



STATE OF WASHINGTON

May 13, 2024

John J. Howard, Director
National Institute for Occupational Safety and Health
Centers for Disease Control and Prevention
Department of Health and Human Service

RE: National Institute for Occupational Safety and Health; Outdoor Workers Exposed to Wildland Fire Smoke; Request for Information [Docket ID No. CDC-2024-0019, NIOSH-352]

Dear Director Howard:

Thank you for this opportunity to respond to the Request for Information (RFI) on Outdoor Workers Exposed to Wildland Fire Smoke, published in the March 14, 2024, issue of the Federal Register. As of December 2023, Washington became the third U.S. state to enact permanent occupational safety and health rules to protect outdoor workers from the hazards posed by wildland fire smoke. Much of the scientific information Washington relied upon to support that rulemaking is reviewed and summarized in the *Final Cost-Benefit Analysis & Significant Legislative Rule Analysis* (December 2023) developed and published by the Washington State Department of Labor and Industries (L&I) Division of Occupational Safety and Health (DOSH).¹ It contains technical information responsive to several of the domains you identify in this RFI.

L&I as well as the Washington state departments of Health (DOH) and Ecology (ECY) submit the following additional information in support of three recommendations we make as you consider the development of evidence-based guidance to protect outdoor workers from wildfire smoke:

- Use epidemiologically based scientific thresholds for action and to categorize recommended health messages based on exposure levels of PM_{2.5} concentrations rather than based solely on the EPA's Air Quality Index.
- In recognition of the disproportionate risk of adverse health outcomes to wildfire-smoke-exposed outdoor workers, when developing health messages and recommendations, ensure they address the specific exposures and risks to workers above and beyond those of the general public.
- Design recommendations for outdoor workers that are feasible and responsive to workers' needs. Infeasible recommendations can be an issue with interventions that are not specific to or adequate for the occupational setting. Engagement with workers is necessary to understand their practical needs.

¹ Available at <https://www.lni.wa.gov/rulemaking-activity/AO20-29/2029FCBA.pdf>

The Washington experience with a multidisciplinary approach

Given the complexity of the science acknowledged in the RFI coupled with the breadth and frequency of these exposures on the West Coast, L&I, DOH, and ECY have found success in transforming scientific review into sound public policy by bringing resources from multiple disciplines together to address a health hazard that only continues to grow in importance.

This approach has been crucial in the continuous development of state-level health messaging recommendations that advise workers as well as the public more broadly on how:

1. To evaluate the degree to which wildfire smoke poses a hazard (hazard identification).
2. To determine the sensitivity of the population (vulnerability).
3. To take action in response (intervention).

Airborne particles 2.5 microns in diameter or smaller (PM_{2.5}) are a key wildfire smoke constituent of health concern, and as the degree to which they pollute the air is routinely and publicly measured, observed PM_{2.5} concentrations form the basis of much air quality policy in Washington, both within workplaces and more generally.

Outdoor populations at risk

Subject to several regulatory exceptions,² L&I completed an analysis of outdoor worker populations at risk to evaluate the impact Washington's permanent wildfire smoke rules would have on the outdoor workforce. The top occupations and industries identified in that Cost-Benefit analysis (CBA)³ are described in chapter 1, section 1.5.2 of that document, and are responsive to NIOSH's request for information related to outdoor worker populations exposed to wildland fire smoke. Data from the U.S. Bureau of Labor Statistics' Occupational Requirement Survey (ORS) and the outdoor, exposed to weather data from the O*Net database were used to derive the top occupations and industries.

Background on the health impact of PM_{2.5} is given in chapter 3, section 3.1 of the CBA, which summarizes the EPA's data pertaining to exposure to PM_{2.5} and potential health impacts, such as to the respiratory, cardiovascular, and nervous systems as well as cancer and all-cause mortality.⁴ Additionally, studies that investigate the relationship of wildfire-specific PM_{2.5} and health effects are summarized. To date there is a small but meaningful body of epidemiological evidence showing consistency for a positive association between wildfire-specific particulate matter and adverse health outcomes.⁵

After the conclusion of this letter, L&I also provides supplemental, previously unpublished state-level workers' compensation data relevant to health effects and occupational populations at risk.

² See WAC 296-820-805, electronically available at <https://app.leg.wa.gov/wac/default.aspx?cite=296-820&full=true#296-820-805>

³ L&I DOSH. *Final Cost-Benefit Analysis & Significant Legislative Rule Analysis*. December 2023

⁴ Ibid.

⁵ Ibid.

Base PM_{2.5} intervention thresholds for outdoor workers on epidemiologic evidence, not the Federal Clean Air Act regulatory criterion for PM_{2.5}

L&I, DOH, and ECY believe EPA's Air Quality Index (AQI) is the most prominent air quality communication tool presently available to the public and is thus relevant to the purposes of the RFI. However, L&I, DOH, and ECY believe using more health-protective breakpoints based on the epidemiology of small particle air pollution rather than on the EPA's enforcement limit (the short-term PM_{2.5} National Ambient Air Quality Standard) would provide individuals and organizations with better and more consistent risk-based information to allow informed decision-making. This is especially crucial for outdoor workers, who are regarded as a "sensitive group," uniquely exposed to higher levels of particulate air pollution—including from wildfire smoke—compared to the general public.⁶

Generally applicable exposure-response considerations

Exposure data from PM_{2.5} events indicate that the proportion of the population that will experience health impacts rises steeply with increasing exposure levels and then tapers off at very high levels (Figure 1). Further, investigators have found evidence that most adverse health outcomes, including cardiovascular hospital admissions and asthma visits, occur at lower concentrations.^{7,8} This indicates most of the health burden from PM_{2.5} occurs at these lower levels.⁹ Figure 1 shows PM_{2.5} concentrations scaled normally in one chart and logarithmically in the other. The logarithmical scale allows easier visualization of the discrepancies of AQI from an ordinary concentration-response relationship. The data are the same in both charts. These charts demonstrate that the AQI is not adequately protective, indicated by the distance between the AQI categories and the blue line in each chart. The World Health Organization's Air Quality Guidelines for PM_{2.5} targeting annual (chronic) exposures of 5 µg/m³, and more acute (24-hour) exposures of 15 µg/m³ provide approachable points of reference that more closely reflect the full health hazard PM_{2.5} emissions pose than the regulatory requirements of the National Ambient Air Quality Standards. However, with occupational safety and health, most of the focus is on the highest AQI categories. Thus, occupational safety and health recommendations need to include and target low PM_{2.5} concentrations, below 35.4 µg/m³ (the NAAQS), to mitigate negative health impacts.

⁶ See page 22, L&I DOSH. *Final Cost-Benefit Analysis & Significant Legislative Rule Analysis*. December 2023

⁷ Lars Perlmutter, David Stieb, and Kevin Cromar. "Accuracy of quantification of risk using a single-pollutant Air Quality Index". In: *Journal of Exposure Science & Environmental Epidemiology* 27.1 (2017), pp. 24–32. doi: 10.1038/jes.2015.43.

⁸ Sarah B. Henderson, PhD, Phuong D.M. Nguyen, BSc, Jiayun Angela Yao, PhD, Michael J. Lee, PhD. The public health paradox of wildfire smoke. *BCMJ*, Vol. 66, No. 3, April, 2024, Page(s) 93,95 - BC Centre for Disease Control.

⁹ Ibid.

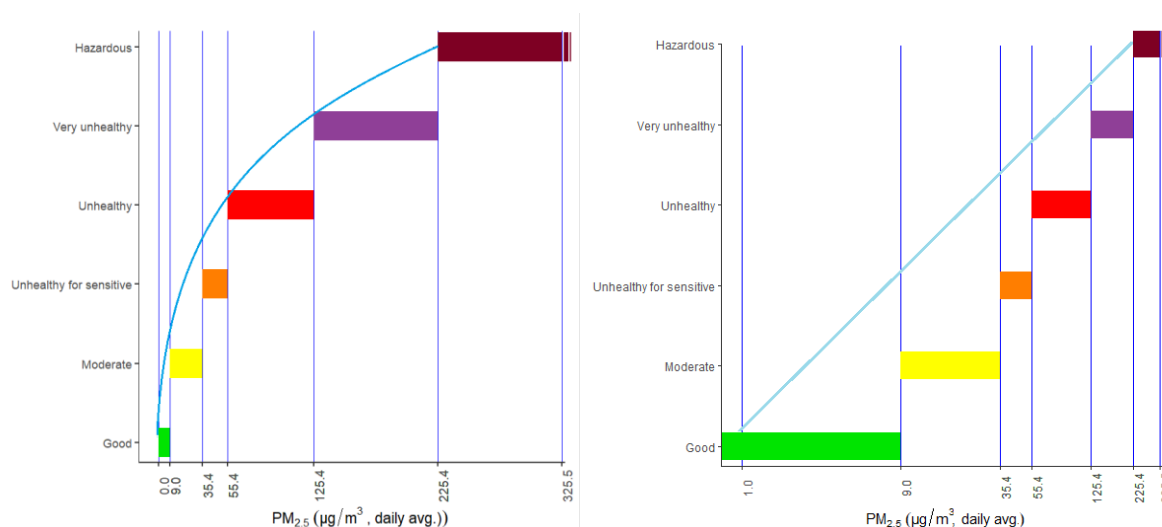


Figure 1. PM_{2.5} versus AQI categories (the levels of health concern), with daily average PM_{2.5} concentrations on a linear scale (left) and a log scale (right)

Exposure-response considerations for outdoor workers

Outdoor workers as a cohort have several characteristics that increase their risk of developing adverse health outcomes from wildfire smoke exposure and explain why L&I, DOH, and ECY regard them to be a vulnerable group with respect to this hazard.

First, the outdoor work environment places employees in direct contact with wildfire smoke, potentially for the duration of their work day, and unabated by technologies that are used in many indoor environments to improve air quality, such as air filtration systems.

Second, the outdoor work they conduct is more likely to be active compared to indoor workplaces:¹⁰ the higher the breathing rate, the greater the exposure to wildfire smoke.

Third, during wildfire smoke events exposure commonly continues outside of the workplace, increasing cumulative exposure, and consequently the risk of adverse health outcomes. Outdoor workers are increasingly working in conditions that are extremely hot and smoky,¹¹ putting them at even greater risk of adverse health impacts, requiring additional protection during these conditions to mitigate impacts.

Fourth, while some groups of workers may be healthier than the general population, that is not true of all workers. Many are vulnerable to impacts from wildfire smoke exposures for reasons beyond pre-existing health conditions, such as race and income. Measures must be protective of the wide range of individual characteristics and experiences of outdoor workers.

¹⁰ For reference, please see Table 1.1. Top occupations with the largest share and number of affected workers from the L&I DOSH *Final Cost-Benefit Analysis and Significant Legislative Rule Analysis*, December 2023.

¹¹ Elena Austin et al. 2021. Combined burden of heat and particulate matter air quality in WA agriculture. *J Agromedicine*. Jan; 26(1): 18-27. 10.1080/1059924X.2020.1795032

And finally, the ability for outdoor workers to respond to wildfire smoke exposures is constrained: outdoor workplace environments without regulatory protections specific to this hazard may have employment structures that limit the autonomy individual employees have to take actions to protect themselves, relative to the duties of their employers or other workplaces. For example, outdoor workers include many groups that are particularly vulnerable, including agricultural workers, who may be especially vulnerable financially, and not have access to linguistically and culturally relevant materials to adequately inform and protect themselves.¹² Blanket recommendations to go indoors are often infeasible in outdoor workplaces, which explains why L&I DOSH wildfire smoke rules:

- Include multiple exposure controls.
- Do not exclusively rely upon the use of respiratory personal protective equipment.
- Anticipate equipment and methods of hazard abatement that can be implemented even at workplaces where work must continue during extreme wildfire smoke events.

For these reasons, L&I, DOH, and ECY recommend NIOSH incorporate an additional margin of safety when developing health recommendations designed to protect outdoor workers from their excess risk of adverse health outcomes, relative to messages for the general public. We strongly recommend NIOSH engage with impacted outdoor workers to inform the development of recommendations that address the needs of outdoor workers and workplaces. We suggest collaboration with investigators conducting community engaged work with socially vulnerable worker populations impacted by wildfire smoke to maximize the positive impact of NIOSH recommendations on worker populations at risk.^{13,14}

L&I's permanent rules establish minimum requirements for workplaces in Washington state to protect employees from wildfire smoke, even while promoting the implementation of additional best-practices to protect workers wherever possible. L&I, DOH, and ECY believe that NIOSH's hazard review and subsequent recommendations will be helpful to employers, workers, and others who elect to take actions to protect outdoor workers from wildfire smoke. To that end, L&I, DOH, and ECY recommend NIOSH tailor those recommendations to:

- Address the needs of outdoor workers.
- Build in an additional margin of safety.

¹² Such concerns are further developed in the L&I DOSH CBA on page 66:

"Outdoor workers, and in particular those of low socio-economic status are identified as 'at risk' by the EPA as extended periods of time exposed to high concentrations of wildfire smoke while at work along with a higher likelihood of untreated or insufficiently treated health conditions (e.g., asthma, diabetes) could lead to increased risks of experiencing adverse health effects due to wildfire smoke. In addition, migrant outdoor workers are especially impacted by factors such as documentation status, and language and cultural barriers that can affect accessing federal aid, legal assistance, and health programs and are likely to be disproportionately impacted by emerging threats, including climate change (Castillo et al. 2021). Specific to agricultural workers in Washington state, most are foreign born Latino males who work long hours, rotate to different employers, have completed little education, and are more likely to suffer from chronic health problems (Bethel et al. 2017).

¹³ C.L. Schollaert et al. 2024. Exposure to Smoke From Wildfire, Prescribed, and Agricultural Burns Among At-Risk Populations Across Washington, Oregon, and California. *GeoHealth*. <https://doi.org/10.1029/2023GH000961>

¹⁴ M. Parker, MJ Ybarra-Vega and Julie Postma. 2023. Agricultural Worker Perspectives on Climate Hazards and Risk Reduction Strategies. *Journal of Agromedicine*. <https://doi.org/10.1080/1059924X.2023.2299378>

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- Base the thresholds for action on epidemiologically supported and internally consistent breakpoints that reflect the current state of knowledge of the dose-response curve for PM_{2.5}.

In addition to these recommendations, L&I, DOH, and ECY are also pleased to make agency staff available to NIOSH policymakers for related topics, including individual-level exposure monitoring; differential health effects connected to various particle size fractions; or other aspects of the science relevant to the public health response to wildfire smoke.

Thank you for considering our response to your RFI. If you have any questions, please do not hesitate to contact Ryan Allen, L&I's Standards and Technical Services Program Manager. Ryan can be reached at 360-902-4758 or alry235@lni.wa.gov.

Sincerely,



Joel Sacks
Director
Department of Labor and Industries



Dr. Umair A. Shah, MD, MPH
Secretary of Health
Department of Health



Kathy Taylor
Air Quality Program Manager
Washington Department of Ecology

cc: Ryan Allen, Standards and Technical Services Program Manager (L&I)

Supplementary workers' compensation data: health effects and populations at risk

The Safety and Health Assessment and Research for Prevention (SHARP) Program at the WA State Department of Labor and Industries maintains surveillance programs for work-related asthma and toxic inhalation injury. These systems offer insight on the health effects, industry and occupations of workers who file workers' compensation claims for exposure to wildland fire smoke and are described here in detail.

Detailed methods for both the work-related asthma and toxic inhalation surveillance systems are available.^{15,16} In brief, the case definition for work-related asthma is a health care professional's diagnosis consistent with asthma and an association between symptoms of asthma and work.¹⁷ The case definition for toxic inhalation injury to wildfire smoke is known or suspected inhalation exposure to wildland fire smoke, to include brush and controlled burn fires.¹⁸ In contrast with work-related asthma, the case definition for toxic inhalation injury is not predicated on a specific diagnosis or health outcome. The primary data source for both systems is Washington state's industrial insurance (workers' compensation) system, which includes claims filed through both the State Fund and self-insurance systems. Claim adjudication is not a factor in determining whether a potential case meets a case definition. Due to barriers in accessing the workers' compensation system, the cases described here are an underestimate of the true burden for exposure to wildland fire smoke.

A total of 104 workers filed a claim for exposure to wildfire smoke with a date of injury from January 2017 through December 2023 (Table 1). A total of 44 claims were accepted (42%). The severity of any health outcome can be estimated by proxy through claim compensability. Among the eight compensable claims, three received outpatient emergency room care, and one was admitted to the hospital. Six claims incurred time loss (4 claims had from 2 to 8 days; and 2 claims had approximately 1,100 time-loss days each) as a result of their wildland fire exposure. One career wildland firefighter received a permanent partial disability award due to acute and subacute respiratory conditions following more than 15 years of exposure to wildland fire smoke. Occupations for the remaining seven compensable cases include fire fighter (non-wildland), pilot (wildland fire fighting), state trooper, canal maintenance worker, light truck driver, and real estate manager. No claims were fatal. Ongoing systematic surveillance for work-related asthma allows asthma to be evaluated as a specific health outcome in this data set. Work-related asthma includes the classification categories of work-aggravated asthma, occupational asthma with

¹⁵ Todorov, D and Reeb-Whitaker C. Washington State's occupational respiratory disease surveillance system, 2017-2022: Surveillance methods and evaluation. February 2024. SHARP Publication # 64-56-2024.

https://www.lni.wa.gov/safety-health/safety-research/files/2024/64_56_2024_ORD_Surveillance_Report_2017_2022.pdf. Accessed April 16, 2024.

¹⁶ Todorov, D and Reeb-Whitaker C. Surveillance of toxic inhalation for Washington workers, 2017 – 2020. August 2021. SHARP Publication # 64-30-2021. https://www.lni.wa.gov/safety-health/safety-research/files/2021/64_30_2021_SurveillanceToxicInhal_2017-2020.pdf. Accessed April 16, 2024.

¹⁷ Todorov, D and Reeb-Whitaker C. Washington State's occupational respiratory disease surveillance system, 2017-2022: Surveillance methods and evaluation. February 2024. SHARP Publication # 64-56-2024.

https://www.lni.wa.gov/safety-health/safety-research/files/2024/64_56_2024_ORD_Surveillance_Report_2017_2022.pdf. Accessed April 16, 2024.

¹⁸ Todorov, D and Reeb-Whitaker C. Surveillance of toxic inhalation for Washington workers, 2017 – 2020. August 2021. SHARP Publication # 64-30-2021. https://www.lni.wa.gov/safety-health/safety-research/files/2021/64_30_2021_SurveillanceToxicInhal_2017-2020.pdf. Accessed April 16, 2024.

latency, and reactive airways dysfunction syndrome (RADS) without latency. Among the 104 cases, 27 were classified as work-aggravated asthma, one as RADS, one case could not be classified, and none were classified as occupational asthma with latency.

One valuable asset of workers' compensation data is the ability to characterize the breadth and scope of occupations and industries affected by exposure to wildland fire smoke (Table 2 and Table 3). By occupation, Protective Service was predominant (n=31) and includes wildland fire fighters (SOC 332022 n=4); followed by Farming (n=13) and Transportation & Material Moving occupations (n=10), including drivers and warehouse workers. By industry, Public Administration was predominant (n=35) and includes Admin of Conservation Programs (n=15) and Fire Protection (n=12). Agriculture (n=12) and Construction (n=11) were also top industries affected by exposure to wildland fire smoke.

Table 1. Year of injury for workers' compensation claims filed due to work-related asthma or toxic inhalation following wildfire smoke

Year	Case Count
2017	20
2018	19
2019	6
2020	25
2021	7
2022	12
2023	14
TOTAL	104

Table 2. Occupation Codes associated with workers' compensation claims filed due to work-related asthma or toxic inhalation following exposure to wildfire smoke. Ordered by numerical SOC code.

Occupational Classification¹⁹	Case Count
11-0000 Management	5
111011 Chief Executive	1
111021 General and Operations Managers	2
119011 Farm, Ranch, and Other Agricultural Managers	1
119141 Property, Real Estate and Community Association Managers	1
13-0000 Business and Financial	2
131111 Management Analysts	1
132081 Tax Examiners, Collectors, and Revenue Agents	1
19-10000 Life, Physical and Social Science	2
191023 Zoologists and Wildlife Biologists	1
192041 Environmental Scientists	1

¹⁹ Standard Occupational Classification (SOC), 2000 System. <https://www.bls.gov/soc/>

29-0000 Healthcare Practitioners and Technical	4
291111 Registered Nurses	1
292043 Paramedic	2
292056 Veterinary Technologists and Technicians	1
31-0000 Healthcare Support	2
319093 Medical Assistant	1
319099 Healthcare Support Workers	1
33-0000 Protective Service	31
331021 First-Line Supervisors Firefighting and Prevention	3
332011 Fire Fighters	17
332022 Forest Fire Inspectors and Prevention Specialists	4
333051 Police and Sheriff's Patrol Officers	3
339032 Security Guards	2
339092 Lifeguards, Ski Patrol, & Other Rec. Protective Service Workers	2
35-0000 Food Preparation and Serving	3
352012 Cooks, Institution and Cafeteria	1
353023 Fast Food and Counter Workers	1
359011 Dining and Cafeteria Workers	1
37-0000 Bldg & Grounds Cleaning and Maintenance	4
372012 Maids and Housekeeping Cleaners	1
372019 Building Cleaning Workers, All Other	1
373011 Landscaping and Groundskeepers	2
39-0000 Personal Care and Service	2
392021 Nonfarm Animal Caretakers	1
393011 Gaming Dealers	1
41-0000 Sales and Related	6
412011 Cashiers	1
412031 Retail Salespersons	3
419022 Real Estate Sales Agents	1
419091 Door-to-Door Sales Workers	1
45-0000 Farming, Fishing, and Forestry	13
451011 First-Line Supervisors, Farming	1
452092 Farmworkers and Laborers, Crop, Nursery and Greenhouse	9
454011 Forest and Conservation Workers	3
47-0000 Construction and Extraction	9
472031 Carpenters	1
472061 Construction Laborers	1
472111 Electricians	3
472152 Plumbers, Pipefitters, and Steamfitters	1
472221 Structural Iron and Steel Workers	1
474041 Hazardous Materials Removal Workers	1
474051 Highway maintenance workers	1

49-0000 Installation, Maintenance, and Repair	5
499021 Heating, Air Conditioning, and Refrig. Mechanics and Installers	1
499042 Maintenance and Repair Workers, General	3
499099 Installation, Maintenance, and Repair Workers, All Other	1
51-0000 Production	5
513011 Bakers	1
513022 Meat, Poultry and Fish, Cutters and Trimmers	1
517041 Sawing machine setters, operators, and tenders, wood	1
519195 Molders, Shapers, and Casters, except Metal and Plastic	1
519199 Production Workers, ALL Other	1
53-0000 Transportation and Material Moving	10
532011 Airline Pilots, Co-Pilots, and Flight Engineers	1
533021 Bus Drivers, Transit and Intercity	1
533032 Heavy and Tractor-Trailer Truck Drivers	3
533033 Light Truck Drivers	2
537062 Laborers and Freight, Stock, and Material Movers, Hand	2
537065 Stockers and Order Fillers	1
999999 Non-classifiable	1
Total	104

Table 3. Industry codes associated with workers' compensation claims filed due to work-related asthma or toxic inhalation following exposure to wildfire smoke. Ordered by numerical NAICS code.

Industry Classification²⁰	Case count
11 Agriculture, Forestry, Fishing and Hunting	12
111219 Other Vegetable (except Potato) and Melon Farming	2
111331 Apple Orchards	3
111339 Other Non-citrus Fruit Farming	1
111998 All Other Miscellaneous Crop Farming	2
113310 Logging	1
115116 Farm Management Services	2
115310 Support Activities for Forestry	1
22 Utilities	1
221119 Other Electric Power Generation	1
23 Construction	11
238130 Framing Contractors	1
238210 Electrical Contractors and Other Wiring Installation Contractors	4
238220 Plumbing, Heating, and Air-Conditioning Contractors	2

²⁰ North American Industry Classification System (NAICS), 2012 system. <https://www.census.gov/naics/>

238910 Site Preparation Contractors	3
238990 All Other Specialty Trade Contractors	1
31-33 Manufacturing	3
313230 Nonwoven Fabric Mills	1
321113 Sawmills	1
331511 Iron Foundries	1
42, 44-45 Wholesale and Retail Trade	9
424710 Petroleum Bulk Stations and Terminals	1
442299 All Other Home Furnishings Stores	1
444220 Nursery, Garden Center, and Farm Supply Stores	1
445110 Supermarkets and Other Grocery (except Convenience) Stores	1
452910 Warehouse Clubs and Supercenters	2
453910 Pet and Pet Supplies Stores	1
454111 Electronic Shopping	2
48-49 Transportation and Warehousing	2
492110 Couriers and Express Delivery Services	2
53 Real Estate and Rental and Leasing	1
531311 Residential Property Managers	1
54 Professional and Business Services	3
541612 Human Resources Consulting Services	1
541620 Environmental Consulting Services	1
541940 Veterinary Services	1
56 Admin & Support & Waste Mgmt & Remediation Services	6
561210 Facilities Support Services	1
561320 Temporary Help Services	1
561612 Security Guards and Patrol Services	1
562112 Hazardous Waste Collection	1
562211 Hazardous Waste Treatment and Disposal	1
562219 Other Nonhazardous Waste Treatment and Disposal	1
62 Healthcare and Social Assistance	4
621111 Offices of Physicians (except Mental Health Specialists)	1
622110 General Medical and Surgical Hospitals	1
622210 Psychiatric and Substance Abuse Hospitals	1
623312 Homes for the Elderly	1
71 Arts, Entertainment and Recreation	3
713110 Amusement and Theme Parks	1
713950 Bowling Centers	1
713990 All Other Amusement and Recreation Industries	1
72 Accommodation and Food Service	7
721110 Hotels (except Casino Hotels) and Motels	3
721214 Recreational and Vacation Camps (except Campgrounds)	2
722110 Full-Service Restaurants	1
722213 Snack and Nonalcoholic Beverage Bars	1
81 Other Services (Except Public Administration)	4

812331 Linen Supply	1
813312 Environment, Conservation and Wildlife Organizations	1
813319 Other Social Advocacy Organizations	1
813990 Otr Similar Organizations (excpt Business, Prof, Labor, & Political Orgs)	1
92 Public Administration	35
921110 Executive Offices	1
921120 Legislative Bodies	1
921190 Other General Government Support	1
922120 Police Protection	2
922160 Fire Protection	12
923130 Admin of Human Resource Progs (excpt Educ., Public Health, & Vets' Affairs)	1
924120 Administration of Conservation Programs	15
925110 Administration of Housing Programs	1
926130 Regulation and Admin of Communications, Electric, Gas, and Other Utilities	1
Unknown	3
Total	104
