%)	90 (8.6%)	10 (7.5%)	-80 (-3.9%)	-50 (-6.8%)	40 (8%)	40 (42.7%)	-40 (-0.5%)
94	Plating solutions	-20 (-8.8%)	-10 (-22.9%)	0 (-37.8%)	20 (20.1%)	-20 (-55.2%)	0 (-16.1%)	0 (-33.1%)	20 (5%)
145	Poly(vinyl acetate)	-130 (-5.9%)	610 (111.9%)	30 (49.7%)	-570 (-58.6%)	-120 (-29.9%)	-30 (-10.5%)	10 (28.6%)	130 (3.3%)
170	Poly(vinyl chloride)	-350 (-22.1%)	-40 (-10.9%)	0 (-4.5%)	-230 (-33.1%)	-80 (-26.8%)	-10 (-6.2%)	10 (21.3%)	350 (12.5%)
180	Polyacrylates	-430 (-14.2%)	180 (23.9%)	0 (1.3%)	-400 (-29.4%)	-170 (-31.4%)	-20 (-4.6%)	-10 (-20.8%)	430 (8%)
79	Polyamides	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)
148	Polychlorinated biphenyls or PCBs	-140 (-26.7%)	-30 (-24.4%)	0 (-15.1%)	-80 (-33.6%)	-30 (-27.6%)	0 (-4.4%)	0 (-35.4%)	140 (15.1%)

		# Excess Employees Exposed (% of Demographic Group Disproportionately Exposed)							
Agent Rank[b]	CANJEM Chemical Agent Category[c]	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
63	Polychloroprene	10 (9.8%)	0 (-26.5%)	0 (-20.6%)	-10 (-23.5%)	20 (142.4%)	0 (13%)	0 (6.9%)	-10 (-5.5%)
28	Polyester fibres	480 (14%)	220 (24.6%)	10 (7.5%)	220 (14.2%)	30 (4.8%)	50 (12.3%)	10 (9.6%)	-480 (-7.9%)
137	Polyesters	-100 (-10.6%)	-30 (-12.2%)	0 (-12.7%)	-50 (-11.5%)	-10 (-8.9%)	-10 (-5.2%)	0 (-18.5%)	100 (6%)
56	Polyethylene	20 (9.8%)	10 (14.2%)	0 (7.1%)	0 (4.3%)	0 (2.2%)	0 (-5.1%)	10 (197.5%)	-20 (-5.6%)
64	Polypropylene	10 (6.9%)	0 (8.1%)	0 (-3.1%)	0 (5.9%)	0 (-5.4%)	0 (-0.8%)	0 (152.2%)	-10 (-3.9%)
95	Polystyrene	-20 (-9%)	30 (53.2%)	0 (31.4%)	-50 (-40.4%)	-10 (-23.2%)	0 (-2.5%)	0 (30.1%)	20 (5.1%)
136	Polyurethanes	-100 (-4.7%)	370 (66.9%)	10 (21.8%)	-350 (-36.1%)	-90 (-23%)	-20 (-6.5%)	20 (38.6%)	100 (2.7%)
209	Portland cement	-1000 (-24.2%)	500 (47.5%)	60 (50.5%)	-1300 (-67.9%)	-210 (-28.4%)	-50 (-10.4%)	10 (12.9%)	1000 (13.7%)
141	Propane	-110 (-5.9%)	170 (35.8%)	10 (23.9%)	-320 (-37.2%)	40 (11.6%)	10 (2.6%)	0 (-3.5%)	110 (3.3%)
152	Propane combustion products	-160 (-2.5%)	700 (43.3%)	50 (28.9%)	-680 (-23.8%)	-180 (-15.9%)	80 (10.9%)	-20 (-10.9%)	160 (1.4%)
200	Propane engine emissions	-830 (-13.9%)	-150 (-9.6%)	10 (3.6%)	-780 (-28.7%)	-40 (-4.1%)	0 (-0.5%)	110 (80.8%)	830 (7.9%)
18	Propellant gases	1500 (19.6%)	420 (22.1%)	20 (11.4%)	980 (29.1%)	50 (3.4%)	110 (13.5%)	-30 (-19.5%)	-1500 (-11.1%)
41	Rayon fibres	120 (20.8%)	20 (16.3%)	0 (1.1%)	110 (39.4%)	-10 (-9.4%)	10 (12.3%)	0 (10.8%)	-120 (-11.8%)
107	RDX	-40 (-38.1%)	-10 (-38.5%)	0 (59.2%)	-30 (-74.2%)	0 (1.8%)	0 (11.7%)	0 (33.3%)	40 (21.6%)
102	Refractory brick dust	-40 (-11.3%)	80 (92%)	10 (54.5%)	-100 (-60.4%)	-20 (-26.9%)	-10 (-15.2%)	0 (1.4%)	40 (6.4%)
123	Rubber dust	-70 (-6.6%)	50 (17.7%)	10 (19.5%)	-170 (-34.3%)	40 (19.7%)	10 (4.5%)	0 (11.9%)	70 (3.7%)
124	Rubber pyrolysis fumes	-70 (-11.9%)	10 (9.1%)	0 (7.8%)	-80 (-29.2%)	-10 (-9%)	0 (1.2%)	0 (14.2%)	70 (6.7%)
48	Selenium	50 (3.8%)	450 (136%)	20 (56.8%)	-330 (-56.2%)	-40 (-15.3%)	-10 (-7.4%)	10 (41.3%)	-50 (-2.2%)
222	Silicon carbide	-1300 (-15.6%)	-40 (-2.1%)	-10 (-4.2%)	-730 (-20.2%)	-370 (-25.5%)	-120 (-13%)	-30 (-13.9%)	1300 (8.9%)
40	Silk fibres	140 (23.1%)	40 (25.8%)	0 (6.8%)	90 (35.7%)	0 (3%)	10 (9%)	0 (19.6%)	-140 (-13.1%)
174	Silver	-380 (-13.2%)	-70 (-9.5%)	-20 (-22.4%)	-100 (-7.5%)	-190 (-36%)	-10 (-2.2%)	-20 (-34.3%)	380 (7.5%)
157	Silver fumes	-200 (-20.3%)	-40 (-16.4%)	0 (-17.7%)	-70 (-16.5%)	-70 (-42.7%)	-10 (-7.2%)	-10 (-34.3%)	200 (11.5%)
29	Sodium carbonate	460 (14.5%)	470 (58.5%)	20 (22.9%)	-270 (-18.5%)	300 (51.6%)	0 (0.5%)	0 (5.6%)	-460 (-8.2%)
103	Sodium hydrosulphite	-40 (-13.2%)	0 (-1.3%)	0 (-1.2%)	-30 (-18.5%)	-20 (-30.1%)	0 (10.6%)	0 (-18.8%)	40 (7.5%)
224	Soldering fumes	-1400 (-20.5%)	-180 (-10.1%)	-20 (-8.7%)	-730 (-23%)	-460 (-36.4%)	-90 (-11.1%)	-30 (-17.3%)	1400 (11.6%)
181	Soot	-440 (-21.3%)	0 (-0.6%)	10 (14.5%)	-470 (-50.3%)	0 (-0.4%)	0 (-2.1%)	30 (57.1%)	440 (12%)
213	Stainless steel dust	-1100 (-15.8%)	-490 (-28.7%)	-40 (-22%)	-110 (-3.6%)	-350 (-28.6%)	-130 (-17.2%)	-40 (-29.3%)	1100 (9%)
13	Starch dust	1600 (26.1%)	950 (60.3%)	50 (29.9%)	390 (13.8%)	210 (18.4%)	170 (24.2%)	30 (19.8%)	-1600 (-14.8%)
116	Styrene	-60 (-7.9%)	-20 (-8.2%)	0 (-8.5%)	-30 (-8.6%)	-10 (-7.7%)	0 (-4.1%)	0 (-17.1%)	60 (4.5%)
126	Styrene-butadiene rubber	-70 (-12.3%)	10 (4.7%)	10 (36.5%)	-100 (-40.4%)	20 (15.4%)	0 (3.3%)	0 (30.1%)	70 (7%)
14	Sugar dust	1600 (24.4%)	970 (59.2%)	60 (35.5%)	260 (9%)	240 (20.4%)	190 (26.4%)	30 (19.9%)	-1600 (-13.8%)

		# Excess Employees Exposed (% of Demographic Group Disproportionately Exposed)							
Agent Rank[b]	CANJEM Chemical Agent Category[c]	BIPOC	Hispanic	AIAN	Asian	Black	Multi-racial	NHPI	White
106	Sulfur	-40 (-37.8%)	-10 (-38.2%)	0 (58%)	-30 (-73.6%)	0 (1.6%)	0 (10.8%)	0 (32.3%)	40 (21.4%)
178	Sulphur dioxide	-400 (-7.6%)	590 (44.1%)	40 (30%)	-890 (-37.7%)	-70 (-7.9%)	10 (1.3%)	-10 (-5.3%)	400 (4.3%)
185	Sulphuric acid	-500 (-12.9%)	-120 (-12%)	-20 (-20%)	-150 (-8.5%)	-190 (-26.8%)	-30 (-6%)	-30 (-32.4%)	500 (7.3%)
218	Synthetic adhesives	-1300 (-10.6%)	710 (22.2%)	20 (7%)	-1400 (-24.7%)	-550 (-24.3%)	-100 (-7%)	30 (11.5%)	1300 (6%)
26	Synthetic fibres	530 (8%)	450 (27.3%)	10 (6.1%)	60 (2%)	-10 (-0.8%)	70 (9.3%)	20 (15.6%)	-530 (-4.5%)
78	Tannic acid	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)
215	Tin	-1200 (-16.6%)	-270 (-15.3%)	-30 (-14.1%)	-360 (-11.4%)	-440 (-35%)	-100 (-13%)	-30 (-18.3%)	1200 (9.4%)
204	Tin fumes	-970 (-19%)	-210 (-15.9%)	-20 (-11.9%)	-370 (-16.3%)	-330 (-36.3%)	-70 (-12.6%)	-20 (-13.4%)	970 (10.7%)
186	Titanium	-520 (-7.9%)	430 (26.2%)	10 (7.5%)	-570 (-19.2%)	-260 (-22.2%)	-100 (-14%)	-10 (-4.7%)	520 (4.5%)
135	Titanium dioxide	-100 (-3.5%)	770 (111.7%)	40 (51.8%)	-720 (-58%)	-100 (-19.9%)	-20 (-7.6%)	20 (28.8%)	100 (2%)
81	Titanium dioxide fumes	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)
77	Tobacco dust	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)
194	Toluene	-710 (-8%)	740 (33.3%)	20 (9.3%)	-1200 (-29.1%)	-230 (-14.6%)	-20 (-2.4%)	10 (5.4%)	710 (4.6%)
176	Trichloroethylene	-390 (-12%)	-280 (-33.6%)	-30 (-27.6%)	10 (0.6%)	-110 (-18.8%)	-50 (-14.4%)	20 (25%)	390 (6.8%)
84	Trinitrotoluene	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)	0 (%)
160	Tungsten compounds	-230 (-22.9%)	-90 (-34.6%)	-10 (-20.6%)	-60 (-14%)	-60 (-33.6%)	-20 (-19.3%)	-10 (-23.8%)	230 (13%)
133	Turpentine	-90 (-7.6%)	270 (87%)	20 (47.2%)	-330 (-58.6%)	-20 (-11%)	-10 (-9.3%)	10 (44.9%)	90 (4.3%)
156	Unsaturated aliphatic hydrocarbons	-200 (-15.5%)	-20 (-4.9%)	10 (17.9%)	-190 (-32.5%)	-10 (-3.3%)	-10 (-3.7%)	10 (19.9%)	200 (8.8%)
111	Urea-formaldehyde	-50 (-7.6%)	190 (113.6%)	10 (45%)	-180 (-60.6%)	-40 (-33.8%)	-10 (-12.3%)	0 (24.5%)	50 (4.3%)
68	Vanadium	0 (5.5%)	0 (18.1%)	0 (-17.6%)	0 (13.5%)	0 (-27.6%)	0 (1.6%)	0 (-5.8%)	0 (-3.1%)
24	Vinyl chloride	530 (25.6%)	10 (2.5%)	10 (9.2%)	620 (66.1%)	-120 (-33.3%)	40 (15.7%)	-10 (-18.1%)	-530 (-14.5%)
34	Waxes, polishes	240 (4.8%)	580 (46.6%)	10 (11%)	-400 (-18.2%)	150 (16.9%)	-30 (-5.2%)	-10 (-8.5%)	-240 (-2.7%)
227	Welding fumes	-1600 (-16.8%)	0 (-0.1%)	20 (8.1%)	-1300 (-28.8%)	-350 (-20%)	-90 (-7.9%)	20 (7.1%)	1600 (9.5%)
49	Wood combustion products	40 (7.8%)	60 (49.7%)	0 (27%)	0 (-1.3%)	-20 (-24.2%)	10 (15%)	0 (-11.4%)	-40 (-4.4%)
243	Wood dust	-3200 (-18.3%)	1900 (42.4%)	160 (33.1%)	-4200 (-53.2%)	-800 (-25.3%)	-100 (-5%)	30 (8.2%)	3200 (10.4%)
140	Wood varnishes, stains and paints	-110 (-3.1%)	950 (104.1%)	50 (45.5%)	-870 (-53.1%)	-130 (-19.9%)	-20 (-6.1%)	20 (27.1%)	110 (1.8%)
32	Wool fibres	330 (17.7%)	160 (35.2%)	10 (15.5%)	140 (16.6%)	20 (7.5%)	20 (11.8%)	0 (5.7%)	-330 (-10%)

172	Xylene	-370 (-8.3%)	560 (50.5%)	30 (22.6%)	-820 (-41.1%)	-70 (-8.9%)	-20 (-3.9%)	10 (9.7%)	370 (4.7%)
208	Zinc	-1000 (-19.4%)	-140 (-10.9%)	-10 (-6.4%)	-600 (-25.4%)	-240 (-25.1%)	-60 (-9.6%)	-10 (-6.2%)	1000 (11%)
203	Zinc fumes	-920 (-24.9%)	-150 (-16.5%)	-10 (-6.2%)	-470 (-28.5%)	-270 (-40%)	-50 (-12.6%)	-10 (-7.4%)	920 (14.1%)
92	Zinc oxide	-20 (-3.4%)	60 (46.5%)	0 (-0.9%)	-30 (-14.2%)	-30 (-39.6%)	0 (-1.3%)	0 (-16.8%)	20 (1.9%)

[a] Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000

[b] Agents are ranked by estimates of disproportionate exposure for BIPOC employees

[c] Table is sorted in alphabetical order by agent

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Appendix B: Estimates of High Exposure

Analysis 1-B: Estimates of High Exposure – All Agents

Table B-1. Estimated prevalence of high exposures to all CANJEM agents in King County by race and ethnicity, 2019.

		# of Employees Highly Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	NHPI	Multi-racial	White
46	1,1,1-Trichlorethane	880 (0.1%)	240 (0%)	60 (0%)	10 (0.1%)	120 (0.1%)	40 (0%)	0 (0%)	30 (0.1%)	640 (0.1%)
20	Abrasives dust	1800 (0.1%)	620 (0.1%)	130 (0.1%)	10 (0.1%)	320 (0.1%)	100 (0.1%)	10 (0.1%)	70 (0.1%)	1200 (0.1%)
171	Acetate fibres	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
210	Acetic acid	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
77	Acetone	370 (0%)	140 (0%)	30 (0%)	0 (0%)	70 (0%)	20 (0%)	10 (0%)	10 (0%)	220 (0%)
193	Acetylene	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
128	Acrylic fibres	30 (0%)	20 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
21	Aliphatic alcohols	1800 (0.1%)	640 (0.1%)	160 (0.1%)	10 (0.1%)	300 (0.1%)	110 (0.1%)	10 (0.1%)	60 (0.1%)	1200 (0.1%)
38	Aliphatic aldehydes	1000 (0.1%)	310 (0.1%)	90 (0.1%)	10 (0.1%)	110 (0%)	60 (0.1%)	10 (0.1%)	40 (0.1%)	700 (0.1%)
35	Aliphatic esters	1100 (0.1%)	350 (0.1%)	80 (0.1%)	10 (0.1%)	180 (0.1%)	50 (0.1%)	10 (0.1%)	40 (0.1%)	750 (0.1%)
27	Aliphatic ketones	1300 (0.1%)	440 (0.1%)	90 (0.1%)	10 (0.1%)	240 (0.1%)	70 (0.1%)	10 (0.1%)	40 (0.1%)	850 (0.1%)
240	Alkanes (C1-C4)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
3	Alkanes (C18+)	8800 (0.6%)	2800 (0.5%)	780 (0.6%)	90 (0.6%)	1200 (0.5%)	430 (0.5%)	60 (0.6%)	300 (0.5%)	6000 (0.7%)
6	Alkanes (C5-C17)	5000 (0.4%)	1700 (0.3%)	660 (0.5%)	50 (0.4%)	620 (0.3%)	240 (0.3%)	40 (0.4%)	180 (0.3%)	3300 (0.4%)
59	Alkyds	580 (0%)	190 (0%)	30 (0%)	0 (0%)	110 (0%)	30 (0%)	0 (0%)	20 (0%)	400 (0%)
133	Alumina	20 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
32	Aluminium	1200 (0.1%)	400 (0.1%)	70 (0.1%)	10 (0.1%)	220 (0.1%)	60 (0.1%)	10 (0.1%)	40 (0.1%)	840 (0.1%)
109	Aluminium fumes	110 (0%)	40 (0%)	10 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	0 (0%)	70 (0%)
90	Ammonia	250 (0%)	120 (0%)	60 (0%)	0 (0%)	30 (0%)	30 (0%)	0 (0%)	10 (0%)	130 (0%)
195	Anaesthetic gases	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
144	Animal, vegetable glues	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
124	Antimony	40 (0%)	20 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	30 (0%)
242	Aromatic alcohols	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
131	Aromatic amines	30 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	30 (0%)
234	Arsenic	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
118	Asbestos	80 (0%)	20 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	70 (0%)
154	Ashes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
31	Asphalt	1200 (0.1%)	460 (0.1%)	290 (0.2%)	20 (0.2%)	70 (0%)	60 (0.1%)	10 (0.1%)	50 (0.1%)	780 (0.1%)

		# of Employees Highly Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	NHPI	Multi-racial	White
225	Aviation gasoline	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
162	Basic lead carbonate	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
78	Benzene	370 (0%)	140 (0%)	80 (0.1%)	10 (0%)	30 (0%)	20 (0%)	10 (0.1%)	10 (0%)	220 (0%)
87	Benzo[a]pyrene	270 (0%)	100 (0%)	60 (0%)	10 (0%)	20 (0%)	10 (0%)	0 (0%)	10 (0%)	170 (0%)
230	Beryllium	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
15	Biocides	2600 (0.2%)	770 (0.2%)	250 (0.2%)	20 (0.2%)	310 (0.1%)	120 (0.1%)	20 (0.2%)	100 (0.2%)	1800 (0.2%)
245	Bleaches	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
152	Brass dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
92	Brick dust	240 (0%)	60 (0%)	30 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	10 (0%)	180 (0%)
151	Bronze dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
237	Cadmium	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
203	Cadmium fumes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
26	Calcium carbonate	1300 (0.1%)	410 (0.1%)	210 (0.2%)	20 (0.2%)	70 (0%)	70 (0.1%)	10 (0.1%)	50 (0.1%)	930 (0.1%)
85	Calcium oxide	270 (0%)	110 (0%)	70 (0.1%)	0 (0%)	20 (0%)	10 (0%)	0 (0%)	10 (0%)	170 (0%)
197	Calcium oxide fumes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
34	Calcium sulphate	1100 (0.1%)	350 (0.1%)	210 (0.2%)	20 (0.1%)	60 (0%)	50 (0.1%)	10 (0.1%)	40 (0.1%)	720 (0.1%)
122	Carbon black	50 (0%)	10 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	40 (0%)
217	Carbon disulphide	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
53	Carbon monoxide	750 (0.1%)	200 (0%)	70 (0.1%)	10 (0.1%)	50 (0%)	40 (0%)	10 (0.1%)	30 (0.1%)	550 (0.1%)
215	Carbon tetrachloride	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
79	Caustic alkali solutions	340 (0%)	150 (0%)	70 (0.1%)	0 (0%)	40 (0%)	30 (0%)	0 (0%)	10 (0%)	190 (0%)
28	Cellulose	1200 (0.1%)	430 (0.1%)	120 (0.1%)	10 (0.1%)	180 (0.1%)	70 (0.1%)	30 (0.2%)	50 (0.1%)	820 (0.1%)
141	Cellulose acetate	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
172	Cellulose nitrate	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
19	Chlorinated alkanes	1900 (0.1%)	570 (0.1%)	130 (0.1%)	20 (0.1%)	280 (0.1%)	90 (0.1%)	10 (0.1%)	70 (0.1%)	1300 (0.1%)
17	Chlorinated alkenes	2400 (0.2%)	830 (0.2%)	180 (0.1%)	20 (0.2%)	430 (0.2%)	120 (0.1%)	20 (0.2%)	90 (0.2%)	1600 (0.2%)
43	Chlorine	890 (0.1%)	430 (0.1%)	100 (0.1%)	10 (0.1%)	130 (0.1%)	170 (0.2%)	10 (0.1%)	30 (0.1%)	470 (0.1%)
44	Chlorine dioxide	890 (0.1%)	430 (0.1%)	100 (0.1%)	10 (0.1%)	130 (0.1%)	170 (0.2%)	10 (0.1%)	30 (0.1%)	470 (0.1%)
216	Chloroform	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
33	Chromium	1200 (0.1%)	400 (0.1%)	70 (0.1%)	10 (0.1%)	220 (0.1%)	60 (0.1%)	10 (0.1%)	40 (0.1%)	840 (0.1%)
57	Chromium (VI)	670 (0%)	210 (0%)	40 (0%)	0 (0%)	120 (0.1%)	30 (0%)	0 (0%)	20 (0%)	450 (0.1%)

		# of Employees Highly Exposed[a] (% of Demographic Group)								
Agent Rank[b]	**CANJEM Chemical Agent Category[c]**	**All**	**BIPOC**	**Hispanic**	**AIAN**	**Asian**	**Black**	**NHPI**	**Multi-racial**	**White**
143	Chromium fumes	10 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
132	Clay dust	20 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
12	Cleaning agents	2900 (0.2%)	1200 (0.2%)	320 (0.2%)	30 (0.2%)	450 (0.2%)	300 (0.3%)	20 (0.2%)	120 (0.2%)	1700 (0.2%)
204	Coal combustion products	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
86	Coal dust	270 (0%)	60 (0%)	10 (0%)	0 (0%)	10 (0%)	20 (0%)	0 (0%)	10 (0%)	210 (0%)
91	Coal tar and pitch	250 (0%)	90 (0%)	60 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	10 (0%)	160 (0%)
233	Cobalt	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
207	Coke combustion products	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
183	Coke dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
41	Concrete dust	940 (0.1%)	220 (0%)	110 (0.1%)	10 (0.1%)	40 (0%)	30 (0%)	10 (0.1%)	30 (0.1%)	720 (0.1%)
1	Cooking fumes	17900 (1.3%)	8200 (1.6%)	2900 (2.2%)	260 (1.8%)	3200 (1.4%)	1200 (1.3%)	150 (1.3%)	1000 (1.7%)	9700 (1.1%)
48	Copper	850 (0.1%)	250 (0%)	50 (0%)	10 (0.1%)	120 (0.1%)	50 (0%)	10 (0.1%)	30 (0.1%)	600 (0.1%)
200	Copper fumes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
165	Cork dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
156	Cosmetic talc	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
100	Cotton dust	180 (0%)	90 (0%)	10 (0%)	0 (0%)	60 (0%)	10 (0%)	0 (0%)	0 (0%)	90 (0%)
145	Creosote	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
52	Cristalline silica	760 (0.1%)	200 (0%)	110 (0.1%)	10 (0.1%)	30 (0%)	30 (0%)	10 (0.1%)	20 (0%)	560 (0.1%)
224	Crude petroleum	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
4	Cutting fluids post-1955	6700 (0.5%)	2000 (0.4%)	410 (0.3%)	50 (0.4%)	1100 (0.5%)	330 (0.4%)	40 (0.3%)	230 (0.4%)	4700 (0.5%)
117	Cyanides	100 (0%)	30 (0%)	10 (0%)	0 (0%)	20 (0%)	0 (0%)	0 (0%)	0 (0%)	70 (0%)
13	Diesel engine emissions	2800 (0.2%)	740 (0.1%)	320 (0.2%)	50 (0.3%)	140 (0.1%)	150 (0.2%)	30 (0.3%)	110 (0.2%)	2000 (0.2%)
222	Diesel oil	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
212	Diethyl ether	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
11	Engine emissions	3700 (0.3%)	1300 (0.3%)	530 (0.4%)	50 (0.4%)	340 (0.1%)	260 (0.3%)	30 (0.3%)	160 (0.3%)	2400 (0.3%)
63	Epoxies	560 (0%)	180 (0%)	30 (0%)	0 (0%)	100 (0%)	30 (0%)	0 (0%)	20 (0%)	380 (0%)
107	Ethanol	150 (0%)	50 (0%)	10 (0%)	0 (0%)	30 (0%)	10 (0%)	0 (0%)	0 (0%)	100 (0%)
121	Ethylene glycol	60 (0%)	20 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	40 (0%)
75	Ethylene oxide	390 (0%)	150 (0%)	20 (0%)	0 (0%)	80 (0%)	30 (0%)	0 (0%)	10 (0%)	240 (0%)
115	Extenders	100 (0%)	30 (0%)	10 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	70 (0%)
70	Fabric dust	490 (0%)	240 (0%)	50 (0%)	0 (0%)	160 (0.1%)	20 (0%)	0 (0%)	20 (0%)	250 (0%)

		# of Employees Highly Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	NHPI	Multi-racial	White
167	Felt dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
88	Fertilizers	270 (0%)	60 (0%)	10 (0%)	0 (0%)	10 (0%)	20 (0%)	0 (0%)	10 (0%)	210 (0%)
164	Flax fibres	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
55	Flour dust	720 (0.1%)	280 (0.1%)	80 (0.1%)	10 (0.1%)	110 (0%)	60 (0.1%)	10 (0.1%)	30 (0.1%)	450 (0%)
227	Fluorides	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
67	Fluorocarbons	530 (0%)	230 (0%)	40 (0%)	0 (0%)	150 (0.1%)	20 (0%)	0 (0%)	20 (0%)	300 (0%)
37	Formaldehyde	1000 (0.1%)	310 (0.1%)	90 (0.1%)	10 (0.1%)	110 (0%)	60 (0.1%)	10 (0.1%)	40 (0.1%)	700 (0.1%)
211	Formic acid	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
126	Fur dust	30 (0%)	20 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
147	Glass dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
148	Glass fibres	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
120	Glycol ethers	80 (0%)	30 (0%)	10 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	0 (0%)	50 (0%)
25	Grain dust	1400 (0.1%)	350 (0.1%)	90 (0.1%)	20 (0.1%)	80 (0%)	100 (0.1%)	20 (0.2%)	60 (0.1%)	1000 (0.1%)
137	Graphite dust	20 (0%)	10 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
166	Hair dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
223	Heating oil	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
112	Hydraulic fluid	110 (0%)	20 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	90 (0%)
185	Hydrogen	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
119	Hydrogen chloride	80 (0%)	30 (0%)	10 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	0 (0%)	40 (0%)
186	Hydrogen cyanide	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
187	Hydrogen fluoride	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
83	Hydrogen peroxide	310 (0%)	150 (0%)	30 (0%)	0 (0%)	100 (0%)	10 (0%)	0 (0%)	20 (0%)	160 (0%)
189	Hydrogen sulphide	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
228	Hypochlorites	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
149	Industrial talc	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
45	Inks	890 (0.1%)	310 (0.1%)	70 (0.1%)	10 (0%)	170 (0.1%)	40 (0%)	10 (0.1%)	30 (0%)	580 (0.1%)
51	Inorganic acid solutions	790 (0.1%)	250 (0%)	50 (0%)	10 (0%)	150 (0.1%)	30 (0%)	0 (0%)	30 (0%)	530 (0.1%)
146	Inorganic insulation dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
95	Inorganic pigments	210 (0%)	70 (0%)	20 (0%)	0 (0%)	30 (0%)	10 (0%)	0 (0%)	10 (0%)	140 (0%)
18	Iron	2300 (0.2%)	750 (0.1%)	160 (0.1%)	20 (0.1%)	380 (0.2%)	130 (0.1%)	10 (0.1%)	80 (0.1%)	1500 (0.2%)
106	Iron fumes	160 (0%)	70 (0%)	30 (0%)	0 (0%)	20 (0%)	10 (0%)	0 (0%)	10 (0%)	100 (0%)

		# of Employees Highly Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	NHPI	Multi-racial	White
99	Iron oxides	180 (0%)	70 (0%)	10 (0%)	0 (0%)	20 (0%)	30 (0%)	0 (0%)	10 (0%)	110 (0%)
36	Isocyanates	1100 (0.1%)	430 (0.1%)	270 (0.2%)	20 (0.1%)	70 (0%)	60 (0.1%)	10 (0.1%)	40 (0.1%)	670 (0.1%)
56	Isopropanol	670 (0%)	270 (0.1%)	90 (0.1%)	10 (0.1%)	110 (0%)	50 (0.1%)	10 (0.1%)	20 (0%)	390 (0%)
221	Kerosene	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
66	Lead	530 (0%)	160 (0%)	30 (0%)	10 (0%)	80 (0%)	20 (0%)	0 (0%)	20 (0%)	370 (0%)
163	Lead chromate	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
68	Lead fumes	520 (0%)	150 (0%)	30 (0%)	10 (0%)	80 (0%)	20 (0%)	0 (0%)	20 (0%)	360 (0%)
161	Lead oxides	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
220	Leaded gasoline	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
140	Leather dust	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
74	Linseed oil	410 (0%)	130 (0%)	40 (0%)	0 (0%)	50 (0%)	20 (0%)	10 (0%)	10 (0%)	280 (0%)
103	Liquid fuel combustion products	170 (0%)	30 (0%)	10 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	0 (0%)	140 (0%)
96	Lubricating oils and greases	210 (0%)	50 (0%)	20 (0%)	0 (0%)	20 (0%)	10 (0%)	0 (0%)	10 (0%)	160 (0%)
231	Magnesium	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
113	Manganese	110 (0%)	40 (0%)	10 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	0 (0%)	70 (0%)
110	Manganese fumes	110 (0%)	40 (0%)	10 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	0 (0%)	70 (0%)
178	Melamine-formaldehyde	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
239	Mercury	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
58	Metal coatings	610 (0%)	190 (0%)	40 (0%)	0 (0%)	110 (0%)	30 (0%)	0 (0%)	20 (0%)	420 (0%)
29	Metal oxide fumes	1200 (0.1%)	390 (0.1%)	150 (0.1%)	20 (0.1%)	130 (0.1%)	60 (0.1%)	10 (0.1%)	50 (0.1%)	850 (0.1%)
7	Metallic dust	4700 (0.3%)	1400 (0.3%)	290 (0.2%)	40 (0.3%)	680 (0.3%)	240 (0.3%)	30 (0.3%)	160 (0.3%)	3300 (0.4%)
191	Methane	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
69	Methanol	510 (0%)	190 (0%)	80 (0.1%)	10 (0%)	60 (0%)	40 (0%)	0 (0%)	20 (0%)	320 (0%)
80	Methyl methacrylate	340 (0%)	100 (0%)	30 (0%)	0 (0%)	40 (0%)	10 (0%)	0 (0%)	20 (0%)	240 (0%)
108	Methylene chloride	120 (0%)	50 (0%)	10 (0%)	0 (0%)	20 (0%)	10 (0%)	0 (0%)	0 (0%)	70 (0%)
155	Mica	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
39	Mild steel dust	950 (0.1%)	320 (0.1%)	70 (0.1%)	10 (0.1%)	150 (0.1%)	70 (0.1%)	10 (0.1%)	30 (0.1%)	630 (0.1%)
8	Mineral spirits post 1970	4100 (0.3%)	1400 (0.3%)	540 (0.4%)	40 (0.3%)	530 (0.2%)	200 (0.2%)	40 (0.3%)	150 (0.3%)	2700 (0.3%)
153	Mineral wool fibres	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
10	Mononuclear aromatic hydrocarbons	3900 (0.3%)	1400 (0.3%)	610 (0.5%)	50 (0.3%)	410 (0.2%)	190 (0.2%)	40 (0.4%)	150 (0.3%)	2500 (0.3%)

		# of Employees Highly Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	NHPI	Multi-racial	White
190	Natural gas	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
23	Natural gas combustion products	1700 (0.1%)	780 (0.2%)	280 (0.2%)	20 (0.2%)	300 (0.1%)	110 (0.1%)	10 (0.1%)	100 (0.2%)	910 (0.1%)
169	Natural rubber	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
65	Nickel	560 (0%)	180 (0%)	30 (0%)	0 (0%)	100 (0%)	30 (0%)	0 (0%)	20 (0%)	380 (0%)
199	Nickel fumes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
229	Nitrates	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
208	Nitric acid	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
138	Nitrogen oxides	20 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
213	Nitroglycerine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
136	Nylon fibres	20 (0%)	10 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
104	Organic dyes and pigments	160 (0%)	50 (0%)	10 (0%)	0 (0%)	20 (0%)	10 (0%)	0 (0%)	0 (0%)	110 (0%)
2	Organic solvents	9000 (0.6%)	3100 (0.6%)	1200 (0.9%)	100 (0.7%)	1200 (0.5%)	460 (0.5%)	80 (0.7%)	330 (0.6%)	5900 (0.7%)
50	Other mineral oils	810 (0.1%)	280 (0.1%)	60 (0%)	10 (0%)	150 (0.1%)	30 (0%)	10 (0.1%)	30 (0%)	530 (0.1%)
14	Other paints, varnishes	2700 (0.2%)	930 (0.2%)	490 (0.4%)	40 (0.3%)	230 (0.1%)	130 (0.1%)	30 (0.2%)	100 (0.2%)	1800 (0.2%)
61	Other pyrolysis fumes	570 (0%)	210 (0%)	50 (0%)	10 (0%)	100 (0%)	30 (0%)	10 (0.1%)	20 (0%)	360 (0%)
123	Ozone	40 (0%)	20 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	30 (0%)
9	PAHs from any source	4100 (0.3%)	1300 (0.3%)	340 (0.3%)	40 (0.3%)	610 (0.3%)	200 (0.2%)	40 (0.3%)	150 (0.3%)	2800 (0.3%)
72	Perchloroethylene	430 (0%)	130 (0%)	50 (0%)	10 (0%)	40 (0%)	20 (0%)	0 (0%)	20 (0%)	300 (0%)
244	Pesticides	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
218	Phenol	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
81	Phenol-formaldehyde	330 (0%)	70 (0%)	30 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	10 (0%)	270 (0%)
194	Phosgene	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
209	Phosphoric acid	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
243	Phthalates	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
97	Plastic dusts	200 (0%)	70 (0%)	30 (0%)	0 (0%)	20 (0%)	10 (0%)	0 (0%)	10 (0%)	140 (0%)
24	Plastics pyrolysis fumes	1600 (0.1%)	580 (0.1%)	140 (0.1%)	10 (0.1%)	260 (0.1%)	90 (0.1%)	20 (0.2%)	60 (0.1%)	1000 (0.1%)
84	Plating solutions	290 (0%)	90 (0%)	20 (0%)	0 (0%)	50 (0%)	10 (0%)	0 (0%)	10 (0%)	200 (0%)
129	Poly(vinyl acetate)	30 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	30 (0%)
105	Poly(vinyl chloride)	160 (0%)	70 (0%)	20 (0%)	0 (0%)	30 (0%)	10 (0%)	0 (0%)	10 (0%)	90 (0%)
142	Polyacrylates	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
176	Polyamides	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

		# of Employees Highly Exposed[a] (% of Demographic Group)								
Agent Rank[b]	CANJEM Chemical Agent Category[c]	All	BIPOC	Hispanic	AIAN	Asian	Black	NHPI	Multi-racial	White
226	Polychlorinated biphenyls or PCBs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
182	Polychloroprene	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
94	Polyester fibres	230 (0%)	110 (0%)	30 (0%)	0 (0%)	60 (0%)	10 (0%)	0 (0%)	10 (0%)	130 (0%)
180	Polyesters	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
173	Polyethylene	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
174	Polypropylene	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
175	Polystyrene	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
179	Polyurethanes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
102	Portland cement	170 (0%)	30 (0%)	10 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	0 (0%)	140 (0%)
192	Propane	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
130	Propane combustion products	30 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	20 (0%)
30	Propane engine emissions	1200 (0.1%)	360 (0.1%)	100 (0.1%)	20 (0.1%)	110 (0%)	90 (0.1%)	20 (0.1%)	50 (0.1%)	850 (0.1%)
196	Propellant gases	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
127	Rayon fibres	30 (0%)	20 (0%)	0 (0%)	0 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
214	RDX	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
150	Refractory brick dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
184	Rubber dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
206	Rubber pyrolysis fumes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
235	Selenium	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
134	Silicon carbide	20 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
139	Silk fibres	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
236	Silver	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
202	Silver fumes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
157	Sodium carbonate	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
158	Sodium hydrosulphite	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
71	Soldering fumes	490 (0%)	170 (0%)	30 (0%)	0 (0%)	120 (0.1%)	10 (0%)	0 (0%)	10 (0%)	310 (0%)
101	Soot	180 (0%)	60 (0%)	20 (0%)	0 (0%)	20 (0%)	10 (0%)	0 (0%)	10 (0%)	120 (0%)
22	Stainless steel dust	1700 (0.1%)	540 (0.1%)	90 (0.1%)	10 (0.1%)	310 (0.1%)	80 (0.1%)	10 (0.1%)	50 (0.1%)	1100 (0.1%)
98	Starch dust	190 (0%)	60 (0%)	10 (0%)	0 (0%)	30 (0%)	10 (0%)	0 (0%)	10 (0%)	120 (0%)
54	Styrene	740 (0.1%)	240 (0.1%)	50 (0%)	10 (0%)	130 (0.1%)	40 (0%)	0 (0%)	30 (0%)	500 (0.1%)
181	Styrene-butadiene rubber	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Agent Rank[b]	CANJEM Chemical Agent Category[c]	# of Employees Highly Exposed[a] (% of Demographic Group) All	BIPOC	Hispanic	AIAN	Asian	Black	NHPI	Multi-racial	White
82	Sugar dust	320 (0%)	90 (0%)	20 (0%)	0 (0%)	30 (0%)	20 (0%)	0 (0%)	10 (0%)	240 (0%)
159	Sulfur	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
188	Sulphur dioxide	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
49	Sulphuric acid	820 (0.1%)	270 (0.1%)	50 (0%)	10 (0%)	160 (0.1%)	40 (0%)	0 (0%)	30 (0%)	550 (0.1%)
40	Synthetic adhesives	950 (0.1%)	330 (0.1%)	120 (0.1%)	10 (0.1%)	130 (0.1%)	40 (0%)	10 (0.1%)	30 (0.1%)	620 (0.1%)
76	Synthetic fibres	380 (0%)	190 (0%)	40 (0%)	0 (0%)	120 (0.1%)	20 (0%)	0 (0%)	10 (0%)	190 (0%)
170	Tannic acid	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
89	Tin	260 (0%)	100 (0%)	20 (0%)	0 (0%)	60 (0%)	10 (0%)	0 (0%)	10 (0%)	170 (0%)
93	Tin fumes	240 (0%)	90 (0%)	20 (0%)	0 (0%)	60 (0%)	10 (0%)	0 (0%)	10 (0%)	160 (0%)
60	Titanium	580 (0%)	190 (0%)	30 (0%)	0 (0%)	100 (0%)	30 (0%)	0 (0%)	20 (0%)	390 (0%)
135	Titanium dioxide	20 (0%)	10 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	20 (0%)
198	Titanium dioxide fumes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
168	Tobacco dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
16	Toluene	2500 (0.2%)	900 (0.2%)	420 (0.3%)	30 (0.2%)	270 (0.1%)	120 (0.1%)	20 (0.2%)	90 (0.2%)	1600 (0.2%)
47	Trichloroethylene	880 (0.1%)	240 (0%)	60 (0%)	10 (0.1%)	120 (0.1%)	40 (0%)	0 (0%)	30 (0.1%)	640 (0.1%)
219	Trinitrotoluene	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
238	Tungsten compounds	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
111	Turpentine	110 (0%)	30 (0%)	10 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	0 (0%)	70 (0%)
241	Unsaturated aliphatic hydrocarbons	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
177	Urea-formaldehyde	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
232	Vanadium	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
64	Vinyl chloride	560 (0%)	250 (0%)	50 (0%)	10 (0%)	140 (0.1%)	30 (0%)	10 (0.1%)	30 (0%)	310 (0%)
116	Waxes, polishes	100 (0%)	30 (0%)	10 (0%)	0 (0%)	20 (0%)	0 (0%)	0 (0%)	0 (0%)	70 (0%)
42	Welding fumes	920 (0.1%)	270 (0.1%)	100 (0.1%)	10 (0.1%)	90 (0%)	40 (0%)	10 (0.1%)	30 (0.1%)	650 (0.1%)
205	Wood combustion products	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
5	Wood dust	5100 (0.4%)	1800 (0.3%)	1000 (0.8%)	80 (0.6%)	330 (0.1%)	260 (0.3%)	60 (0.5%)	190 (0.3%)	3400 (0.4%)
62	Wood varnishes, stains and paints	570 (0%)	220 (0%)	140 (0.1%)	10 (0.1%)	30 (0%)	30 (0%)	10 (0.1%)	20 (0%)	350 (0%)
125	Wool fibres	30 (0%)	20 (0%)	0 (0%)	0 (0%)	20 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (0%)
73	Xylene	420 (0%)	160 (0%)	80 (0.1%)	10 (0%)	40 (0%)	20 (0%)	10 (0%)	10 (0%)	270 (0%)
114	Zinc	110 (0%)	40 (0%)	10 (0%)	0 (0%)	10 (0%)	10 (0%)	0 (0%)	0 (0%)	70 (0%)
201	Zinc fumes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

		# of Employees Highly Exposed[a] (% of Demographic Group)								
Agent Rank[b]	**CANJEM Chemical Agent Category[c]**	**All**	**BIPOC**	**Hispanic**	**AIAN**	**Asian**	**Black**	**NHPI**	**Multi-racial**	**White**
160	Zinc oxide	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

[a] Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000
[b] Agents are ranked by estimates for all employees
[c] Table is sorted in alphabetical order by agent

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Appendix C: Sensitivity Analysis

Sensitivity Analysis Results

Coverage analysis

A summary of CANJEM's coverage of industries and employees in King County in the stringent analysis are shown in Table C-1. Coverage of industries reduced from 136 (47.7%) in the primary analysis to 127 (44.6%) in the stringent analysis. Coverage of all employees reduced from 1,040,900 (73.6%) in the primary analysis to 1,024,400 (72.5%) in the stringent analysis. Lastly, coverage of BIPOC employees reduced from 372,100 (72.8%) in the primary analysis to 365,000 (71.4%) in the stringent analysis. Overall, this suggests that applying more stringent criteria for the CANJEM data had very little effect on coverage of exposure information for the King County workforce.

Sensitivity analysis for all worker exposure estimates

Comparison of all worker exposure estimates calculated in the primary analysis versus the more stringent analysis are present in Table C-2. In the both the primary and stringent analyses, cleaning agents, organic solvents, and biocides remained the most common exposures. Of the 25 most common exposures in the primary analysis, 24 of the agents remained in the top 25 rankings in the stringent analysis. Among the 25 most common exposures, using the more stringent confidence rating resulted in a reduction of burden estimates of 12.9 to 68.0%. The median percent reduction in the exposure estimates was 33.0%. (IQR: 25.6%, 35.6%).

In the entire dataset, using the more stringent confidence rating resulted in a reduction of exposure estimates from 0% (i.e., no change, 1 agent) to 100% (11 agents). The median percent reduction in the exposure estimates was 49.3% (IQR: 32.7%, 68.3%). The rank of exposures changed a minimum of zero positions to a maximum of 99 positions. The median change in ranks was 10 positions (IQR: 5, 21).

Overall, applying more stringent criteria lowered the overall exposure estimates, as expected, but had less effect on rankings of the agent categories in terms of most prevalent exposures in King County, especially among the most common occupational hazards.

Sensitivity analysis for BIPOC worker exposure estimates

Comparison of BIPOC worker exposure estimates calculated in the primary analysis versus the more stringent analysis are present in Table C-3. In the both the primary and stringent analyses, cleaning agents remained the most common exposure. Of the 25 most common exposures among BIPOC workers in the primary analysis, 23 of the agents remained in the top rankings in the stringent analysis. Among the 25 most common exposures experienced by BIPOC workers, using the more stringent confidence rating resulted in a reduction of burden estimates of 12.6 to 67.6%. The median percent reduction in the exposure estimates was 33.0%(IQR: 26.5%, 38.8%)

In the entire dataset, using the more stringent confidence rating resulted in a reduction of exposure estimates from 0% (i.e., no change, 1 agent) to 100% (11 agents). The median percent reduction in the exposure estimates was 49.9% (IQR: 31.9%, 69.1%). The rank of exposures changed a minimum of zero positions to a maximum of 102 positions. The median change in ranks was 9 positions (IQR: 3, 21).

Similar to the analysis of all workers, applying more stringent criteria had the expected effect of lowering the overall exposure estimates among BIPOC workers, but had less effect on rankings of the agent categories in terms of most prevalent exposures among this workforce, especially among the most common occupational hazards.

Sensitivity analysis for number of excess exposures

The results of the sensitivity analysis examining changes in the number of excess exposures identified within each race/ethnicity group as a result of using a more stringent confidence rating are presented in Table C-4. The number of agents in which a group is disproportionately exposed decreased for all race/ethnicity categories with a median reduction of 12 agents. The magnitude of reduction varied by race/ethnicity, with Asian and Black workers having one and two less excess exposures, respectively, and NHPI and AIAN having 19 and 25 less excess exposures. The latter finding of more change among NHPI and AIAN may be due smaller populations of these workers in King County, which results in a substantial reduction in the proportion of estimated workers exposed in these groups when the more stringent inclusion criteria are applied.

Table C-1. Summary of CANJEM coverage for stringent analysis. Table contains the number and percent of King County industries and employees within these industries with exposure information.

Indicator	Number of Industry Groups (%)	Number of Employees[a] (%)	Number of BIPOC Employees[a]
Total workforce	285 (100%)	1,413,400 (100%)	511,600 (100%)
Have exposure information	127 (44.6%)	1,024,400 (72.5%)	365,000 (71.4%)
No exposure information	158 (55.4%)	388,900 (27.5%)	146,200 (28.6%)

[a]Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000

Table C-2. Summary of sensitivity analysis results for exposures to all workers in King County, 2019.

	CANJEM Chemical Agent Category[b]	Primary analysis estimate (#)[a]	Stringent analysis estimate (#)[a]	Absolute change (#)[a]	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
1	Cleaning agents	208500	181600	-26900	-12.9	1	1	0
2	Organic solvents	156900	116400	-40600	-25.8	2	2	0
3	Biocides	144200	96600	-47600	-33	3	3	0
4	Aliphatic aldehydes	123800	50100	-73700	-59.5	4	10	6
5	Engine emissions	123500	89600	-34000	-27.5	5	5	0
6	Cooking fumes	114100	90200	-23800	-20.9	6	4	-2
7	Formaldehyde	103300	33000	-70200	-68	7	21	14
8	PAHs from any source	99600	74500	-25200	-25.3	8	6	-2
9	Aliphatic alcohols	97100	63800	-33300	-34.3	9	8	-1
10	Ozone	84700	64100	-20600	-24.3	10	7	-3
11	Alkanes (C5-C17)	75200	51400	-23800	-31.7	11	9	-2
12	Isopropanol	75000	49700	-25300	-33.8	12	11	-1
13	Calcium carbonate	63100	42000	-21100	-33.4	13	14	1
14	Mononuclear aromatic hydrocarbons	59400	43000	-16400	-27.7	14	13	-1
15	Abrasives dust	59100	33200	-25800	-43.8	15	20	5
16	Ammonia	58500	39100	-19400	-33.2	16	15	-1
17	Alkanes (C18+)	56800	38100	-18700	-32.9	17	16	-1
18	Diesel engine emissions	56400	34000	-22300	-39.6	18	18	0
19	Carbon monoxide	54500	43300	-11200	-20.6	19	12	-7
20	Metallic dust	51700	33800	-17900	-34.6	20	19	-1
21	Iron	49600	31500	-18100	-36.5	21	24	3
22	Natural gas combustion products	49400	32500	-16900	-34.2	22	22	0
23	Wood dust	48500	36400	-12100	-25	23	17	-6
24	Mineral spirits post 1970	47400	31700	-15600	-33	24	23	-1
25	Cellulose	44500	24000	-20500	-46	25	30	5
26	Ashes	44100	15100	-29000	-65.8	26	44	18
27	Aluminium	40900	21800	-19200	-46.8	27	33	6
28	Cristalline silica	38400	16300	-22100	-57.5	28	42	14
29	Hypochlorites	36500	25800	-10700	-29.3	29	27	-2
30	Other paints, varnishes	36200	24900	-11300	-31.1	30	29	-1
31	Lead	35800	27600	-8100	-22.7	31	25	-6
32	Synthetic adhesives	34900	26500	-8500	-24.3	32	26	-6
33	Calcium sulphate	34300	25100	-9200	-26.9	33	28	-5
34	Fabric dust	32800	21600	-11200	-34.2	34	34	0
35	Inorganic acid solutions	31300	17900	-13500	-43	35	38	3
36	Nitrogen oxides	30500	23600	-6900	-22.5	36	31	-5
37	Mild steel dust	29700	18600	-11100	-37.3	37	37	0
38	Alumina	28500	10500	-18000	-63.2	38	65	27
39	Inorganic insulation dust	28100	17200	-10900	-38.7	39	40	1

	CANJEM Chemical Agent Category[b]	Primary analysis estimate (#)[a]	Stringent analysis estimate (#)[a]	Absolute change (#)[a]	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
40	Metal oxide fumes	28000	20200	-7800	-27.9	40	35	-5
41	Chromium	27800	14100	-13700	-49.3	41	46	5
42	Welding fumes	27000	16800	-10100	-37.6	42	41	-1
43	Concrete dust	26900	21900	-5000	-18.5	43	32	-11
44	Inorganic pigments	25900	17500	-8400	-32.3	44	39	-5
45	Cosmetic talc	25700	10900	-14800	-57.7	45	62	17
46	Lead fumes	25300	20200	-5100	-20.3	46	36	-10
47	Hydrogen chloride	25000	11000	-14000	-56	47	58	11
48	Toluene	24300	13200	-11200	-45.9	48	50	2
49	Asbestos	22700	11000	-11700	-51.6	49	59	10
50	Lubricating oils and greases	22400	14100	-8400	-37.4	50	47	-3
51	Silicon carbide	22200	6700	-15600	-69.9	51	89	38
52	Cotton dust	22000	15400	-6500	-29.6	52	43	-9
53	Flour dust	21900	10700	-11200	-51.2	53	63	10
54	Caustic alkali solutions	21300	14700	-6600	-30.9	54	45	-9
55	Nickel	20900	12000	-8900	-42.7	55	54	-1
56	Propellant gases	20800	14000	-6700	-32.5	56	48	-8
57	Mineral wool fibres	20700	10600	-10100	-48.6	57	64	7
58	Benzo[a]pyrene	20100	6400	-13800	-68.4	58	92	34
59	Manganese	19900	8000	-11900	-59.7	59	78	19
60	Soldering fumes	19300	13800	-5500	-28.5	60	49	-11
61	Tin	19200	12600	-6600	-34.3	61	53	-8
62	Aliphatic ketones	18900	7400	-11400	-60.5	62	82	20
63	Stainless steel dust	18700	11600	-7100	-37.8	63	55	-8
64	Manganese fumes	18400	7400	-11000	-59.7	64	83	19
65	Synthetic fibres	18200	10200	-8000	-43.9	65	68	3
66	Titanium	18200	8700	-9400	-51.8	66	74	8
67	Chlorinated alkanes	18100	5800	-12400	-68.2	67	96	29
68	Plastic dusts	18000	10200	-7800	-43.5	68	69	1
69	Sugar dust	17900	6100	-11800	-66.1	69	93	24
70	Alkanes (C1-C4)	17800	10300	-7500	-42.1	70	67	-3
71	Cutting fluids post-1955	17700	12700	-5000	-28	71	51	-20
72	Propane combustion products	17500	10400	-7200	-40.9	72	66	-6
73	Starch dust	17100	9100	-8100	-47	73	72	-1
74	Chlorinated alkenes	16900	4500	-12400	-73.2	74	101	27
75	Propane engine emissions	16600	12600	-3900	-23.7	75	52	-23
76	Iron fumes	15900	9100	-6900	-43.1	76	73	-3
77	Other pyrolysis fumes	15800	7800	-8000	-50.6	77	80	3
78	Organic dyes and pigments	15500	7300	-8200	-53.1	78	84	6
79	Copper	15400	10900	-4400	-28.8	79	61	-18

	CANJEM Chemical Agent Category[b]	Primary analysis estimate (#)[a]	Stringent analysis estimate (#)[a]	Absolute change (#)[a]	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
80	Acetic acid	14700	11500	-3200	-21.6	80	56	-24
81	Sulphur dioxide	14500	11300	-3200	-22.3	81	57	-24
82	Zinc	14500	7100	-7300	-50.7	82	85	3
83	Benzene	14200	9100	-5100	-35.8	83	71	-12
84	Tin fumes	14100	8600	-5500	-38.7	84	75	-9
85	Anaesthetic gases	14000	7500	-6500	-46.6	85	81	-4
86	Extenders	13700	9900	-3800	-27.5	86	70	-16
87	Waxes, polishes	13500	10900	-2600	-19.3	87	60	-27
88	Ethanol	13500	3000	-10500	-77.7	88	124	36
89	Inks	12800	3800	-9000	-70.6	89	108	19
90	Xylene	12200	5600	-6600	-54	90	97	7
91	Plastics pyrolysis fumes	12000	7000	-5000	-41.8	91	86	-5
92	Aromatic amines	12000	5100	-7000	-57.9	92	99	7
93	Portland cement	11500	6900	-4600	-39.8	93	87	-6
94	Methanol	11100	7900	-3200	-28.9	94	79	-15
95	Glass fibres	11100	4600	-6600	-59	95	100	5
96	Acetone	11000	5900	-5100	-46.8	96	95	-1
97	Bleaches	10900	6400	-4500	-41.1	97	91	-6
98	Sulphuric acid	10700	6600	-4100	-38.7	98	90	-8
99	Metal coatings	10600	8000	-2600	-24.5	99	76	-23
100	Zinc fumes	10200	3600	-6600	-64.9	100	114	14
101	Wood varnishes, stains and paints	10000	8000	-2000	-19.8	101	77	-24
102	Calcium oxide	9900	2900	-7000	-71.1	102	125	23
103	Hydrogen peroxide	9600	5900	-3700	-39	103	94	-9
104	Polyester fibres	9600	3700	-5900	-61.6	104	109	5
105	Chromium (VI)	9400	3000	-6400	-67.7	105	121	16
106	Iron oxides	9100	3600	-5600	-61.1	106	115	9
107	Trichloroethylene	9000	3600	-5400	-60.2	107	113	6
108	Sodium carbonate	8800	240	-8500	-97.3	108	207	99
109	Fluorocarbons	8500	2000	-6500	-75.9	109	138	29
110	Alkyds	8400	3100	-5300	-63.3	110	120	10
111	Polyacrylates	8300	3400	-4900	-58.9	111	117	6
112	Chromium fumes	8200	2700	-5500	-67.1	112	128	16
113	Aromatic alcohols	8100	900	-7200	-88.8	113	169	56
114	Silver	8000	4400	-3500	-44.5	114	102	-12
115	Methylene chloride	7900	1200	-6700	-84.8	115	159	44
116	Brick dust	7900	5600	-2300	-29	116	98	-18
117	Nickel fumes	7900	2700	-5200	-65.6	117	127	10
118	Hydraulic fluid	7800	3700	-4100	-52.6	118	110	-8
119	Hair dust	7700	6800	-950	-12.3	119	88	-31

	CANJEM Chemical Agent Category[b]	Primary analysis estimate (#)[a]	Stringent analysis estimate (#)[a]	Absolute change (#)[a]	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
120	Titanium dioxide	7600	2300	-5200	-69.1	120	132	12
121	Aluminium fumes	7300	3400	-3900	-53.1	121	116	-5
122	Nylon fibres	6600	3000	-3600	-54.1	122	123	1
123	Linseed oil	6500	3300	-3200	-49.2	123	118	-5
124	Liquid fuel combustion products	6200	4000	-2200	-35.6	124	105	-19
125	Leaded gasoline	6200	4200	-2000	-31.8	125	103	-22
126	Asphalt	6100	3800	-2200	-36.7	126	106	-20
127	Polyurethanes	6000	2200	-3800	-63.9	127	136	9
128	Diesel oil	6000	4100	-1900	-31.7	128	104	-24
129	Poly(vinyl acetate)	6000	400	-5600	-93.3	129	194	65
130	Vinyl chloride	5700	80	-5600	-98.6	130	220	90
131	Soot	5700	3600	-2100	-36.5	131	112	-19
132	Propane	5300	1600	-3700	-69.2	132	146	14
133	Copper fumes	5300	2400	-2900	-55.2	133	129	-4
134	Mercury	5200	3800	-1500	-27.9	134	107	-27
135	Cadmium	5200	340	-4800	-93.5	135	199	64
136	Wool fibres	5100	3600	-1500	-28.6	136	111	-25
137	Aliphatic esters	5000	2200	-2800	-55.5	137	135	-2
138	Grain dust	4900	2300	-2600	-53.2	138	133	-5
139	Glycol ethers	4800	130	-4700	-97.3	139	214	75
140	Other mineral oils	4700	2000	-2700	-57.7	140	139	-1
141	1,1,1-Trichlorethane	4700	2400	-2300	-49.1	141	130	-11
142	Industrial talc	4400	830	-3600	-81	142	171	29
143	Ethylene oxide	4400	1800	-2600	-59.2	143	143	0
144	Poly(vinyl chloride)	4300	1400	-2900	-66.8	144	152	8
145	Methane	4100	1700	-2400	-58.1	145	144	-1
146	Carbon black	4000	1400	-2600	-64.2	146	151	5
147	Epoxies	3800	2700	-1000	-27.5	147	126	-21
148	Ethylene glycol	3800	1300	-2500	-66.5	148	158	10
149	Hydrogen sulphide	3700	1400	-2300	-61.5	149	153	4
150	Pesticides	3700	3000	-670	-18.2	150	122	-28
151	Fluorides	3700	1200	-2500	-67.8	151	161	10
152	Selenium	3600	180	-3400	-95	152	210	58
153	Unsaturated aliphatic hydrocarbons	3500	1900	-1600	-46.1	153	140	-13
154	Nitric acid	3500	2300	-1100	-32.6	154	131	-23
155	Turpentine	3400	2300	-1200	-34.1	155	134	-21
156	Coal combustion products	3400	1600	-1800	-51.9	156	145	-11
157	Clay dust	3300	520	-2800	-84.3	157	185	28
158	Bronze dust	3300	3300	-10	-0.3	158	119	-39
159	Rubber dust	3100	1500	-1600	-50.4	159	149	-10

	CANJEM Chemical Agent Category[b]	Primary analysis estimate (#)[a]	Stringent analysis estimate (#)[a]	Absolute change (#)[a]	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
160	Hydrogen fluoride	3100	620	-2500	-80	160	181	21
161	Diethyl ether	3100	1300	-1800	-58.3	161	155	-6
162	Acetylene	2900	1600	-1300	-45.9	162	148	-14
163	Cobalt	2800	560	-2200	-80.1	163	183	20
164	Tungsten compounds	2700	560	-2200	-79.6	164	183	19
165	Methyl methacrylate	2700	2100	-580	-21.6	165	137	-28
166	Silver fumes	2700	970	-1700	-63.5	166	166	0
167	Polyesters	2500	690	-1800	-72.7	167	175	8
168	Phosphoric acid	2500	660	-1900	-73.8	168	177	9
169	Mica	2500	0	-2500	-100	169	226	57
170	Isocyanates	2500	360	-2100	-85.4	170	195	25
171	Perchloroethylene	2500	1500	-970	-39.6	171	150	-21
172	Kerosene	2200	360	-1900	-83.7	172	196	24
173	Heating oil	2200	1200	-1000	-46.5	173	162	-11
174	Fertilizers	2200	1300	-860	-39.5	174	154	-20
175	Styrene	2200	620	-1600	-71.3	175	180	5
176	Acrylic fibres	2200	650	-1500	-69.9	176	178	2
177	Natural gas	2200	1200	-980	-45.4	177	160	-17
178	Brass dust	2100	1900	-240	-11.2	178	141	-37
179	Coal tar and pitch	2100	250	-1900	-88.3	179	206	27
180	Carbon tetrachloride	2000	1900	-110	-5.4	180	142	-38
181	Flax fibres	1900	1600	-260	-14	181	147	-34
182	Chlorine	1800	430	-1400	-76	182	192	10
183	Urea-formaldehyde	1800	680	-1100	-61.9	183	176	-7
184	Rubber pyrolysis fumes	1700	520	-1200	-69.7	184	187	3
185	Rayon fibres	1700	1100	-560	-33.6	185	163	-22
186	Chloroform	1600	920	-720	-43.8	186	167	-19
187	Silk fibres	1600	860	-750	-46.5	187	170	-17
188	Coal dust	1600	1300	-330	-20.8	188	157	-31
189	Glass dust	1500	1000	-520	-33.9	189	165	-24
190	Natural rubber	1500	440	-1100	-70.3	190	190	0
191	Styrene-butadiene rubber	1500	440	-1100	-70.3	190	190	0
192	Creosote	1500	120	-1400	-91.8	192	217	25
193	Polychlorinated biphenyls or PCBs	1500	400	-1100	-72.7	193	193	0
194	Phthalates	1500	270	-1200	-81.5	194	201	7
195	Calcium oxide fumes	1400	170	-1300	-87.9	195	212	17
196	Fur dust	1400	520	-860	-62.4	196	186	-10
197	Graphite dust	1300	920	-420	-31.4	197	168	-29
198	Zinc oxide	1300	780	-550	-41.4	198	172	-26
199	Wood combustion products	1300	1100	-250	-19.2	199	164	-35

	CANJEM Chemical Agent Category[b]	Primary analysis estimate (#)[a]	Stringent analysis estimate (#)[a]	Absolute change (#)[a]	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
200	Lead chromate	1300	630	-640	-50.3	200	179	-21
201	Magnesium	1300	1300	0	0	201	156	-45
202	Hydrogen	1100	490	-650	-57.2	202	188	-14
203	Chlorine dioxide	1100	0	-1100	-100	203	226	23
204	Aviation gasoline	1100	0	-1100	-100	204	226	22
205	Cyanides	1000	350	-660	-65.1	205	197	-8
206	Lead oxides	990	450	-540	-54.8	206	189	-17
207	Refractory brick dust	980	730	-250	-25.2	207	173	-34
208	Phenol	940	10	-930	-99	208	223	15
209	Sodium hydrosulphite	920	0	-920	-100	209	226	17
210	Hydrogen cyanide	850	260	-590	-69.8	210	204	-6
211	Melamine-formaldehyde	780	260	-520	-66.4	211	203	-8
212	Phenol-formaldehyde	780	130	-650	-83.8	212	215	3
213	Polystyrene	700	690	0	-0.7	213	174	-39
214	Plating solutions	660	620	-40	-6.7	214	182	-32
215	Phosgene	570	180	-390	-68.4	215	210	-5
216	Basic lead carbonate	570	270	-300	-52	216	200	-16
217	Acetate fibres	550	250	-300	-54.8	217	205	-12
218	Polyethylene	450	120	-330	-73	218	216	-2
219	Antimony	440	90	-350	-79	219	219	0
220	Felt dust	400	0	-400	-100	220	226	6
221	Cellulose nitrate	390	340	-50	-12.9	221	198	-23
222	Crude petroleum	360	110	-250	-68.9	222	218	-4
223	Animal, vegetable glues	350	220	-120	-35.4	223	208	-15
224	Sulfur	270	270	0	-0.8	224	202	-22
225	Polypropylene	270	10	-260	-97.7	225	224	-1
226	RDX	270	0	-270	-100	226	226	0
227	Nitroglycerine	240	190	-50	-20.6	227	209	-18
228	Leather dust	190	130	-60	-32.5	228	213	-15
229	Cellulose acetate	190	10	-180	-94.1	229	222	-7
230	Polychloroprene	180	0	-180	-100	230	226	-4
231	Vanadium	110	0	-110	-100	231	226	-5
232	Cork dust	80	0	-80	-98.2	232	225	-7
233	Arsenic	60	0	-60	-100	233	226	-7
234	Cadmium fumes	60	20	-40	-68.3	234	221	-13
235	Nitrates	60	0	-60	-100	235	226	-9
236	Carbon disulphide	20	0	-20	-100	236	226	-10

[a]Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000
[b]Table is sorted by agents with the highest exposure estimates in the primary analysis

Table C-3. Summary of sensitivity analysis results for exposures to BIPOC workers in King County, 2019.

	CANJEM Chemical Agent Category[b]	Primary analysis estimate[a] (#)	Stringent analysis estimate[a] (#)	Absolute change[a] (#)	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
1	Cleaning agents	87900	76800	-11100	-12.6	1	1	0
2	Biocides	59300	40000	-19300	-32.6	2	4	2
3	Organic solvents	55900	41900	-14000	-25	3	2	-1
4	Aliphatic aldehydes	52100	20900	-31200	-59.9	4	9	5
5	Cooking fumes	51500	40800	-10700	-20.8	5	3	-2
6	Formaldehyde	44200	14300	-29800	-67.6	6	14	8
7	Engine emissions	41200	29800	-11500	-27.8	7	5	-2
8	Aliphatic alcohols	38900	25500	-13400	-34.4	8	6	-2
9	PAHs from any source	33800	25200	-8600	-25.4	9	7	-2
10	Isopropanol	31800	20900	-11000	-34.5	10	10	0
11	Ozone	28700	21600	-7100	-24.8	11	8	-3
12	Alkanes (C5-C17)	25700	17700	-8000	-31	12	11	-1
13	Ammonia	24000	16300	-7700	-32.2	13	12	-1
14	Natural gas combustion products	22400	14600	-7800	-34.8	14	13	-1
15	Abrasives dust	20700	10800	-9900	-47.9	15	21	6
16	Ashes	19800	6800	-13100	-65.9	16	35	19
17	Mononuclear aromatic hydrocarbons	19700	14300	-5400	-27.5	17	15	-2
18	Calcium carbonate	18200	11600	-6600	-36.5	18	18	0
19	Alkanes (C18+)	18100	12000	-6100	-33.8	19	17	-2
20	Diesel engine emissions	17900	10600	-7300	-41	20	23	3
21	Carbon monoxide	17500	14100	-3500	-19.7	21	16	-5
22	Mineral spirits post 1970	16300	10900	-5400	-33	22	20	-2
23	Cellulose	16300	8900	-7400	-45.2	23	27	4
24	Hypochlorites	15900	11300	-4600	-28.6	24	19	-5
25	Metallic dust	15500	10200	-5400	-34.6	25	24	-1
26	Iron	14800	9400	-5500	-36.9	26	25	-1
27	Wood dust	14300	10700	-3600	-25.3	27	22	-5
28	Fabric dust	13500	9300	-4100	-30.7	28	26	-2
29	Cristalline silica	13300	4800	-8500	-64.1	29	46	17
30	Aluminium	12800	6800	-6000	-46.9	30	34	4
31	Other paints, varnishes	11800	8400	-3400	-28.9	31	30	-1
32	Lead	11500	8700	-2800	-24.4	32	29	-3
33	Synthetic adhesives	11300	8700	-2600	-22.7	33	28	-5
34	Cosmetic talc	10900	4900	-6000	-55.2	34	45	11
35	Inorganic acid solutions	10000	5600	-4400	-44.2	36	40	4
36	Nitrogen oxides	10000	7900	-2100	-20.7	35	31	-4
37	Flour dust	9700	4700	-4900	-51.3	37	47	10
38	Cotton dust	9600	7100	-2400	-25.3	38	32	-6
39	Calcium sulphate	9500	7000	-2500	-26.2	39	33	-6

	CANJEM Chemical Agent Category[b]	Primary analysis estimate[a] (#)	Stringent analysis estimate[a] (#)	Absolute change[a] (#)	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
40	Alumina	9000	3300	-5600	-62.8	41	67	26
41	Propellant gases	9000	6200	-2800	-31.3	40	37	-3
42	Chromium	8900	4400	-4500	-50.7	42	51	9
43	Inorganic pigments	8700	6100	-2600	-30.2	43	38	-5
44	Mild steel dust	8500	5400	-3100	-37	45	43	-2
45	Metal oxide fumes	8500	6100	-2500	-28.9	44	39	-5
46	Welding fumes	8100	5000	-3100	-37.9	46	44	-2
47	Toluene	8100	4500	-3600	-44.7	47	48	1
48	Lead fumes	8000	6200	-1800	-22.2	49	36	-13
49	Sugar dust	8000	2700	-5300	-66.5	48	81	33
50	Starch dust	7800	4200	-3600	-46.3	50	54	4
51	Hydrogen chloride	7700	3100	-4700	-60.2	51	69	18
52	Caustic alkali solutions	7700	5400	-2300	-29.5	52	42	-10
53	Inorganic insulation dust	7300	4400	-2900	-39.5	54	50	-4
54	Lubricating oils and greases	7300	4400	-2900	-39.3	53	49	-4
55	Synthetic fibres	7100	4000	-3100	-43.7	55	55	0
56	Silicon carbide	6800	2000	-4800	-70.1	56	94	38
57	Concrete dust	6700	5500	-1200	-17.6	57	41	-16
58	Benzo[a]pyrene	6700	2200	-4500	-66.6	58	90	32
59	Aliphatic ketones	6600	2700	-3900	-59.2	60	82	22
60	Chlorinated alkanes	6600	1800	-4700	-72	59	97	38
61	Nickel	6500	3600	-2900	-44.2	61	60	-1
62	Chlorinated alkenes	6500	1700	-4800	-73.6	62	99	37
63	Asbestos	6400	3100	-3300	-51.9	63	70	7
64	Alkanes (C1-C4)	6400	3400	-2900	-45.9	64	64	0
65	Manganese	6300	2500	-3800	-60.7	65	84	19
66	Propane combustion products	6200	3400	-2700	-44.4	66	65	-1
67	Organic dyes and pigments	6100	3000	-3100	-51.3	67	74	7
68	Titanium	6000	3000	-3100	-50.7	68	72	4
69	Tin	5800	3600	-2200	-37.5	70	61	-9
70	Manganese fumes	5800	2300	-3600	-60.8	69	88	19
71	Stainless steel dust	5700	3500	-2200	-39	72	63	-9
72	Ethanol	5700	1300	-4400	-77.2	71	107	36
73	Soldering fumes	5600	3800	-1800	-31.7	73	59	-14
74	Plastic dusts	5500	3100	-2400	-44	75	71	-4
75	Acetic acid	5500	4300	-1200	-22.2	74	52	-22
76	Mineral wool fibres	5200	2800	-2400	-46.6	77	78	1
77	Cutting fluids post-1955	5200	3800	-1400	-27	76	58	-18
78	Propane engine emissions	5200	3800	-1300	-25.6	78	57	-21
79	Other pyrolysis fumes	5100	2400	-2600	-51.9	80	86	6

	CANJEM Chemical Agent Category[b]	Primary analysis estimate[a] (#)	Stringent analysis estimate[a] (#)	Absolute change[a] (#)	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
80	Anaesthetic gases	5100	2700	-2400	-46.5	81	80	-1
81	Waxes, polishes	5100	4200	-910	-17.6	79	53	-26
82	Iron fumes	4800	2800	-2000	-42.2	85	79	-6
83	Copper	4800	3400	-1400	-30	83	66	-17
84	Sulphur dioxide	4800	3800	-990	-20.5	82	56	-26
85	Benzene	4800	3000	-1800	-37.7	86	73	-13
86	Bleaches	4800	2900	-1900	-38.7	84	75	-9
87	Extenders	4700	3600	-1100	-23.7	87	62	-25
88	Aromatic amines	4700	2100	-2600	-55.4	88	92	4
89	Plastics pyrolysis fumes	4400	2500	-1900	-43.9	89	85	-4
90	Zinc	4200	2100	-2200	-51	90	93	3
91	Tin fumes	4100	2300	-1800	-44	91	87	-4
92	Xylene	4100	1800	-2300	-56.1	94	98	4
93	Acetone	4100	2200	-1900	-47.1	92	91	-1
94	Hydrogen peroxide	4100	2500	-1500	-37.5	93	83	-10
95	Polyester fibres	4000	1600	-2400	-60.4	95	103	8
96	Inks	3900	1200	-2700	-69.2	96	110	14
97	Hair dust	3700	3300	-400	-10.8	97	68	-29
98	Metal coatings	3600	2800	-820	-22.7	100	77	-23
99	Calcium oxide	3600	940	-2600	-73.7	101	124	23
100	Sodium carbonate	3600	120	-3500	-96.7	98	199	101
101	Fluorocarbons	3600	750	-2900	-79.4	99	131	32
102	Wood varnishes, stains and paints	3500	2900	-650	-18.5	102	76	-26
103	Sulphuric acid	3400	1900	-1400	-42.6	104	96	-8
104	Methylene chloride	3400	450	-2900	-86.6	103	154	51
105	Methanol	3300	2300	-1100	-31.6	105	89	-16
106	Portland cement	3200	2000	-1200	-37.7	106	95	-11
107	Chromium (VI)	3100	930	-2200	-70.4	107	125	18
108	Aromatic alcohols	3100	280	-2800	-91.1	108	169	61
109	Glass fibres	3000	1300	-1700	-56	110	106	-4
110	Iron oxides	3000	1100	-1900	-62	109	113	4
111	Trichloroethylene	2900	1200	-1700	-59.5	111	112	1
112	Zinc fumes	2800	890	-1900	-67.8	112	126	14
113	Alkyds	2800	1100	-1600	-59.6	113	115	2
114	Polyacrylates	2600	1100	-1400	-56	116	114	-2
115	Titanium dioxide	2600	880	-1800	-66.5	114	127	13
116	Vinyl chloride	2600	30	-2600	-98.7	115	217	102
117	Chromium fumes	2500	770	-1800	-69.8	117	130	13
118	Silver	2500	1400	-1100	-45.2	118	105	-13
119	Nickel fumes	2500	770	-1700	-68.7	119	129	10

	CANJEM Chemical Agent Category[b]	Primary analysis estimate[a] (#)	Stringent analysis estimate[a] (#)	Absolute change[a] (#)	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
120	Nylon fibres	2400	1100	-1300	-53.3	120	117	-3
121	Hydraulic fluid	2300	1100	-1300	-53.6	121	119	-2
122	Aluminium fumes	2300	1100	-1200	-53.3	122	118	-4
123	Linseed oil	2300	1200	-1200	-49.7	123	111	-12
124	Brick dust	2200	1600	-530	-24.7	124	100	-24
125	Leaded gasoline	2200	1600	-580	-26.9	126	102	-24
126	Wool fibres	2200	1600	-550	-25.4	125	101	-24
127	Polyurethanes	2100	790	-1300	-61.8	127	128	1
128	Diesel oil	2000	1400	-640	-31.8	129	104	-25
129	Poly(vinyl acetate)	2000	140	-1900	-93.1	128	191	63
130	Cadmium	1900	130	-1800	-93.3	130	197	67
131	Asphalt	1800	1100	-700	-38.9	132	116	-16
132	Propane	1800	370	-1400	-79.6	131	162	31
133	Glycol ethers	1800	40	-1700	-97.6	133	215	82
134	Liquid fuel combustion products	1700	1200	-520	-29.8	134	109	-25
135	Mercury	1700	1200	-490	-28.5	135	108	-27
136	Other mineral oils	1700	670	-1000	-60.5	136	139	3
137	Methane	1700	710	-950	-57.4	137	134	-3
138	Soot	1600	1000	-590	-36.4	139	122	-17
139	Copper fumes	1600	680	-920	-57.6	140	138	-2
140	Aliphatic esters	1600	700	-940	-57.3	138	136	-2
141	Industrial talc	1500	340	-1200	-77.9	142	165	23
142	Ethylene oxide	1500	620	-910	-59.4	141	144	3
143	1,1,1-Trichlorethane	1400	700	-700	-49.9	143	135	-8
144	Selenium	1400	70	-1300	-94.7	144	208	64
145	Grain dust	1300	630	-700	-52.8	145	143	-2
146	Carbon black	1300	520	-780	-60	147	149	2
147	Epoxies	1300	950	-340	-26.2	149	123	-26
148	Ethylene glycol	1300	460	-850	-64.8	146	152	6
149	Pesticides	1300	1100	-230	-17.9	148	121	-27
150	Poly(vinyl chloride)	1200	310	-910	-74.2	151	166	15
151	Coal combustion products	1200	610	-630	-50.7	150	146	-4
152	Fluorides	1100	360	-780	-68.3	152	163	11
153	Unsaturated aliphatic hydrocarbons	1100	600	-480	-44.4	156	147	-9
154	Turpentine	1100	740	-410	-35.7	153	132	-21
155	Clay dust	1100	130	-930	-87.5	157	193	36
156	Bronze dust	1100	1100	0	-0.2	158	120	-38
157	Rubber dust	1100	520	-530	-50.5	159	150	-9
158	Diethyl ether	1100	440	-640	-59.1	155	156	1
159	Perchloroethylene	1100	730	-400	-35.7	154	133	-21

	CANJEM Chemical Agent Category[b]	Primary analysis estimate[a] (#)	Stringent analysis estimate[a] (#)	Absolute change[a] (#)	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
160	Nitric acid	1000	670	-340	-33.9	160	140	-20
161	Hydrogen sulphide	970	370	-600	-61.6	163	161	-2
162	Hydrogen fluoride	970	180	-780	-80.9	161	182	21
163	Natural gas	970	540	-430	-44.6	162	148	-14
164	Phosphoric acid	930	210	-720	-77.6	164	179	15
165	Isocyanates	920	140	-780	-85.2	165	192	27
166	Cobalt	900	180	-720	-80.1	166	183	17
167	Methyl methacrylate	860	650	-210	-24.1	167	141	-26
168	Mica	840	0	-840	-100	168	226	58
169	Acetylene	830	460	-370	-44.4	169	153	-16
170	Kerosene	830	120	-700	-85	170	198	28
171	Polyesters	820	240	-580	-70.5	171	174	3
172	Acrylic fibres	780	280	-500	-63.6	172	167	-5
173	Silver fumes	770	230	-540	-70.4	173	177	4
174	Tungsten compounds	760	180	-580	-76.3	175	183	8
175	Flax fibres	760	630	-140	-17.9	174	142	-32
176	Brass dust	750	680	-70	-9.2	176	137	-39
177	Fertilizers	740	440	-300	-40.5	177	157	-20
178	Heating oil	730	400	-330	-45.3	178	159	-19
179	Styrene	730	220	-510	-70.2	179	178	-1
180	Rayon fibres	730	470	-260	-35.8	180	151	-29
181	Silk fibres	720	350	-370	-50.9	181	164	-17
182	Carbon tetrachloride	680	610	-60	-9.4	183	145	-38
183	Chlorine	680	130	-550	-81.1	182	195	13
184	Coal tar and pitch	660	90	-570	-86.1	184	204	20
185	Urea-formaldehyde	600	200	-400	-66.3	185	180	-5
186	Rubber pyrolysis fumes	540	160	-380	-69.7	186	185	-1
187	Chlorine dioxide	520	0	-520	-100	187	226	39
188	Chloroform	510	250	-250	-49.8	189	171	-18
189	Wood combustion products	510	450	-60	-11.4	188	155	-33
190	Coal dust	500	410	-90	-17.7	190	158	-32
191	Creosote	490	30	-460	-93.4	191	219	28
192	Lead chromate	480	240	-240	-50.4	192	175	-17
193	Natural rubber	470	140	-330	-69.6	193	189	-4
194	Styrene-butadiene rubber	470	140	-330	-69.6	193	189	-4
195	Phthalates	470	90	-380	-81.1	196	205	9
196	Zinc oxide	470	280	-180	-39.7	195	168	-27
197	Glass dust	460	270	-190	-41.3	197	170	-27
198	Fur dust	430	160	-260	-61.7	198	186	-12
199	Calcium oxide fumes	420	50	-370	-89.1	200	214	14

	CANJEM Chemical Agent Category[b]	Primary analysis estimate[a] (#)	Stringent analysis estimate[a] (#)	Absolute change[a] (#)	Percent change (%)	Primary analysis rank	Stringent analysis rank	Rank change
200	Graphite dust	420	250	-180	-41.9	199	173	-26
201	Magnesium	400	400	0	0	201	160	-41
202	Polychlorinated biphenyls or PCBs	390	130	-260	-67.4	202	196	-6
203	Cyanides	360	110	-250	-68.9	203	200	-3
204	Aviation gasoline	350	0	-350	-100	204	226	22
205	Lead oxides	340	160	-180	-53.5	205	187	-18
206	Refractory brick dust	310	250	-70	-21	206	172	-34
207	Phenol	300	0	-290	-99.2	209	224	15
208	Hydrogen cyanide	300	80	-220	-73.1	207	206	-1
209	Phosgene	300	70	-230	-76	208	208	0
210	Sodium hydrosulphite	290	0	-290	-100	210	226	16
211	Hydrogen	280	150	-130	-45.6	211	188	-23
212	Acetate fibres	260	130	-130	-49.4	212	194	-18
213	Polystyrene	230	230	0	-0.5	213	176	-37
214	Phenol-formaldehyde	220	30	-190	-84.7	216	218	2
215	Plating solutions	220	200	-20	-7.5	215	181	-34
216	Basic lead carbonate	220	110	-110	-51.1	214	202	-12
217	Melamine-formaldehyde	210	60	-150	-70.8	217	211	-6
218	Polyethylene	180	50	-130	-72.3	218	213	-5
219	Animal, vegetable glues	170	110	-60	-35.6	219	201	-18
220	Antimony	150	30	-120	-81	220	220	0
221	Cellulose nitrate	110	100	-10	-11.1	221	203	-18
222	Felt dust	100	0	-100	-100	223	226	3
223	Crude petroleum	100	40	-60	-61.3	224	216	-8
224	Polypropylene	100	0	-100	-97.1	222	222	0
225	Nitroglycerine	90	70	-10	-14.1	226	207	-19
226	Leather dust	90	70	-20	-25.8	225	210	-15
227	Polychloroprene	70	0	-70	-100	227	226	-1
228	Sulfur	60	60	0	-1.2	228	212	-16
229	RDX	60	0	-60	-100	229	226	-3
230	Cellulose acetate	50	0	-50	-95.6	230	223	-7
231	Vanadium	40	0	-40	-100	231	226	-5
232	Nitrates	40	0	-40	-100	232	226	-6
233	Cork dust	30	0	-30	-99.5	233	225	-8
234	Arsenic	20	0	-20	-100	234	226	-8
235	Cadmium fumes	20	10	-10	-64.9	235	221	-14
236	Carbon disulphide	10	0	-10	-100	236	226	-10

[a]Employee counts are rounded to the nearest 10s if <1000, and to the nearest 100s if >1000
[b]Table is sorted by agents with the highest exposures estimates in the primary analysis

Table C-4. Summary of sensitivity analysis results showing changes in the number of disproportionate exposures. The results compare changes in the number of disproportionate exposures in the primary analysis to that of the analysis using a more stringent exposure assignment reliability rating.

Race/ethnicity	# Disproportionate exposures in primary analysis	# Disproportionate exposures in stringent analysis	Change in # of disproportionate exposures
Hispanic	149	130	-19
BIPOC	67	61	-6
AIAN	118	93	-25
Asian	56	55	-1
Black	48	46	-2
Multiracial	60	51	-9
NHPI	73	54	-19
White	160	145	-15