ENVIRONMENTAL JUSTICE

MAPPING, ASSESSMENT, AND PROTECTION (EJMAP): TECHNICAL GUIDANCE

GUIDANCE DOCUMENT FOR ENVIRONMENTAL JUSTICE PROPOSED NEW RULE N.J.A.C. 7:1C AND ONLINE BETAMAPPING TOOL

June 6, 2022

New Jersey Department of Environmental Protection

Contents

Introduction

On September 18, 2020, Governor Phil Murphy signed New Jersey's Environmental Justice Law (N.J.S.A 13:1D-157). This groundbreaking new law (hereafter referred to as the Act) requires the New Jersey Department of Environmental Protection (NJDEP) to adopt rules and regulations to implement the provisions of the Act. On June 6, 2022, NJDEP formally proposed these promulgating regulations (Proposed Environmental Justice Rules).

Upon adoption, the Environmental Justice Rules will establish a process for assessing relevant environmental and public health stressors affecting overburdened communities (OBCs) and to deny or condition permits where facilities cannot avoid the occurrence of disproportionate environment or public health stressors in the OBC.

In furtherance of this effort, NJDEP has developed the Environmental Justice Mapping, Assessment and Protection (EJMAP) tool. EJMAP establishes an objective, publicly available representation of the existing environmental and public health stressors in the State's OBCs and supports the analysis required under the Environmental Justice Rules

Specifically, EJMAP enables users to:

- Identify OBCs in the State;
- Search by address to determine whether a specific facility is located or proposed to be located in an OBC;
- Examine the presence of existing environmental and public health stressors in an OBC;
- Compare the existing environmental and public health stressors in an OBC to their appropriate geographic point of comparison and determine which, if any, stressors are considered adverse; and
- Determine whether an OBC is subject to adverse cumulative stressors.

Background

OBCs are block groups with:

(1) At least 35 percent low-income households; or

(2) At least 40 percent of the residents identify as minority or as members of a State recognized tribal community; or

(3) At least 40 percent of the households have limited English proficiency

Census block groups with zero population and located immediately adjacent to an OBC are labeled as "adjacent." Existing or proposed facilities located in adjacent block groups may be required to conduct further analysis in accordance with the Environmental Justice Rules.

A census block group only needs to meet one of the three demographic criteria to be designated as an OBC. The Department has previously released mapping and a list of OBCs and notified those municipalities that they had areas designated as an OBCs. This mapping and list were recently updated to include 2020 Census data and will continue to be maintained and updated at least once every two years. This updated OBC mapping is the first tab in the EJMAP.

As defined under the proposed Environmental Justice Rules, facilities seeking permits or permit renewals in OBCs must analyze their potential contributions to environmental and public health stressors in the OBC.

“Environmental or public health stressors” are sources of environmental pollution, including, but not limited to:

1. concentrated areas of air pollution,
2. mobile sources of air pollution,
3. contaminated sites,
4. transfer stations or other solid waste facilities, recycling facilities, scrap metal facilities, and point sources of water pollution including, but not limited to, water pollution from facilities or combined sewer overflows; or
5. conditions that may cause potential public health impacts, including, but not limited to
6. asthma, cancer, elevated blood lead levels, cardiovascular disease, and developmental problems in the overburdened community.

For more information on the definitions of “facility” and “permit,” see Proposed Environmental Justice Rules.

Therefore, implementation of the Environmental Justice Rules requires consideration of whether and how any “facility” seeking a NJDEP “permit” in an OBC will contribute to these environmental or public health stressors in a manner that results in a disproportionate impact when compared to the OBC’s geographic point of comparison.

This comparative analysis considers:

- The existing environmental and public health stressors values in an OBC,
- Whether the value of an environmental or public health stressor in an OBC is higher than its geographic point of comparison, i.e., adverse,
- Whether the total number of adverse environmental and public health stressors in an OBC is higher than the OBC’s geographic point of comparison, i.e., subject to adverse cumulative stressors, and
- How and whether a facility will contribute to environmental and public health stressors in the OBC.

To facilitate this comparative analysis, the Department 1) identified justifiable and quantifiable environmental and public health stressors in overburdened communities, 2) designated a geographic unit of analysis for comparison, and 3) developed a methodology for determining whether an OBC is currently subject to adverse cumulative stressors.

Methodology Development

In developing its comparison methodology for evaluating stressors in an OBC, the Department first reviewed existing methodologies to inform its approach. The EPA's EJScreen and California's CalEnviroScreen are the two best-known environmental justice evaluation tools available in the US, and as such, formed the foundation of the Department's research efforts for establishing its own method of comparison.

EJ Screen

The EPA developed EJScreen to better meet the agency's responsibilities to protect public health and the environment and provide a nationally consistent environmental justice screening and mapping tool. Combining environmental and demographic indicators, EJScreen highlights which geographic areas are candidates for further review, analysis or outreach by the EPA. Specifically, EJScreen uses environmental indicators as proxy estimates of risk, pollution levels or potential exposure, and demographic indicators as proxies for community health status and potential susceptibility to pollution. EPA characterizes EJSCREEN as a pre-decisional screening tool not designed for decision-making or determinations regarding the existence or absence of EJ concerns.

EJScreen contains 11 environmental and six demographic indicators. The tool's basic level of geographic resolution is the census block group. Environmental indicators were selected for inclusion in the tool based on the following characteristics: available data for the entire U.S. at the block group level; relevance to environmental justice; and public health significance.

Figure 1 presents the environmental indicators included in EJScreen. The demographic indicators in EJScreen flow from Executive Order 12898, which specifically culls out low-income and minority populations as two core factors representing the "social vulnerability characteristics of a disadvantaged population." Based on a review of other relevant factors, EJScreen also includes less than a high school education, linguistic isolation, individuals under the age of five and individuals over the age of 64 as demographic indicators.

EJScreen calculates two indexes from the available indicators: a demographic index and an EJ index. The demographic index is the average of the percent minority and percent low-income in the block group and is designed to address the potential overlap or synergy between these two indicators (i.e., these two social determinants of health are strongly correlated, it is difficult to assess the individual impacts from each or the amount of symbiosis there is between them).

The EJ index is a combination of environmental and demographic information designed to consider the extent to which the local demographics are above the national average. Specifically, the EJ index looks at the difference between the demographic composition of the block group, as measured by the demographic index, and the national average (which is approximately 35 percent). It also considers the population of the block group.

Figure 1: EJScreen Environmental Indicators

Indicator	Place on Exposure–Risk Continuum	Key Medium
NATA Air Toxics Cancer Risk Lifetime inhalation cancer risk	Risk/ Hazard	Air
NATA Respiratory Hazard Index Ratio of exposure concentration to RfC		
NATA Diesel PM (DPM) ($\mu g/m^3$)	Potential Exposure	
Particulate Matter ($PM_{2.5}$) Annual average ($\mu g/m^3$)		
Ozone Summer seasonal average of daily maximum 8-hour concentration in air (ppb)		
Lead Paint Percentage of housing units built before 1960		Dust/ Lead Paint
Traffic Proximity and Volume Count of vehicles (average annual daily traffic) at major roads within 500 meters (or nearest neighbor outside 500 meters), divided by distance in kilometers (km)	Proximity/Quantity	Air/ Other
Proximity to RMP Sites Count of facilities within 5 km (or nearest neighbor outside 5 km), divided by distance		Waste/ Water/ Air
Proximity to TSDFs Count of major TSDFs within 5 km (or nearest neighbor outside 5 km), divided by distance		
Proximity to NPL Sites Count of proposed and listed NPL sites within 5 km (or nearest neighbor outside 5 km), divided by distance[6]		
Wastewater Discharge Toxicity weighted stream concentrations divided by distance in kilometers (km)		Water

Abbreviations:

NATA	National Air Toxics Assessment
NPL	National Priorities List, Superfund program RMP Risk Management Plan
TSDFs	Hazardous waste Treatment, Storage, and Disposal Facilities
RfC	Reference concentration from EPA's Integrated Risk Information System
$PM_{2.5}$	Particulate matter (PM) composed of particles smaller than 2.5 microns
$\mu g/m^3$	micrograms of $PM_{2.5}$ per cubic meter of air
ppb	parts per billion, of ozone in air

CalEnviroScreen

California's Office of Environmental Health Hazard Assessment (OEHHA) developed and maintains the CalEnviroScreen tool on behalf of the California Environmental Protection Agency (CalEPA). The tool analyzes the cumulative effects of pollution burden and additional socioeconomic and health factors to identify which communities might need policy, investment, or programmatic interventions.

CalEnviroScreen applies a place-based geographic framework for assessing cumulative impacts categorized into four "bins" – two representing pollution burden (exposures and environmental effects) and two representing population characteristics (sensitive populations and socioeconomic factors). Twenty-one (21) statewide indicators are sorted into these bins and "scored" for a given geographic area using percentiles. These "scores" are averaged by bin, and then a combined score is calculated for a given area in a way that uses the population characteristics as a modifier of the pollution burden. The tool's basic level of geographic resolution is the census tract. Figure 2 below highlights the 21 indicators and how they are categorized in CalEnviroScreen. Figure 3 provides an example of how the final combined score is calculated.

Figure 2: CalEnviroScreen Indicators

Pollution Burden	Population Characteristics
Exposures • Ozone concentrations • PM2.5 concentrations • Diesel PM emissions • Drinking water contaminants • Children's lead risk from housing pesticide use • Toxic releases from facilities • Traffic impacts	Sensitive populations • Asthma emergency department visits • Cardiovascular disease (Emergency department visits for heart attacks) • Low birth-weight infants
Environmental effects • Cleanup sites • Groundwater threats • Hazardous waste • Impaired water bodies • Solid waste sites and facilities	Socioeconomic factors • Educational attainment • Housing-burdened low-income households • Linguistic isolation • Poverty • Unemployment

Figure 3: CalEnviroScreen Combined Score Calculations

	Pollution Burden		Population Characteristics	
	Exposure Indicators	**Environmental Effects Indicators***	**Sensitive Population Indicators**	**Socioeconomic Factor Indicators**
Component Score	79.67	(0.5 × 45.95) =22.98	96.51	79.78
Average of Component Score	102.65 ÷ (1 + 0.5) = 68.43 Pollution Burden is calculated as the average of its two component scores, with the Environmental Effects component half-weighted.		176.29 ÷ 2 = 88.15 Population Characteristics is calculated as the average of its two component scores.	
Scaled Component Scores (Range 0-10)	(68.43 ÷ 81.9**) × 10 = 8.36 The Pollution Burden percentile is scaled by the statewide maximum Pollution Burden scores.		(88.15 ÷ 96.4***) × 10 = 9.14 The Population Characteristics percentile is scaled by the statewide maximum Population Characteristics scores.	
CalEnviroScreen Score	8.36 x 9.14 = 76.4 A score of 76.4 puts this census tract in the 95-100 percentile or top 5% of all CalEnviroScreen scores statewide.			

* The Environmental Effects component was given half the weight of the Exposures component.
** The tract with the highest Pollution Burden score in the state had a value of 81.9.
*** The tract with the highest Population Characteristics score in the state had a value of 96.4.

New Jersey's Method

The Department looked at three broad areas to develop its own baseline comparison method:

1. Identification of Core Environmental and Social Stressors:

The Department established the following guidelines for stressor inclusion in its OBC's baseline environmental and public health comparative impact analysis:

- At least one core stressor in each of the legislatively mandated categories of concern (i.e., concentrated source of air pollution, mobile sources of air pollution, point sources of water pollution, solid waste facilities and scrap metal facilities, contaminated sites and other environmental or social stressors that may cause public health issues).
- The quantifiability of the stressor.
- The availability of robust, quality, statewide, public data meaningful at the block group geographic scale.
- The value of the stressor in terms of adequately representing the environmental or public health concerns of distressed communities.
- Consistency with stressors chosen for use by either California or EPA for their tools (although the data and methodologies used for determining these stressors varied).

The Department initially developed a brainstorming list of more than 60 potential stressors from various sources, including past NJ Environmental Justice initiatives, the California and EPA Environmental Justice tools, and input from program staff and stakeholders. Applying the guidelines above, this list was reduced to approximately 30 indicators for a more in-depth review, with the stated goal of minimizing the number of stressors necessary to accurately assess the environmental and public health conditions in an OBC. Upon completion of this analysis, twenty-six (26) stressors were incorporated into New Jersey's method. Table 1 below lists each of the 26 stressors. The next section of this document discusses each stressor in greater detail.

Table1: New Jersey's Twenty-Six (26) Environmental and Public Health Stressors

Concentrated areas of air pollution (5 stressors)
Ground-Level Ozone
Fine Particulate Matter
Cancer Risk from Diesel Particulate Matter
Cancer Risk from Air Toxics Excluding Diesel Particulate Matter
Non-Cancer Risk from Air Toxics
Mobile Sources of Air Pollution (3 stressors)
Traffic– Cars, Light- and Medium-Duty Trucks
Traffic – Heavy-Duty Trucks
Railways
Contaminated Sites (3 Stressors)
Known Contaminated Sites
Soil Contamination Deed Restrictions
Ground Water Classification Exception Areas/Currently Known Extent Restrictions
Transfer Stations or other Solid Waste Facilities, Recycling Facilities, Scrap Metal Facilities (2 stressors)
Solid Waste Facilities
Scrap Metal Facilities
Point Sources of Water Pollution (2 stressors)
Surface Water
Combined Sewer Overflows
May Cause Potential Public Health Impacts (6 stressors)
Drinking Water
Potential Lead Exposure
Lack of Recreational Open Space
Lack of Tree Canopy
Impervious Surface
Flooding (Urban Land Cover)
Density/Proximity Stressors (3 stressors)
Emergency Planning Sites
Permitted Air Sites
NJPDES Sites
Social Determinants of Health (2 stressors)
Unemployment
Education

2. Determination of the geographic unit(s) of analysis

the Act required the Department to determine the appropriate geographic unit of analysis (GeoPC) o conduct the required OBC comparative analysis. While California uses a statewide geographic unit, the EPA provides several different geographic units (nation, state, region) for users to consider. After contemplating different geographic units and discussing their pros and cons of each with stakeholders, the Department ultimately agreed with the EPA's premise that a "one-size-fits-all" approach to geographic comparison would not provide equitable protection in a state as diverse as New Jersey.

Instead, New Jersey compares to both the State and relevant county non-OBC 50th percentile levels, relying on whichever is most protective (e.g., lower) in each instance to establish the basis of comparison. Comparison to aggregate non-OBCs was determined as the most protective comparison, since it does not dilute the standard by including other areas in the State or county values that are already impacted by social determinants of health such as income and minority status.

3. Development of a comparison methodology to determine adverse cumulative stressors when compared to the geographic unit(s) of analysis

New Jersey devised the following two-step comparison approach to determine if an OBC's environmental and public health stressors are "higher than" the GeoPC:

First, individual stressor values were determined for every block group in the State. Next, the non-OBC block groups were separated out and sorted by county and by State to determine the 50th percentile (e.g, the median or middle value when a data set is ordered from least to greatest) non-OBC values for each stressor. For example, for the stressor "ground-level ozone", the NJDEP first determined the 50th percentile for the ozone values for the non-OBC portions of the State and each county. The GeoPC is the lower (e.g., most protective) of the non-OBC State or relevant county values. The individual OBC stressor value is then compared to the GeoPC to determine if that individual stressor is "adverse" for that OBC. If the OBC stressor is higher than the lower non-OBC State or relevant county value, it is considered "adversely stressed". For each stressor for each OBC, that determination is either yes (=1) or no (=0). The number of adverse stressors is then counted to determine the combined stressor total (CST) for that OBC.

Step 2 repeats this process for the CST. First, the CST is calculated for all block groups in the State. Next, the non-OBC block groups are selected and sorted to determine the non-OBC State and county CST values. This results in the median or middle value of the total "yes" responses (counts with a maximum of 26 if all stressors are "yes") for the non-OBC portion of the State and each county. The GeoPC is the lower (e.g., most protective) of the non-OBC State or relevant county values. If an OBC block group CST value is higher than the GeoPC, that e OBC is subject to adverse cumulative stressors. Table 2 below shows each county non-OBC CST as compared with the State non-OBC CST and includes a final column that indicates which would be the GeoPC in each case for block groups in that county. The EJMAP tool includes layers that show OBCs only to identify which are subject to adversely cumulative stressors, as well as a second layer that shows the CST for all block groups in the State.

Table 2: CST Geographic Points of Comparison by County

County	County Non-OBC 50th Percentile	State Non-OBC 50th Percentile	Geographic Point Comparison
Atlantic	10	13	10
Bergen	15	13	13
Burlington	12	13	12
Camden	14	13	13
Cape may	11	13	11
Cumberland	10	13	10
Essex	15	13	13
Gloucester	11	13	11
Hudson	17	13	13
Hunterdon	11	13	11
Mercer	11	13	11
Middlesex	15	13	13
Monmouth	11	13	11
Morris	12	13	12
Ocean	10	13	10
Passaic	13	13	13
Salem	12	13	12
Somerset	11	13	11
Sussex	11	13	11
Union	14	13	13
Warren	12	13	12

Leveraging the table above, if an OBC in Ocean County has a combined stressor total of 11, it would be considered subject to adverse cumulative stressors, since its CST exceeds the most protective GeoPC of 10. Had that OBC's combined stressor total been 9, it would not be considered subject to adverse cumulative stressors.

Stressors: Descriptions & Analysis

The following section discusses in detail each stressor included in the comparative analysis. The stressors are grouped into broader related categories (e.g., concentrated areas of air pollution, mobile sources of air pollution, etc.) and each individual stressor discussion includes:

- a general description of the stressor,
- the specific indicator and measurement unit(s),
- the scientific rationale for including the stressor in the baseline analysis, and
- discussion of the publicly available data source(s) relied on to quantify the indicator and the method the used to calculate the stressor values.

Concentrated areas of air pollution

The Act specifically discusses the detrimental environmental and health impacts from the "numerous industrial, commercial and governmental facilities" located in low-income communities and communities of color. These facilities, despite being subject to permit and approval conditions intended to control and minimize emissions, still produce air pollutants that can cause or contribute to environmental and health impacts in surrounding communities. These pollutants include precursors to the formation of ground-level ozone (i.e., volatile organic compounds (VOCs) and nitrogen oxides (NOx)), fine particulate matter ($PM_{2.5}$), and other pollutants that have carcinogenic and other serious health impacts.

Ground-Level Ozone

Description

In the upper atmosphere, stratospheric ozone provides protection against the sun's ultraviolet rays. In contrast to ozone in the upper atmosphere, tropospheric ozone at ground level is harmful to public health. Ground-level ozone is the only National Ambient Air Quality Standard (NAAQS) that the two multi-state nonattainment areas inclusive of New Jersey are yet to attain. Ground-level ozone forms when VOCs and NOx react in the presence of sunlight. Ground-level ozone is an irritant that causes swelling in the lung's passageways making it harder to breath. This irritation can also damage lung tissue making them more vulnerable to lung-related illness such as bronchitis and asthma.

Of the six NAAQS, ozone and particulate matter pose the most widespread and significant health threats. New Jersey maintains a network of monitoring stations that provide data to better understand exposures to ground-level ozone and other air pollutants across the state. Ground-level ozone is measured at 16 monitoring stations throughout New Jersey, 10 of which operate year-round and six that operate only during the ozone season (May through October). There is also a monitor in Washington Crossing State Park in Mercer County that is maintained and operated by the EPA.

Indicator and Measurement Unit(s)

The Department utilized the 3-year (2018 to 2020) average of the Air Quality Index (AQI) days greater than 100 for ozone. The AQI is a system for communicating daily air quality to the public and warning them when air pollutant levels in their area are unhealthy. Its easiest to visualize the AQI as a yardstick that runs from 0 to 500; the higher the AQI daily value, the greater the concern. AQI values correspond to a NAAQS for a particular pollutant, with AQI values below 100 considered safe.

Rationale

Ground-level ozone can irritate the entire respiratory tract. Repeated exposure to ozone pollution may cause permanent damage to the lungs. Even when ozone is present at low levels, inhaling it can trigger a variety of health problems including chest pains, coughing, nausea, throat irritation, and congestion. Ozone also can aggravate other medical conditions such as bronchitis, heart disease, emphysema, and asthma, and can reduce lung capacity.[1]

Anyone who spends time outdoors in the summer can be affected by ozone, as studies show that even healthy adults can have trouble breathing when exposed. However, people with pre-existing respiratory ailments are especially prone to the effects of ozone. For example, asthmatics affected by ozone may have more frequent or severe attacks during periods when ozone levels are high. Children are particularly at risk for ozone-related problems since they breathe more air per pound of body weight than adults, and ozone can affect the development of their immature respiratory systems. Also, children tend to be active outdoors during the summer when ozone levels are at their highest. These additional impacts are particularly concerning in Environmental Justice areas that already experience a higher-than-average share of at-risk communities. During 2016, asthma affected 15.7 percent of African American children and 12.9 percent of children of Puerto Rican descent, while it affected only 7.1 percent of white children.[2] African American children were burdened by 138,000 asthma attacks and 101,000 lost school days each year.

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[1] New Jersey Department of Environmental Protection (2021), 2020 New Jersey Air Quality Report, see https://www.state.nj.us/dep/airmon/pdf/2020-nj-aq-report.pdf

[2] Fleischman, L. & Franklin, M. (2017) "Fumes Across the Fence-Line: The Health Impacts of Air Pollution from Oil & Gas Facilities on African American Communities", NAACP & Clean Air Task Force report, see https://cdn.catf.us/wp-content/uploads/2017/11/21092330/catf-rpt-naacp-4.21.pdf

Stressor Value Calculation Method

- Obtained daily ozone monitoring results for all New Jersey air monitoring sites as well as nearby monitors in Connecticut, Delaware, Pennsylvania, and New York from the EPA's Daily Summary Data Site for the years 2018 to 2020. See Appendix A of this document for the coordinates of all the air quality monitors used in this analysis.
- Created separate GIS files from the monitoring sites' latitude and longitude data for each applicable year.
- Applied ArcGIS' Inverse Distance Weighting (IDW) interpolation tool to each year's monitoring results to estimate daily grid level concentrations of ozone in parts per million (ppm). The IDW interpolation tool determines cell values using a linearly weighted combination of a set of sample points. The weight is a function of inverse distance. The surface being interpolated is the locationally dependent variable (e.g., the monitor locations). The following specific parameters were used:
  - Grid cell size of 0.05 degrees
  - Power: of 5
  - Search Radius: Variable 10
- Summarized the daily results for each grid to determine the number of days the estimated concentration was above the Air Quality Index (AQI) level of 100 (which equals 0.070 ppm for ozone (averaged over 8-hours), and then averaged those summarized results to create one 3-year value for each grid.
- Created the final block group GIS data layer by using a spatial join between the 3-year average grid results and the 2020 NJ census block group file. If a block group was intersected by more than one grid, the mean of the grid was used.

Fine Particulate Matter ($PM_{2.5}$)

Description

Particulate matter is the descriptive term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. These particles can be manmade or naturally occurring, and directly emitted or formed in the atmosphere from the chemical reactions of other pollutants. Particles less than 2.5 micrometers in diameter, referred to as fine particulate matter or $PM_{2.5}$, pose the greatest public health risk. $PM_{2.5}$ can penetrate deeper into the lungs and may even get into the bloodstream. New Jersey was redesignated to attainment for the latest $PM_{2.5}$ 24-hour primary NAAQS (35 micrograms per cubic meter ($\mu g/m^3$)) in 2013 and the latest $PM_{2.5}$ annual primary NAAQS (12 $\mu g/m^3$) in 2015 and continues to maintain both those standards.[3]

A strong body of scientific evidence shows that long- and short-term exposure to $PM_{2.5}$ below the current standards can lead to heart attacks, asthma attacks, and premature death.[4] Of the six NAAQS, ozone and particulate matter pose the most widespread and significant health threats. New Jersey maintains a network of monitoring stations that provide data to better understand exposures to $PM_{2.5}$ and other air pollutants across the state. Fine particulate matter is measured at 20 monitoring stations throughout New Jersey, 13 of which use the Federal Reference Method of filter-based samplers that pull a predetermined amount of air through the selective inlets for a 24-hour period. To provide real-time hourly data to the public, the State also has particle monitors that operate continuously.

[3] https://www.nj.gov/dep/baqp/aas.html#annualpm

[4] https://www.epa.gov/newsreleases/epa-reexamine-health-standards-harmful-soot-previous-administration-left-unchanged

Indicator and Measurement Unit(s)
The Department utilized a 3-year (2018 to 2020) average AQI days greater than 100 for fine particulate matter. The AQI is a system for communicating daily air quality to the public, warning them when air pollutant levels in their area are unhealthy. It's easiest to visualize the AQI as a yardstick that runs from 0 to 500; the higher the AQI daily value, the greater the concern. AQI values correspond to a NAAQS for a particular pollutant, with AQI values below 100 considered safe.

Rationale
$PM_{2.5}$ has known adverse effects on the heart and lungs and can exacerbate existing respiratory diseases and cardiovascular effects. Health studies show a significant association between exposure to particle pollution and health risks, including premature death. The smaller the size of the particles, the greater the potential for causing health issues. In 2013, the World Health Organization's International Agency for Research on Cancer concluded that outdoor air pollution is carcinogenic to humans, with the particulate matter component most closely associated with increased cancer incidence, particularly lung cancer.[5] Other health effects from $PM_{2.5}$ exposure include lung disease, decreased lung function, asthma attacks, heart attacks and irregular heartbeat.

As with ground-level ozone, people with pre-existing respiratory ailments are especially prone to the effects of $PM_{2.5}$. Roughly one out of every three people in the United States is at a higher risk of experiencing $PM_{2.5}$ related health effects, from active children that spend a lot of time playing outdoors as their bodies develop to the elderly population. These additional impacts are particularly concerning in overburdened communities that already experience a higher-than-average share of at-risk communities. For $PM_{2.5}$, those in poverty had 1.35 times higher burden than did the overall population, and non-whites had 1.28 times higher burden. Black people, specifically, had 1.54 times higher burden than did the overall population. These patterns were relatively unaffected by sensitivity analyses, and disparities held not only nationally but within most states and counties as well.[6]

Particulate matter comes from many sources, both stationary and mobile, emitted as direct solid particles made of various components, including black and organic carbon, metals, and indirect formation from gas emissions (nitrates and sulfates. The main sources of black carbon are combustion engines, particularly diesel engines, residential wood and coal burning, fossil fuel power stations and forest and other vegetative burning. Consequently, black carbon is a universal indicator of particulate matter from a large variety of combustion sources and, when measured in the atmosphere, is always associated with other substances from combustion sources, such as organic compounds. Because of these links, the health outcomes associated with exposure to particulate matter are also associated with exposure to black carbon.[7]

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[5] PR 221 - IARC: Outdoor air pollution a leading environmental cause of cancer deaths (who.int)
[6] Mikati, I.; Benson, A.F.; Luben, T.J.; Sacks, J.D.; & Richmond-Bryant, J. "Disparities in distribution of particulate matter emission sources by race and poverty status." American Journal of Public Health, vol. 108, no. 4, 2018, pp. 480-485) https://doi.org/10.2105/AJPH.2017.304297
[7] World Health Organization, Regional Office for Europe (2012), Health Effects of Black Carbon, see https://www.euro.who.int/__data/assets/pdf_file/0004/162535/e96541.pdf

Stressor Value Calculation Method

- Obtained $PM_{2.5}$ FRM/FEM Mass daily monitoring results for all NJ air monitoring sites as well as nearby monitors in Connecticut, Delaware, Pennsylvania, and New York from the EPA's Daily Summary Data Site for the years 2018 to 2020. See Appendix A of this document for the coordinates of all the air quality monitors used in this analysis.
- Created separate GIS files from the monitoring sites' latitude and longitude data for each applicable year.
- Applied ArcMap's Inverse Distance Weighting (IDW) interpolation tool in to these monitoring results to estimate daily grid level concentrations of $PM_{2.5}$ in micrograms per cubic meter ($\mu g/m^3$). The IDW interpolation tool determined cell values using a linearly weighted combination of a set of sample points. The weight is a function of inverse distance. The surface being interpolated is the locationally dependent variable (e.g., the monitor locations). The following specific parameter were used:
    - Grid cell size of 0.05 degrees
    - Power: of 5
    - Search Radius: Variable 10
- Summarized the daily results for each grid to determine the number of days the estimated concentration was above the Air Quality Index (AQI) level of 100 (which equals 35 $\mu g/m^3$ for PM2.5 (averaged over 24-hours)) and then averaged those summarized results to create one 3-year value for each grid.
- Developed block group data using a spatial join between the 3-year average grid results and the 2020 NJ census block group file. If a block group was intersected by more than one grid, the mean of the grid was used.

Cancer Risk from Diesel Particulate Matter

Description

Diesel is a type of fuel derived from crude oil that is used most in the large engines in trucks, buses, trains, construction and farm equipment, generators, and ships. Diesel exhaust is comprised of gases, including carbon dioxide, carbon monoxide, nitric oxide, nitrogen dioxide, sulfur oxides, and hydrocarbons, and particulates, including black carbon, organic materials, and metallic compounds. Both parts of diesel exhaust contain polycyclic aromatic hydrocarbons or PAHs. Several national and international agencies, including the WHO's International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), EPA, and the National Institute for Occupational Safety and Health (NIOSH) have classified diesel exhaust as a probable human carcinogen, based largely on its link to lung cancer.[8]

Indicator and Measurement Unit(s)

AirToxScreen, formally known as the National Air Toxics Assessment or NATA, is a key part of the EPA'sAir Toxics Data Update, an ongoing thorough evaluation of air toxics in the United States. AirToxScreen is a screening tool to help state, local and tribal agencies identify which pollutants, emission sources, and places they may wish to study further to better understand any possible risks to public health. AirToxScreen gives a snapshot of outdoor air quality based on inhalation of air toxics, estimating cancer risk for all covered air toxics and noncancer health effects for certain covered pollutants at the census tract level. The 2017 AirToxScreen, the most recent publicly available assessment, can estimate any of the 188 current HAPs defined in the Clean Air Act including diesel particulate matter.[9] The Department utilized 2017 AirToxScreen ambient air concentration data and California's Diesel Unit Risk Factor to estimate the potential cancer risk from Diesel Particulate Matter in Risk per Million.

[8] https://www.cancer.org/cancer/cancer-causes/chemicals/diesel-exhaust-and-cancer.html

[9] USEPA (2022), Technical Support Document EPA's Air Toxics Screening Assessment, 2017 AirToxScreen TSD, March 2022, see https://www.epa.gov/system/files/documents/2022-03/airtoxscreen_2017tsd.pdf.

Rationale
AirToxScreen includes diesel particulate matter as an indicator of diesel exhaust as one of its core stressors. The key measures of cancer risk developed for the 2017 AirToxScreen NATA include upper-bound estimated lifetime individual cancer risk and the estimated numbers of people within specific risk ranges (e.g., number of individuals with estimated long-term cancer risk of 1-in-1 million or greater). Starting in 2014, the National Emission Inventory (NEI) included diesel particulate matter along with NEI criteria and hazardous air pollutants. In the NEI, diesel particulate matter is computed as the PM_{10} emissions (particulate matter with diameters less than or equal to 10 $\mu g/m^3$, inclusive of $PM_{2.5}$) from on-road and nonroad engines burning diesel or residual oil fuels. Although stationary engines also can burn diesel fuel, only mobile sources were used for estimating diesel PM emissions in the NEI. [10]

Diesel engines emit a variety of pollutants, with diesel particulate matter having potentially the greatest health impacts. In fact, diesel exhaust may contribute as much as 70 percent of the cancer risk from air toxic pollution, making it more harmful than all the other toxic air contaminants combined. Diesel particulate matter can also cause or aggravate other health problems and has been linked with illnesses and deaths from heart and lung disease. These effects have been associated with both short-term exposures (over a 24-hour period) and long-term exposures (over many years). Diesel exhaust includes over 40 substances, including benzene, toluene, arsenic, and formaldehyde, that are listed by the EPA as hazardous air pollutants and by the California Air Resources Board as toxic air contaminants. Fifteen of these substances are listed by the International Agency for Research on Cancer (IARC) as carcinogenic to humans, or as probable human carcinogens. Long-term exposure to diesel exhaust particles poses the highest cancer risk of any toxic air contaminant. [11, 12] California has long identified diesel exhaust as a chemical known to cause cancer and developed a unit risk factor for quantifying its cancer risk in the range of 1.3×10^{-4} to 1.5×10^{-3} per $\mu g/m^3$ with a "reasonable estimate" of 3×10^{-4}, which equates to the air concentration that gives a one in a million cancer risk (.0033 $\mu g/m^3$). [13]

There is an extensive body of empirical evidence detailing the health impacts of from the $PM_{2.5}$ component of diesel and other goods movement-related transportation emissions in environmental justice communities. Those communities located adjacent to ports and related goods movement infrastructure (e.g., warehouses, logistics centers, railyards, etc.) experience higher levels of truck traffic, both from surrounding thruways and on local streets.[14] A recent study by the Union of Concerned Scientists found that communities of color throughout the Northeast and Mid-Atlantic U.S. are more likely to be expose to the highest levels of $PM_{2.5}$. Specifically, the Union of Concerned Scientist's noted that average annual $PM_{2.5}$ concentrations of exposures from cars, trucks and buses for Latino residents are 75 percent higher, and for Asian American residents they are 73 percent higher, than they are for white residents. Exposures for African American residents are 61 percent higher than for white residents.[15]

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[10] Ibid.
[11] https://www.stopthesoot.org/Raritan%20health%20effects%20final%20Feb%2008_1.pdf
[12] https://oehha.ca.gov/air/health-effects-diesel-exhaust
[13] https://www.nj.gov/dep/airtoxics/diesemis.htm
[14] NJB&A (2020), Newark Community Impacts of Mobile Source Emissions: A Community-Based Participatory Research Analysis, November 2020, see https://www.njeja.org/wp-content/uploads/2021/04/NewarkCommunityImpacts_MJBA.pdf
[15] Union of Concerned Scientists (2019), Inequitable Exposure to Air Pollution from Vehicles in the Northeast and Mid-Atlantic, see https://www.ucsusa.org/sites/default/files/attach/2019/06/Inequitable-Exposure-to-Vehicle-Pollution-Northeast-Mid-Atlantic-Region.pdf

Stressor Value Calculation Method

- Obtained New Jersey's 2017 state summary file from AirToxScreen's State Summary Files dropdown menu, and isolated the Diesel PM concentrations from the Ambient Concentration.
- Applied the Diesel exhaust particulate Unit Risk Factor (URF) from NJ's Toxicity Values for Inhalation Exposure (0.0003 (ug/m3)-1) to the Diesel PM concentrations to determine the estimate potential cancer risk in risk per million.
- Developed block group data using a spatial join between the estimated potential cancer risk results and the 2020 NJ census block group file..

Cancer Risk from Air Toxics Excluding Diesel Particulate Matter

Description

While cancer risk from diesel exhaust is significant, it does not negate the carcinogenic effects of other air toxics in the atmosphere. However, it does make them less noticeable when presented together with the carcinogenic impacts from diesel particulate matter. As such, the Department removed diesel PM from the equation and concentrated on the remaining air toxics with carcinogenic effects assessed in the 2017 AirToxScreen. Air toxics (also referred to as toxic air pollutants or hazardous air pollutants (HAPs)) include benzene, found in gasoline; perchloroethylene, emitted from dry cleaning facilities; vinyl chloride, used to make polyvinyl chloride (PVC) plastic and vinyl products; and ethylene oxide, emitted from commercial and hospital sterilizers.

Indicator and Measurement Unit(s)

The Department utilized the 2017 AirToxScreen's ambient concentration data for all air toxics except for diesel particulate matter and aligned those values with the pollutant's corresponding unit risk factor (URF) to estimate the potential cancer risk from 138 of the non-diesel particulate matter air toxics in Risk per Million.

Rationale

AirToxScreen includes air toxics that the EPA has classified as "carcinogenic to humans," "likely to be carcinogenic to humans," or "suggestive evidence of carcinogenic potential." The key measures of cancer risk developed for the 2017 AirToxScreen include upper-bound estimated lifetime individual cancer risk and the estimated numbers of people within specific risk ranges (e.g., number of individuals with estimated long-term cancer risk of 1-in-1 million or greater.[16] Zhou et al. (2015) identified formaldehyde, carbon tetrachloride, acetaldehyde, and benzene as the most frequently found air toxics with cancer risk greater than 1-in-1 million in the U.S. Zhou et al. (2015) further determined that the most frequently occurring binary pairs or ternary mixtures were various combinations of those four air toxics, with formaldehyde and benzene together contributing nearly 60 percent of the total cancer-related health impacts.[17]

The 2017 AirToxScreen estimates that nationwide average cancer risk from air toxics exposure (excluding diesel) is 30 in 1 million, with about half of that risk coming from the secondary formation of formaldehyde in the atmosphere. The other half of the nationwide cancer risk comes from pollution that is directly emitted into the atmosphere. From 1990 to 2017 emissions of air toxics declined by 74 percent, largely driven by federal and state implementation of stationary and mobile source regulations.[18]

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[16] USEPA (2022), Technical Support Document EPA's Air Toxics Screening Assessment, 2017 AirToxScreen TSD, March 2022, see https://www.epa.gov/system/files/documents/2022-03/airtoxscreen_2017tsd.pdf.

[17] Zhou, Y., Li, C., Huijbregts, M. A., & Mumtaz, M. M. (2015). Carcinogenic Air Toxics Exposure and Their Cancer-Related Health Impacts in the United States. *PloS one*, *10*(10), e0140013https://doi.org/10.1371/journal.pone.0140013

[18] https://www.epa.gov/air-trends/air-quality-national-summary

Much of the published literature supports the hypothesis that proximity to environmental hazards translates to higher risks, including increased adverse health risks. Concern about proximity to industrial facilities and other pollutant sources stems from the fact that industrial areas generally carry a higher environmental burden than do purely residential neighborhoods in terms of pollution and risks.[19] (Given that carcinogenic air toxics are associated with industrial sources, its unsurprising that these elevated exposures would align with environmental justice communities where there is greater air toxics exposure overall.

Stressor Value Calculation Method

- Obtained New Jersey's 2017 state summary file from AirToxScreen's State Summary Files dropdown.
- Applied the corresponding Unit Risk Factor (URF) from NJ's Toxicity Values for Inhalation Exposure to each applicable pollutant's estimated ambient concentration, excluding Diesel PM to estimate each individual pollutant's potential cancer risk in risk per million. If there was not a corresponding URF, that pollutant only has non-carcinogenic impacts, and was excluded from this analysis.
- Summed the potential cancer risk from each pollutant for each census tract to estimate total potential cancer risk in risk per million.
- Developed block group data using a spatial join between the estimated total potential cancer risk results and the 2020 NJ census block group file.

Non-Cancer Risk from Air Toxics

Description

The EPA's 2017 AirToxScreen also accounts for the noncancer health impacts from exposure to air toxics. These health effects include impacts on the lungs and other parts of the respiratory system; on the immune, nervous, and reproductive systems; and to organs such as the heart, liver, and kidneys. These effects can range from headaches and nausea to respiratory arrest and death, with the severity depending on the amount and length of exposure and the nature of the chemical itself.[20]

Indicator and Measurement Unit(s)

The Department utilized the EPA 2017 AirToxScreen data to estimate the potential non-cancer risk from 138 of the air toxics in Risk per Million.

Rationale

AirToxScreen includes air toxics that are associated with many noncancer adverse health effects. Unlike other pollutants that EPA regulates, air toxics have no universal, predefined risk levels that clearly represent acceptable or unacceptable thresholds. Instead, EPA sets regulatory-specific targets (e.g., benzene NESHAP rule) to protect the most people possible to an individual lifetime risk level no higher than about 1-in-1 million. These determinations require the consideration of other health and risk factors, including risk assessment uncertainty, in making an overall judgment on risk acceptability.

To estimate noncancer air toxic health impacts, EPA calculates a Hazard Index (HI) that sums the Hazard Quotients (HQs) to account for potential noncancer health effects to certain human organs and organ systems due to long-term exposure to air toxics. Each air toxic HQ is a ratio of the potential exposure to that substance and the level at which no adverse effects are expected. An HQ or HI of 1 or lower means a specific air toxic, or air toxics combined, are unlikely to cause adverse noncancer health effects over a lifetime of exposure. However, an HQ or HI greater than 1 does not necessarily mean adverse effects are likely. Instead,

[19] Maantay, Chakraborty, and Brender (2010), Proximity to Environmental Hazards: Environmental Justice and Adverse Health Outcomes, May 12, 2010, see https://archive.epa.gov/ncer/ej/web/pdf/brender.pdf
[20] USEPA (2022), Technical Support Document EPA's Air Toxics Screening Assessment, 2017 AirToxScreen TSD, March 2022, see https://www.epa.gov/system/files/documents/2022-03/airtoxscreen_2017tsd.pdf.

the EPA evaluates this on a case-by-case basis, considering the confidence level of the underlying health data, the uncertainties, the slope of the dose-response curve (if known), the magnitude of the exceedances, and the numbers or types of people exposed at various levels above the Reference Concentration (RfC).
As discussed previously, much of the published literature supports the hypothesis that proximity to environmental hazards translates to higher risks, including increased adverse health risks. Concern about proximity to industrial facilities and other pollution sources stems from the fact that industrial areas generally carry a higher environmental burden than do purely residential neighborhoods in terms of pollution and risks.[21] Health disparities (adverse health outcomes disproportionately affecting minority and lower-income populations) are a well-documented phenomena in the United States.

Despite overall health improvements over time, significant disparities remain in several health indicators, most notably in life expectancy and infant mortality.[22] In addition, racial disparities have widened over time; in 2015, black infants had 2.3 times higher mortality than white infants (11.4 vs. 4.9 per 1,000 live births). Infant and child mortality was markedly higher in rural areas and poor communities, and Black infants and children in poor, rural communities had nearly three times higher mortality rate compared to those in affluent, rural areas. Racial/ethnic, socioeconomic, and geographic disparities were particularly marked in mortality and/or morbidity from cardiovascular disease, cancer, diabetes, COPD, HIV/AIDS, homicide, psychological distress, hypertension, smoking, obesity, and access to quality health care.

Stressor Value Calculation Method

- Obtained New Jersey's 2017 state summary file from AirToxScreen's State Summary Files dropdown.
- Applied the corresponding Reference Concentration (RfC) from NJ's Toxicity Values for Inhalation Exposure to each applicable pollutant's estimated ambient concentration to estimate each individual pollutant's potential noncancer HQ. If there was not a corresponding RfC, that pollutant only has carcinogenic impacts, and was excluded from this analysis.
- Summed all pollutant HQs for each census tract to estimate the total HI.
- Developed block group data using a spatial join between the total HI results and the 2020 NJ census block group file. If a block group was intersected by more than one grid, the mean of the grid was used.

Mobile sources of air pollution

The State's transportation network, including cars, buses, light-, medium- and heavy-duty trucks, and rail, is its large source of criteria and hazardous, as well as climate, air pollutants. Cars and light-duty trucks alone account for approximately 30% of the total VOCs and NOx emissions that contribute to ground-level ozone formation. Additionally, the transportation sector accounts for 42% of the State's net greenhouse gas emissions, making it New Jersey's largest contributor to climate change.

Traffic – Cars and Light- and Medium-Duty Trucks

Description

There are over 6.5 million cars and light- and medium-duty trucks (up to 14,000 pounds) registered in New Jersey. These vehicles, primarily fueled by gasoline, join larger trucks as well as commuter and thru traffic from surrounding states to make New Jersey roads some of the most densely travelled in the U.S. Traffic

[21] Maantay, Chakraborty, and Brender (2010), Proximity to Environmental Hazards: Environmental Justice and Adverse Health Outcomes, May 12, 2010, see https://archive.epa.gov/ncer/ej/web/pdf/brender.pdf
[22] Singh, G. K., Daus, G. P., Allender, M., Ramey, C. T., Martin, E. K., Perry, C., Reyes, A., & Vedamuthu, I. P. (2017). Social Determinants of Health in the United States: Addressing Major Health Inequality Trends for the Nation, 1935-2016. International journal of MCH and AIDS, 6(2), 139–164. https://doi.org/10.21106/ijma.236.

congestion, defined as periods when traffic volume exceeds roadway capacity[23], creates stop and go traffic and idling in place. Idling for more than 10 seconds uses more fuel, thereby producing more emissions, than stopping and restarting the engine, which is simply not practical in gridlock traffic.[24] In many instances, congestion is recurring, as high traffic volumes regularly overload roadways during weekday peak "rush hour" periods. This recurring congestion increases risk for both on- and near-road populations.

Indicator and Measurement Unit(s)
The Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS) Average Annual Daily Traffic (AADT)-mile per square mile within a block group as an indicator of cars and light- and medium-duty truck traffic proximity to residences and other institutions (e.g., schools).

Rationale
Residential proximity to traffic is associated with various health impacts, particularly the onset of, or exacerbation of asthma, as well as mortality rates.[25] Proximity to traffic has also been associated with subclinical atherosclerosis (a key pathology underlying cardiovascular disease (CVD)), prevalence of CVD and coronary heart disease (CHD), incidence of myocardial infarction, and CVD mortality. These health impacts likely stem from increased exposure to vehicle-related emissions such as ultrafine and other components of PM2.5, lead and other metals, and mobile source air toxics such as benzene, nitrogen oxides (NOx), volatile organic compounds (VOXs) and carbon monoxide (CO). Vehicles also emit ozone and $PM_{2.5}$ precursors in addition to being New Jersey's largest source of CO_2 emissions. Ambient exposure to nitrogen oxides, sulfur dioxide, and fine particulate matters significantly increases the risk of lung cancer.[26]

Traffic proximity is also associated with noise, which is a risk factor for various health problems. Workplace and transportation-related noise is associated with the release of stress hormones; sleep disturbance; hypertension; altered heart rate; ischemic heart disease; myocardial infarction; and, among the elderly, risk of stroke.[27] In one study, Sørensen et al. (2011) found that among those older than 64.5 years of age, the stroke incidence rate ratio was 1.27 per 10 decibels from road traffic.[28] (Whether noise or other factors account for it, local traffic volume is a predictor of stress which itself is associated with significant health risks. In 2010, Yang & Matthews concluded that, "[a]t the neighborhood level, the presence of hazardous waste sites and traffic volume were determinants of self-rated stress even after controlling for other individual characteristics".[29] A 2022 study from the Rutgers Robert Wood Johnson Medical School found that 5% of hospitalizations for heart attacks were attributable to elevated high noise levels (an average of 65

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[23] Zhang, K., & Batterman, S. (2013). Air pollution and health risks due to vehicle traffic. The Science of the total environment, 450-451, 307–316. https://doi.org/10.1016/j.scitotenv.2013.01.074
[24] US Department of Energy (2015), Idling Reduction for Personal Vehicles, see https://afdc.energy.gov/files/u/publication/idling_personal_vehicles.pdf
[25] U.S. Environmental Protection Agency (EPA), 2019. EJSCREEN Technical Documentation, see https://www.epa.gov/sites/default/files/2021-04/documents/ejscreen_technical_document.pdf
[26] Chen, G., Wan, X., Yang, G., & Zou, X. (2015). Traffic-related air pollution and lung cancer: A meta-analysis. Thoracic cancer, 6(3), 307–318. https://doi.org/10.1111/1759-7714.12185.
[27] U.S. Environmental Protection Agency (EPA), 2019. EJSCREEN Technical Documentation, see https://www.epa.gov/sites/default/files/2021-04/documents/ejscreen_technical_document.pdf
[28] Sørensen, M., Hvidberg, M., Andersen, Z. J., Nordsborg, R. B., Lillelund, K. G., Jakobsen, J., . . . Raaschou-Nielsen, O. (2011). Road traffic noise and stroke: A prospective cohort study. Eur Heart J, 32(6), 737-744, https://doi.org/10.1093/eurheartj/ehq466.
[29] Yang, T.-C., & Matthews, S. A. (2010). The Role of Social and Built Environments in Predicting Self-rated Stress: A Multilevel Analysis in Philadelphia. Health & Place, 16(5), 803-810, https://doi.org/10.1016/j.healthplace.2010.04.005.

decibels or higher over the course of the day) in New Jersey.[30] The study further found that the heart attack rate was 72% higher in places with high transportation noise exposure, with these areas seeing 3,336 heart attacks per 100,000 people compared with 1,938 heart attacks per 100,000 people in quieter areas. Based on the relative rates of heart attack in different locations, the researchers calculated that high noise exposure accounted for about 1 in 20 heart attacks in the state.

Stressor Value Calculation Method

- Obtained NJ's 2018 HPMS GIS file data.
- Summed the single unit (attribute field labeled aadt_single_unit) and combined truck (attribute field labeled aadt_combination) AADT values for each road segment in New Jersey to determine the total AADT Truck values representing all heavy-duty trucks classes 4 through 13 (i.e., buses, singe-unit trucks, single- and multi-trailer trucks) for each road segment.
- Subtracted the calculated AADT Truck values from the total AADT (attribute field labeled aadt) values for each road segment for New Jersey, to calculate the AADT for cars, and light- and medium-duty trucks only for each road segment.
- Applied ArcGIS' line density function to the calculated AADT for cars and light-duty trucks using the following parameters:
    - Grid cell size 100 ft.
    - Search radius of 1000 ft.
    - AADT used as population field

  This created a raster surface file.
- Apply Zonal Statistics as a Table function in ArcMap Spatial Analyst using the created raster surface file as the input to determine the spatially weighted average AADT for each 2020 NJ census block groupas the indicator for light-duty traffic on major roads.

Traffic – Heavy-Duty Trucks

Description

There are approximately 189,000 vehicles over 14,000 lbs. (e.g., delivery vans, tractors pulling trailers) registered in New Jersey. These trucks, predominately fueled by diesel, join commuter and thru traffic from surrounding states to make New Jersey roads some of the most densely travelled in the U.S. According to the American Transportation Research Institute, New Jersey is home to some of the most congested stretches of highway in America; in particular, 1-96 and Route 4 in Fort Lee.[31] These trucks are vital to goods movement in and around the state, transporting freight from source of production to points of consumption. However, the ports of entry and intermediary storage for goods (e.g., seaports, airports, railyards and warehouse and distribution facilities) are often collocated with low-income communities and communities of color.[32] The amplified truck traffic in and around these facilities, coupled with the increased emissions from stop and go traffic and unavoidable idling on roads in these communities, increases exposure to diesel particulate matter and other toxic air pollutants.

Indicator and Measurement Unit(s)

FHWA HPSM AADT-mile per square mile within a block group as an indicator of heavy-duty truck traffic proximity to residences and other institutions (e.g., schools).

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[30] Moreyra A, Subramanian K, Mi Z, et al. THE IMPACT OF EXPOSURE TO TRANSPORTATION NOISE ON THE RATES OF MYOCARDIAL INFARCTION IN NEW JERSEY. J Am Coll Cardiol. 2022 Mar, 79 (9_Supplement) 1148, https://doi.org/10.1016/S0735-1097(22)02139-8.

[31] https://truckingresearch.org/2021/02/23/atri-releases-annual-list-of-top-100-truck-bottlenecks-4/

[32] https://www.epa.gov/community-port-collaboration/ports-primer-51-goods-movement-and-transportation-planning

Rationale
Residential proximity to traffic is associated with various health impacts, particularly the onset of, or exacerbation of asthma, as well as mortality rates.[33] Proximity to traffic has also been associated with subclinical atherosclerosis (a key pathology underlying cardiovascular disease (CVD)), prevalence of CVD and coronary heart disease (CHD), incidence of myocardial infarction, and CVD mortality. These health impacts likely stem from increased exposure to vehicle-related emissions such as ultrafine and other components of $PM_{2.5}$, lead and other metals, and mobile source air toxics such as benzene, nitrogen oxides (NOx), volatile organic compounds (VOCs) and carbon monoxide (CO). Ambient exposure to nitrogen oxides, sulfur dioxide, and fine particulate matter significantly increase the risk of lung cancer.[34] Heavy-duty trucks contribute to $PM_{2.5}$ and its precursors because of their primary reliance on diesel fuel.

Traffic proximity is also associated with noise, which is a risk factor for various health problems. Workplace and transportation-related noise are associated with the release of stress hormones; sleep disturbance; hypertension; altered heart rate; ischemic heart disease; myocardial infarction; and, among the elderly, risk of stroke.[35] In one study, Sørensen et al., (2011) found among those older than 64.5 years of age, the stroke incidence rate ratio was 1.27 per 10 dB more road traffic noise.[36] Whether noise or other factors account for it, local traffic volume is a predictor of stress (which itself is associated with significant health risks). In 2010, Yang & Matthews concluded that, "[a]t the neighborhood level, the presence of hazardous waste sites and traffic volume were determinants of self-rated stress even after controlling for other individual characteristics".[37]

A 2022 study from the Rutgers Robert Wood Johnson Medical School found that 5% of hospitalizations for heart attacks were attributable to elevated high noise levels (an average of 65 decibels or higher over the course of the day) in New Jersey.[38] The study further found that the heart attack rate was 72% higher in places with high transportation noise exposure, with these areas seeing 3,336 heart attacks per 100,000 people compared with 1,938 heart attacks per 100,000 people in quieter areas. Based on the relative rates of heart attack in different locations, the researchers calculated that high noise exposure accounted for about 1 in 20 heart attacks in the state.

Stressor Value Calculation Method
- Obtained NJ's 2018 HPMS GIS file data.
- Combined the single unit (attribute field labeled aadt_single_unit) and combined truck (attribute field labeled aadt_combination) AADT values for each road segment in New Jersey to calculate total AADT Truck values representing all heavy-duty trucks classes 4 through 13 (i.e., buses, singe-unit trucks, single- and multi-trailer trucks) for each road segment.

[33] U.S. Environmental Protection Agency (EPA), 2019. EJSCREEN Technical Documentation, see https://www.epa.gov/sites/default/files/2021-04/documents/ejscreen_technical_document.pdf.
[34] Chen, G., Wan, X., Yang, G., & Zou, X. (2015). Traffic-related air pollution and lung cancer: A meta-analysis. Thoracic cancer, 6(3), 307–318. https://doi.org/10.1111/1759-7714.12185.
[35] U.S. Environmental Protection Agency (EPA), 2019. EJSCREEN Technical Documentation, see https://www.epa.gov/sites/default/files/2021-04/documents/ejscreen_technical_document.pdf.
[36] Sørensen, M., Hvidberg, M., Andersen, Z. J., Nordsborg, R. B., Lillelund, K. G., Jakobsen, J., . . . Raaschou-Nielsen, O. (2011). Road traffic noise and stroke: A prospective cohort study. Eur Heart J, 32(6), 737-744, https://doi.org/10.1093/eurheartj/ehq466.
[37] Yang, T.-C., & Matthews, S. A. (2010). The Role of Social and Built Environments in Predicting Self-rated Stress: A Multilevel Analysis in Philadelphia. Health & Place, 16(5), 803-810, https://doi.org/10.1016/j.healthplace.2010.04.005.
[38] Moreyra A, Subramanian K, Mi Z, et al. THE IMPACT OF EXPOSURE TO TRANSPORTATION NOISE ON THE RATES OF MYOCARDIAL INFARCTION IN NEW JERSEY. J Am Coll Cardiol. 2022 Mar, 79 (9_Supplement) 1148. https://doi.org/10.1016/S0735-1097(22)02139-8.

- Applied ArcGIS' line density function to the calculated total AADT for Truck values using the following parameters:
  - Grid cell size 100 ft.
  - Search radius of 1000 ft.
  - AADT used as population field

  This creates a raster surface file.
- Apply Zonal Statistics as a Table function in ArcMap Spatial Analyst using the created raster surface file as the input to determine the spatially weighted average AADT for each 2020 NJ census block group as the indicator for heavy-duty traffic on major roads.

Railways

Description

There are two type of rail systems operating in New Jersey: passenger (both light rail and commuter rail) and freight. New Jersey Transit Corporation (NJ Transit) is the State-owned public transportation system that services the State, along with portions of New York State and Pennsylvania. NJ Transit operates three light-rail systems – Hudson-Bergen (20.6 miles from Bayonne to North Bergen), Newark (4.3 miles from Newark Pen station to North Newark and Bloomfield) and the River Line (34 miles from Trenton to Camden).[39]

In addition, NJTransit operates 11 commuter rail lines throughout the State. While the Hudson-Bergen and Newark light rails are electric, the River Line light rail is diesel-powered. NJ Transit commuter lines currently operate 100 diesel and 61 electric locomotives. Other private passenger rail entities, such as Amtrak, share use of the rail lines throughout the State. New Jersey has eighteen (18) freight railroads operating on approximately 1,000 miles of rail freight lines.[40] The two Class 1 freight railroads operating in the State are CSX Transportation and Norfolk Southern. Freight railroads operate their own tracts and associated rail yards, and often share tract access through use agreements.

Indicator and Measurement Unit(s)

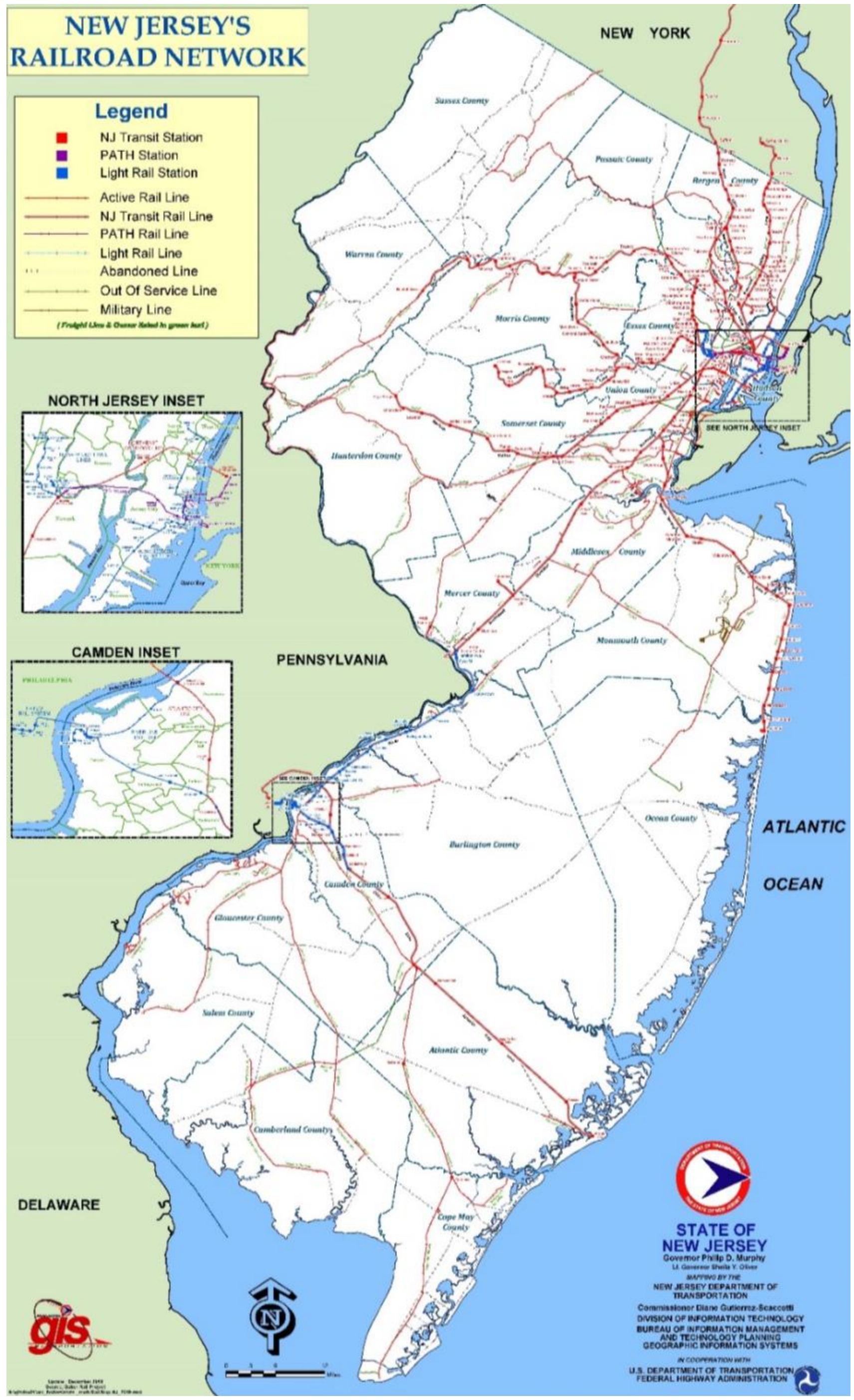
The New Jersey Department of Transportation's rail miles per square mile within a block group as an indicator of rail traffic proximity to residences and other institutions (e.g., schools).

Rationale

According to data from the U.S. Bureau of Transportation Statistics (BTS), at the end of 2020 just over 23,500,000 freight and 484 passenger rail locomotives were in operation in the U.S.[41] Except for a few electrified passenger light and commuter rail lines, the majority of passenger rail and all of freight rail in the U.S. is diesel-powered. As seen in the map below, these predominately diesel locomotives regularly operate on rail lines and in rail yards concentrated in and around the most densely populated areas of New Jersey.

[39] https://en.wikipedia.org/wiki/NJ_Transit
[40] New Jersey Department of Transportation (NJDOT) (2014), New Jersey Statewide Freight Rail Strategic Plan, June 2014, see https://www.state.nj.us/transportation/freight/rail/pdf/NewJerseyStatewideFreightRailStrategicPlanJune2014.pdf
[41] https://www.bts.gov/content/rail-profile

Of particular concern are freight locomotives transporting goods to and from the State's container ports. The Port Authority of New York and New Jersey is the third largest container port in the U.S.[42], transporting approximately 9 million Twenty-foot Equivalent Units (TEUs) in 2021, with approximately 70,000 total rail lifts through four on-dock rail terminals.[43]



Freight operations often operate round-the-clock, and in addition to air and climate emissions from the locomotives and associated truck traffic and rail yard equipment, also contribution to noise, traffic congestion and industrial blight.[44] A 2014 study of freight rail impacts on environmental justice communities in California found that 167,000 residents in proximity of their three highest priority rail yards had an estimated diesel cancer of greater than 100 in a million, which is characterized as a significant risk.[45]

Overall, there was a statistically higher percentage of non-white residents, particularly Latinos, in the high-risk cancer isopleths near rail yards than the comparative county population. The same study found that with respect to income, the estimated percentage of low-income households in the 100 in a million-risk isopleth was higher than the comparative county population for most of their rail yards.

[42] https://www.bts.gov/archive/publications/port_performance_freight_statistics_annual_report/2016/ch3
[43] https://www.panynj.gov/port/en/our-port/facts-and-figures.html
[44] Trade, Health and Environmental Impact Project (2012), Tracking Harm: Health and Environmental Impacts of Rail Yards, January 2012, see https://envhealthcenters.usc.edu/wp-content/uploads/2016/11/Tracting-Harm.pdf
[45] Hricko, A., Rowland, G., Eckel, S., Logan, A., Taher, M., & Wilson, J. (2014). Global trade, local impacts: lessons from California on health impacts and environmental justice concerns for residents living near freight rail yards, International journal of environmental research and public health, 11(2), 1914–1941, https://doi.org/10.3390/ijerph110201914.

Stressor Value Calculation Method

- Obtained NJDOT ArcGIS REST Railroad Network layer. https://njogis-newjersey.opendata.arcgis.com/datasets/NJDOT::railroads-network/about
- Applied the ArcGIS line density function to railroad length (attribute field labeled Shape_Length) using the following parameters:
    - Grid cell size 100 ft.
    - Search radius of 1000 ft.

  This created a raster surface file.
- Apply Zonal Statistics as a Table function in ArcMap Spatial Analyst using the created raster surface file as the input to determine the spatially weighted average rail length for each 2020 NJ census block group as the indicator for proximity to railroads.

Contaminated Sites

The legacy of New Jersey's industrialized past is thousands of known contaminated sites (KCS) with polluted soil and/or groundwater throughout the State. The Site Remediation Reform Act (SRRA) established the Department's Licensed Site Remediation Professional (LSRP) program, which fundamentally changed the process for how sites are remediated in New Jersey. With the primary goal of reducing the threat of contamination to public health and the environment, the LSRP program has demonstrated success in accelerating the process of returning contaminated properties to productive use.

Known Contaminated Sites

Description

New Jersey's Known Contaminated Sites (KCS) List identifies all properties within the state with confirmed soil and/or groundwater contamination levels greater than applicable standards. This dataset broadly includes contaminated sites various stages of remediation (not yet started, currently underway or completed with implementation of an institutional/engineering control). For this stressor, however, only KCS where remediation is pending or in progress are included. Fully remediated sites with institutional/engineering controls in place under a Remedial Action Permit (RAP) are included under other stressors in this category. The Contaminated Sites stressor is also weighted to accentuate the most critically contaminated locations from a public health and environmental prospective.

Indicator and Measurement Unit(s)

Weighted KCS per square mile as an indicator of proximity to residents and other institutions (e.g., schools) within the block group.

Rationale

Starting in the early 1800s, New Jersey grew and prospered as a manufacturing center in the U.S. Major New Jersey cities like Paterson, Trenton, Camden, Elizabeth, Jersey City, Newark, Vineland, and Passaic, developed distinctive industries, including textiles, trains, clay products, iron, and steel.[46] Those industries contributed to significant contamination with waste products and chemical pollutants. Many of these sites were abandoned following cessation of industrial activity without a responsible party to remediate for future use. Presently, those same cities and their citizens, many of whom are low-income and/or communities of color, bear the brunt of that legacy pollution as well as newer contaminated sites such as former dry cleaners and gas stations.

Soil contamination can impact human health through various exposure routes. Common routes of human exposure involve direct contact with soil pollutants via dermal-incidental soil ingestion and inhalation of soil

[46] https://nj.gov/nj/about/history/short_history.html

and dust particles, as well as inhalation of substances volatilized to the atmosphere. Soil contaminants can also be transported to potable water aquifers, which can result in the ingestion of contaminated groundwater. Children in urban environments are particularly susceptible to soil contamination.[47] They may absorb more contaminants (e.g., lead) and metabolize them differently and their developing nervous systems are more susceptible to chemicals. From conception through adolescence, children have critical developmental windows when the nervous system is more susceptible to damage. Children from low-income and minority families are more likely to be at risk of exposure because they (1) spend more time playing on contaminated soil than children from higher-income families, (2) spend more time in houses that have lead paint or high dust levels, (3) may be exposed to higher levels of contaminants in utero and in breast milk because their mothers are also disproportionately exposed, and (4) have inadequate diets that may increase the absorption of toxic chemicals from their digestive system.

In New Jersey, about 41 percent of potable water comes from groundwater, either through public- or domestic-supply wells.[48] Groundwater is supplied by rain that infiltrates the ground. A geological unit that can yield water to a well is called an aquifer. Aquifers are the primary source of water in Southern New Jersey, particularly in the Pine Barrens. While water seeping into the ground is cleansed of many pollutants by natural soil, if a pollutant is one which is resistant to break-down, or if the pollutant doesn't get exposed to the soil long enough (such as by entering a bedrock fracture or by entering the ground water through sub-surface disposal), it can spread underground and potentially cause health issues and other problems. [49]

A 2021 Report by the National Environmental Justice Advisory Council (NEJAC) looked more closely at how federal Superfund cleanups were addressed in environmental justice communities.[50] That report noted that EPA's data shows that Superfund sites disproportionately impact minorities, people living under the poverty level, and communities who are linguistically isolated, and urged EPA to perform an analysis of the of the demographics in the communities surrounding National Priorities List Superfund sites to gain a better prospective on the impacted communities.

Stressor Value Calculation Method

- Obtained NJ's Known Contaminated Sites List (KCSL) GIS file data. This publicly available dataset now includes an attribute field (labeled CATEGORY) with a weighted ranking for each site based on environmental concerns. Sites in the Immediate Environmental Concern (IEC) GIS layer with a receptor status of in-progress, and those sites on the NPL were given the highest stressor score (3). Licensed Site Remediation Professional (LSRP) program cases with 10 or fewer contaminated Areas of Concern, and Pending sites, were given the lowest weighted stressor score (1). All other sites were given a weighted stressor score of 2. Unregulated Heating Oil USTs (UHOT) sites and sites with a restricted or limited restricted Remedial Action Outcome (RAO) were not included in the stressor evaluation and are assigned a weighted stressor score of 0. RAO sites are identified as Remedial Action Permit (RAP) sites in the Lead field in the KCSL layer. Unregulated heating oil underground

[47] Gochfeld, M., & Burger, J. (2011). Disproportionate exposures in environmental justice and other populations: the importance of outliers. American journal of public health, 101 Suppl 1(Suppl 1), S53–S63. https://doi.org/10.2105/AJPH.2011.300121

[48] New Jersey Department of Environmental Protection (NJDEP) (2014), Water Withdrawals in New Jersey from 2000-2009, see https://www.nj.gov/dep/njgs/enviroed/infocirc/withdrawals2009.pdf

[49] https://www.co.hunterdon.nj.us/mun/Holland/GroundWater.pdf

[50] National Environmental Justice Advisory Council, "Superfund Remediation and Redevelopment for Environmental Justice Communities", May 2021, see https://www.epa.gov/sites/default/files/2021-05/documents/superfund_remediation_and_redevelopment_for_environmental_justice_communities_may_2021.pdf

storage tank sites were assigned a weighted stressor score of zero because they are considered low risk since they discharge smaller quantities which do not typically impact ground water or travel off site from the discharge location. Also, any discharges from an unregulated heating oil underground storage tank that cannot be remediated by a simple excavation are elevated to a higher rank, and not listed as an unregulated heating oil underground storage tank site. Sites with a restricted or limited restricted RAO are included in the "Soil Contamination Deed Restriction" and/or the "Ground Water Classification Exception/Currently Known Extent Restrictions" stressor evaluations and are therefore also assigned a weighted stressor score of zero for this evaluation. Finally, all sites where remediation has been completed were assigned a weighted stressor score of zero.

- Applied ArcGIS' Kernel Density function using the weighted list as input with the following parameters:
    - Search radius of 1 mile, which is consistent with the distance requirements in Department's Hazardous Waste rules
    - Used field CATEGORY as population to weight sites
    - Grid size of 100 ft.

    This calculated the raster density file.
- Apply Zonal Statistics as a Table function in ArcMap Spatial Analyst using the created raster surface file as the input to determine the spatially weighted average number of sites for each 2020 NJ census block group as the indicator for proximity to each site.

Soil Contamination Deed Restrictions

Description

Sites with complex contamination issues can have several sources of contamination and can impact both the soil and groundwater as well as additional media. For KSCL sites where remediation is complete such that it no longer poses a threat to public health, but the soil and/or ground water still does not meet the requisite standards, restrictions are placed on use of the site. In cases where soil contamination remains above the Soil Remediation Standards (N.J.A.C. 7:26D), the Department requires the addition of a deed notice to the property's title. Specifically, the deed notice requires a property owner's consent, specifies the location of the contamination as well as its concentrations, and outlines how the remaining contamination must be controlled, maintained, and/or monitored for protection of human health and the environment.

The deed notice is intended to inform prospective holders with an interest in the property of the remaining contamination and related use restrictions. A soil Remedial Action Permit (RAP) is issued by the Department to ensure that the remedial action remains protective. Remedial actions involving a Deed Notice require institutional and, if necessary, engineering controls (e.g., soil and asphalt caps) designed to eliminate contact with contaminated soil, prevent contaminant infiltration into the groundwater, eliminate airborne particulate contamination, and eliminate erosion or off-site migration of contaminated soil from storm runoff.

Indicator and Measurement Unit(s)

The percent of acreage within the block group with Deed Notice restrictions.

Rationale

While soil contamination deed restrictions are protective, sites subject to such restrictions cannot be used for any purpose and, when found in abundance, reflect siting inequities that the Act seeks to address. Further, soil contamination deed restrictions are an indicator of historical and ongoing contamination. See the rationale under "Known Contaminated Sites" above for more detail on the impacts of soil contamination.

Stressor Value Calculation Method

- Obtained Deed Notice Area GIS file and isolated the Deed Notice Percent Areas for all block groups data file in each.
- Applied the Intersect geoprocessing tool to calculate the geometric intersection between the 2020 NJ census block group file and the Deed Notice Percent Area data file such that only the common features are represented in the output coverage.
- Applied the Dissolve geoprocessing tool to the output coverage to aggregate features based on the percentage of each block group that is soil restricted.

Groundwater Classification Exception Area/Currently Known Extent Restrictions

Description

For Known Contaminated Sites where remediation is complete such that it no longer poses a threat to public health, but the soil and/or groundwater still does not meet the requisite standards, restrictions are placed on use of the site. A Classification exception area (CEA) is established as a notification that the Ground Water Quality Standards (N.J.A.C. 7:9C) have been exceeded and ensures the use of the ground water in an area is restricted until the standards are achieved. Specifically, the Department initially establishes a classification exception area (CEA) at the completion of a remedial investigation. The CEA is based on existing ground water quality data and modeling to determine the extent and duration the contamination will remain above standards.

The Department also establishes a Currently Known Extents (CKEs) based on potable well sampling results conducted during the initial stages of an Immediate Environmental Concern (IEC) investigation. CEAs boundaries may change over time, while CKEs boundaries generally don't change. CKEs can be replaced by a CEA when the source(s) of the ground water IEC is identified, and sufficient data exists to establish a CEA for the site. The CEA can only be lifted when the established ground water quality standards are met. A ground water RAP is issued by the NJDEP to ensure a remedial action remains protective. Remedial actions involving a CEA require institutional and if necessary, engineering controls when contamination remains above applicable ground water standards. An example of an engineering control is a system to treat ground water contamination.

Indicator and Measurement Unit(s)

The percent of acreage within the block group with CEA/CKEs restrictions.

Rationale

Like Soil Contamination Deed Restrictions, while the establishment of a CEA and/or CKE is protective, the measures also restrict the overall utility of a given site. In accordance with the findings of the Act, the Department has determined that the presence of multiple such restricted sites in an overburdened community is an impediment to the growth, stability, and long-term well-being of that community. This stressor is also an indicator of historical and ongoing contamination. See the rationale under "Known Contaminated Sites" above for more detail on the impacts of ground water contamination.

Stressor Value Calculation Method

- Obtained CEA and CKE GIS file and isolated CEA/CKE Percent Areas for all block groups data file in each.
- Applied the Intersect geoprocessing tool to determine the geometric intersection between the 2020 NJ census block grouphttps://www2.census.gov/geo/tiger/TIGER_DP/2019ACS/ -:~:text=ACS_2019_5YR_BG_34.gdb.zip,50M file and the Groundwater Contamination (CEA/CKA) Percent Area data file such that only the common features are represented in the output coverage.
- Applied the Dissolve geoprocessing tool to the output coverage to aggregate features based on the percentage of each block group that is groundwater restricted.

Transfer stations or other solid waste, recycling, and scrap metal facilities

In 2018, New Jersey municipalities and counties generated 23 million total tons of solid waste (including municipal waste, construction debris and other types of non-municipal waste), with 13.3 million of that waste recycled and 9.7 million tons disposed of in landfills or waste incinerators. While waste management is essential to New Jersey's public and environmental health, solid waste facilities emit air and water pollution, generate truck and rail traffic-related emissions, and create noise, odor, dust, and sometimes light pollution.

Solid waste landfills can release methane and carbon dioxide into the air for decades, even after they are permanently closed. Traditional solid waste facilities include landfills, waste incinerators, recycling centers, and transfer stations. Scrap metal facilities include automotive recycling and scrap metal processing facilities. Improperly managed scrap metal facilities can contaminate soils, groundwater, and surface waters with hazardous materials and release refrigerants containing fluorocarbons into the air.

Solid Waste Facilities

"Solid waste facilities" are part of the definition of "environmental or public health stressors" under the New Jersey Environmental Justice Law. Specifically, the Law's definition of "facility" includes resource recovery facilities and incinerators, transfer stations or other solid waste facilities, recycling facilities intended to receive at least 100 tons of recyclable materials per day, landfills (including, but not limited to those accepting ash, construction or demolition debris, or solid waste), and medical waste incinerators (except those associated with a hospital or university to process self-generated regulated medical waste). Resource recovery facilities and other waste incinerators in the State are captured under the regulated air pollution facilities stressor, and as such are not included in this stressor. In State operated sanitary landfills, recycling facilities, and transfer stations (where solid waste is transferred from collection vehicles to larger trucks or rail cars for long distant transport to another location for disposal) are all considered in this stressor.

Indicator and Measurement Unit(s)

The density of solid waste facilities per square mile as an indicator of proximity to residents and other institutions (e.g., schools) within the block group.

Rationale

Currently, 12 of New Jerseys 21 counties have operating sanitary landfills. Available landfill capacity in the State is less than anticipated due to higher levels of waste acceptance, the fact that new landfills are difficult to site, and the expansion of existing facilities is limited. Eight (8) counties awarded waste disposal contracts requiring county-generated waste go only to those facilities under contract, while the remaining 13 counties can send waste to a facility of its choosing. Transfer station capacity is approximately 10 million tons and There are dozens of transfer stations spread throughout the State.

New Jersey's recycling industry is highly regulated with dozens of facilities licensed throughout the State to deal with one or more of the 4 classes of recyclable materials. Class A recyclable materials are those most people are familiar with; post-consumer materials such as glass, carboard, paper, plastic, and ferrous metals. Class B recyclable materials include construction and demolition items such as concrete, asphalt, non-painted/treated wood, tires, non-hazardous (<30,000 ppm) petroleum contaminated soils, and processed tree and bush materials. Class C recyclable materials are composted matter such as grass, leaves and food waste. Class D recyclable materials are various types of universal waste such as used oils, antifreeze, latex paints, light bulbs, batteries, mercury-containing equipment, and consumer electronics (e-waste).

Available data provides consistent proof that all types of waste facilities are disproportionally sited in low-income and Black, Indigenous, and people of color (BIPOC) communities.[51] [52] In fact, in the United States, race is the biggest predictor of an individual's likelihood of living near a hazardous waste site. The waste industries know that these communities often lack resources to fight their facility siting to protect their health. Policies like exclusionary zoning and redlining have further concentrated polluting facilities, including waste facilities, in EJ and BIPOC communities. Studies considering the health effects from living in proximity to these facilities observe inequalities in exposure and health and represent a case of environmental injustice as they are the result of social processes and may be prevented, at least partly.

Food waste and other organic matter comprise the largest portion of trash in landfills.[53] As it decomposes, organic waste creates off-putting odors, attracts disease-carrying rodents, and releases the greenhouse gas methane. Landfill gases have been associated with increased incidence of respiratory illnesses and various types of cancer. Additionally, all landfills will eventually leak toxins into the soil and groundwater. These toxins can contaminate sources of drinking water, and they persist for years, threatening the health of nearby communities even after landfills are closed.

Stressor Value Calculation Method

- Obtained NJ's Solid & Hazardous Waste facilities GIS file data.
- Applied ArcGIS' Kernel Density function using the GIS file data as input with the following parameters:
  - Search radius of 1 mile, which is consistent with the distance requirements in Department's Environmental and Health Impact Statement requirements in the Solid Waste rules.
  - Grid size of 100 ft.

    This calculated a raster density file.
- Apply Zonal Statistics as a Table function in ArcMap Spatial Analyst using the created raster surface file as the input to determine the spatially weighted average number of sites for each 2020 NJ census block group as the indicator for proximity to each site.

Scrap Metal Facilities

Description

"Scrap yards" are part of the Law's "environmental or public health stressors" definition, similar to "solid waste facilities." The Law also includes scrap metal facilities in its definition of "facility." Unlike traditional solid waste facilities that are regulated primarily through one program area of the Department for how they manage waste, scrap metal facilities are regulated by various Department permitting programs (e.g., some, but not all, require air and/or stormwater permits) depending on their size and location. As such, this stressor required identification of these facilities through various data sets and processes. In general, scrap metal facilities were considered synonymous with establishments primarily engaged in distribution of wholesale or retail of used motor vehicle parts (SIC 5015) and those primarily engaged in assembling, breaking up, sorting, or wholesale distribution of scrap and waste metal (SIC 5093). These facilities were compared to the list of

[51] Marco Martuzzi, Francesco Mitis, Francesco Forastiere, Inequalities, inequities, environmental justice in waste management and health, European Journal of Public Health, Volume 20, Issue 1, February 2010, Pages 21–26, https://doi.org/10.1093/eurpub/ckp216.

[52] Yang, C. (2021), Q&A: Addressing the Environmental Justice Implications of Waste, Environmental and Energy Study Institute, May 14, 2021, see https://www.eesi.org/articles/view/qa-addressing-the-environmental-justice-implications-of-waste.

[53] Williams, I. (2020), One Man's Trash is Another's Burden: Social Justice & Waste Management, Population Education, February 19, 2020, see https://populationeducation.org/one-mans-trash-is-anothers-burden-social-justice-waste-management/.

active NJPDES discharge sites for scrap metal processing, as stormwater management is one of the most important operational and regulatory issue for these facilities.

Indicator and Measurement Unit(s)
Density of scrap metal facilities per square mile in the block group as an indicator of proximity to residents and other institutions (e.g., schools).

Rationale
Metal emissions are generated during outdoor operations in most scrap metal facilities from gas torch cutting and mechanical cutting methods used to downsize scrap metal for eventual consumption by end users.[54] Metal torch cutting typically is of most concern because it has the potential to generate inhalable particles containing toxic heavy metals. However, little information is available about the impact on outdoor air quality from metal emissions due to torch cutting and associated health outcomes of residents in the downwind community. More is known about exposures from metal welding and torch cutting from data obtained in the occupational arena.

In Houston, the Health Department conducted metal recycling facility fence line air monitoring from 2010 – 2012 in response to numerous citizen complaints, and found that at some locations, particularly those with torch cutting, known carcinogenic metals (e.g., nickel compounds) were detected in the ambient air. Other metals (e.g., manganese and cobalt) with non-carcinogenic adverse health effects were also detected.[55] A follow up study using a community-based participatory research method characterized metal emissions in four environmental justice communities.[56] Those results indicated that metal concentrations were the highest at the fence line and decreased by 57-70% within 100 meters and reached similar levels to background at 600 meters. After adjusting the measured data for meteorological parameters and operating hours, estimated inhalation cancer risks ranged from 0.12 cases to 24 cases in 1 million people and hazard index values ranged from 0.04 to 11.

Based on the nature of industrial activity and operations at scrap metal processing and recycling sites, there is potential for surface and/or ground water contamination from stormwater runoff.[57] Pollutants are discharged to surface water if stormwater is exposed to industrial activity on the site and is then discharged to surface water. Likewise, pollutants are discharged to ground water if industrial activity is exposed to stormwater and pollutants are mobilized downward as stormwater infiltrates into ground. The volume and quality of stormwater discharges will depend on a variety of factors, including the outdoor activities at the facility (e.g., material storage, loading/unloading, vehicle maintenance), extent of impervious surfaces, type of ground cover, and duration and intensity of precipitation. Stormwater quality can also vary depending on the effectiveness and implementation of Best Management Practices (BMPs) as well as the performance of any pollution prevention and/or treatment methods.

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[54] Symanski, E., An Han, H., Hopkins, L. et al. Metal air pollution partnership solutions: building an academic-government-community-industry collaboration to improve air quality and health in environmental justice communities in Houston. Environ Health 19, 39 (2020). https://doi.org/10.1186/s12940-020-00590-1.
[55] Ibid.
[56] Inkyu Han, Donald Richner, Heyreoun An Han, Loren Hopkins, Daisy James& Elaine Symanski (2020) Evaluation of metal aerosols in four communities adjacent to metal recyclers in Houston, Texas, USA, Journal of the Air & Waste Management Association, 70:5,568-579, https://doi.org/10.1080/10962247.2020.1755385.
[57] https://www.nj.gov/dep/dwq/pdf/sm-sm2-fact-sheet-5-16-13.pdf

Stressor Value Calculation Method

Obtained Scrap Metal Facilities in New Jersey GIS file.

- Applied ArcGIS' Kernel Density function using the scrap metal facility GIS file data as the input with the following parameters:
  - Search radius of 1 mile to be consistent with the Solid Waste Facilities stressor.
  - Grid size of 100 ft.

  This calculated the raster density file.
- Apply Zonal Statistics as a Table function in ArcMap Spatial Analyst using the created raster surface file as the input to determine the spatially weighted average number of sites for each 2020 NJ census block group as the indicator for proximity to each site.

Point-sources of water pollution

including, but not limited to, water pollution from facilities or combined sewer overflows

New Jersey's surface waters, including rivers, streams, and lakes, provide numerous functions for the citizens of the state, including potable water, crop irrigation, aquatic life habitat and recreation. However, urban and agricultural pollution continues to threaten water quality. Since the passage of the Clean Water Act in 1972, Federal, State, and local governments have invested billions of dollars to reduce pollution entering surface water sources. Still, surface water ecosystems are fragile, and can undergo rapid environmental changes from exposure to external effects from the atmosphere, or their watershed or groundwater. Human activities often accelerate these changes.[58]

New Jersey's Surface Water Quality Standards (SWQS) are designed to protect the quality of New Jersey's surface waters and ensure they are suitable for all existing and designated uses, including drinking water supply, fish consumption, shellfish resources, propagation of fish and wildlife, recreation, agriculture, and industrial water supply.[59] The SWQS objectives are met through various Department programs include the New Jersey Pollutant Discharge Elimination System (NJPDES) discharge to surface water permits, derived effluent limits for discharge of remediated groundwater to surface water, Total Maximum Daily Load (TMDL) program, Water Quality Assessment program and water compliance and enforcement.

Surface Water

Description

Every two years, New Jersey conducts a Statewide assessment of the State's surface water quality and publishes the results in New Jersey's Integrated Water Quality Assessment Report. As its name suggests, the report employs an integrated approach to assessing water quality by evaluating water monitoring data and other information collected from numerous sources throughout the state to determine the health of New Jersey's surface water regions. In addition, each report includes a comprehensive assessment of one of the State's five water regions (i.e., Atlantic Coastal, Raritan, Lower and Upper Delaware and Northeast) on a rotating basis. This integrated water quality assessment process helps determine if water quality conditions have changed over time; determine if water quality standards are met and if designated uses, such as recreation and water supply, are fully supported; identify causes and sources of water quality impairment; and develop restoration strategies for impaired waters and protection strategies for healthy waters. While the integrated water quality assessment process evaluates if all freshwaters fully support the drinking water supply use, it does not assess drinking water quality.

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[58] https://www.usgs.gov/special-topics/water-science-school/science/lakes-and-reservoirs?qt-science_center_objects=0#qt-science_center_objects

[59] https://www.state.nj.us/dep/wms/bears/swqs.htm

Indicator and Measurement Unit(s)

To analyze this stressor, the Department utilizes water quality results from the 2016 Integrated Report at the Assessment Unit (AU) level. The AU is determined by the United States Geological Service (USGS) Hydrologic Unit Code 14, or HUC14 (where 14 indicates the number of digits in the code), for delineating and identifying drainage systems and watershed boundaries. For each AU, all station parameter results (i.e., chemicals or pollutants tested) were aggregated to determine if the General Aquatic Life Use designated use was supported (that is, in attainment).

If an AU included more than one station, the results for each parameter were aggregated with the 'worst case' station assessment representing the AU (i.e., if any of the stations are impaired for a parameter, then the parameter is impaired (e.g., in nonattainment) at the AU level). If some stations were fully supported for a parameter but others had insufficient data, then the parameter was considered fully supported (e.g., in attainment). The 2016 Integrated Report covered 958 AUs, over 19,000 miles of rivers and streams, 48,000 acres of lakes, ponds, and reservoir, 950,000 acres of wetlands, 610 square miles of estuaries, 127 miles of coastline, and 450 square miles of ocean. The indicator is the percent of designated uses in nonattainment.

Rationale

Surface water quality is the key to a healthy ecosystem and safe public recreation. Water quality parameters such as concentrations of pathogenic bacteria (e.g., Enterococcus and *E. coli*) and dissolved oxygen are used to understand how swimmable and fishable surface waters are when assessed against federal recreational water quality recommendations and guidance. Excess nitrogen, phosphorus and sediment pollution has resulted in algae blooms, beach closures, fish consumption advisories and dead zones.[60] New Jersey is divided into five water regions (see map below), with the Northeast and Raritan regions having the most urban and industrialized settings.

New Jersey's long history of industrial activity has left a legacy of toxic surface water contaminants such as polychlorinated biphenyls (PCBs), heavy metals (e.g., mercury), pesticides, and polyaromatic hydrocarbons (PAHs)[61] . Some of these toxins are particularly troubling because they persist in the environment for great lengths of time and can bioaccumulate in the tissues of fish, aquatic plants, and wildlife, existing in greater quantities higher up the food chain.[62]

While statewide metals and toxins discharge into waterbodies is drastically reduced, legacy issues still impact some areas of the state where metals remain in the sediment.[63] During storms and high flow, these sediments can become resuspended in the water column, elevating metal levels. However, in the Raritan region, metal levels remain low even during high flow events indicating clean sediment and/or metals that are buried too far below the sediment for resuspension.

[60] Steinzor, r., Verchick, R., Vidargas, & Huang Y. (2012), Environmental Justic and Nutrient Trading, Center for Progressive Reform Briefing Paper No. 1208, August 2012, see https://cpr-assets.s3.amazonaws.com/documents/WQT_and_EJ_1208.pdf

[61] Lodge, J., Landeck Miller, R.E., Suszkowski, D., Litten, S., Douglas, S. 2015. Contaminant Assessment and Reduction Project Summary Report. Hudson River Foundation. New York, NY, see https://www.hudsonriver.org/article/contaminants

[62] US Environmental Protection Agency (EPA) (2002), Fish Consumption and Environmental Justice, November 2002, see https://www.epa.gov/sites/default/files/2015-02/documents/fish-consump-report_1102.pdf

[63] https://njdep.maps.arcgis.com/apps/MapSeries/index.html?appid=5d2d107d80b54eb48450a7d7c7248c73

Communities of color, low-income communities, tribes, and other indigenous peoples depend on healthy aquatic ecosystems and the fish and aquatic plants and wildlife that these ecosystems support to a greater extent and in different ways than does the general population.[64] These resources are consumed and used to meet nutritional and economic needs, and for many there are no real alternatives to eating and using fish and aquatic plants and wildlife; it is entirely impractical to "switch" to "substitutes" when the fish and other resources on which they rely have become contaminated.

For some groups, these resources are also consumed or used for cultural, traditional, or religious purposes. For members of these groups, the conventional understandings of the "health benefits" or "economic benefits" of catching, harvesting, preparing, and eating fish and aquatic plants and wildlife do not adequately capture the significant value these practices have in their lives and the life of their culture. The harms caused by aquatic habitat degradation and fishery depletion also have a generational toll, impeding the transfer of ecological knowledge, customs and traditions surrounding harvest, preparation, and consumption of aquatic resources.

Stressor Value Calculation Method

- Obtained NJ's Surface Water Nonattainment GIS file.
- Calculated the percent of impaired designated uses for each HUC 14 by dividing the number of impaired designated uses by the total number of assessed designated uses applicable. If a designated use did not apply to a waterbody or there were insufficient data to complete an assessment, it was eliminated from the calculations (e.g., shellfish harvesting is limited to saline waters, so if there was insufficient data for shellfish harvesting in a freshwater water body, it was eliminated from the calculation). The higher the percentage, the worse the overall water quality. The results are a short-term 'snapshot' of water quality conditions. The latest 5 years of data was used to determine if waterbodies supported their designated uses.
- Applied ArcMap's Polygon to Raster tool to convert the HUC percent impaired data into 100 ft. raster data using percent uses not in attainment as pixel value.
- Apply Zonal Statistics as a Table function in ArcMap Spatial Analyst using the created raster surface file as the input to determine the spatially weighted average of nonattainment surface waters for each 2020 NJ census block group as the indicator for percent impaired.

Combined Sewer Overflows

Description

Twenty-one (21) of New Jersey's oldest communities have combined sewer systems that collect rainwater runoff, domestic sewage, and industrial wastewater into one pipe, rather than having separate systems for wastewater and stormwater.[65] These combined systems are remnants of the country's early infrastructure and are often in urban areas that overlap with low-income areas or communities of color.[66] Under normal conditions, these systems transport all the wastewater collected to a sewage plant for treatment, then discharge the treated water into a water body.

However, the volume of wastewater can sometimes exceed the system's capacity, particularly during heavy rainfall or snowmelt events, creating an "overflow of untreated stormwater and wastewater" from their outfalls directly into nearby streams, rivers, and other water bodies. Combined sewer overflows, or CSOs, can contain untreated or partially treated human and industrial waste, toxic materials, and other debris, and often contain high levels of total suspended solids, pathogens, nutrients, oxygen-demanding organic

[64] US Environmental Protection Agency (EPA) (2002), Fish Consumption and Environmental Justice, November 2002, see https://www.epa.gov/sites/default/files/2015-02/documents/fish-consump-report_1102.pdf
[65] https://www.nj.gov/dep/dwq/cso-basics.htm
[66] https://www.epa.gov/npdes/combined-sewer-overflows-csos

compounds, oil, and grease. These contaminants and pollutants impair water quality and the recreational use of urban waterways, resulting in beach closures, contamination of local drinking water sources and impacts on aquatic ecosystems.[67] With climate impacts expected to increase regional average annual precipitation by 4 percent to 11 percent by 2050, with more intense and frequent precipitation events, CSOs are also expected to increase in frequency and impact more people as flooding covers larger areas.[68,69]

Indicator and Measurement Unit(s)
The presence of any Combined Sewer System in the block group.

Rationale
Over 700 U.S. cities, mostly on the East Coast, Great Lakes, and Pacific Northwest, continue to rely on combined sewer systems.[70] Research has determined CSO from these systems is a significant source of polycyclic aromatic hydrocarbons, organochlorine compounds, nutrients, and chemical oxygen demand. In addition, CSOs are a potential source of wastewater micropollutants (WMPs), trace levels of synthetic organic substances (e.g., caffeine, pharmaceuticals) released into receiving waters from human activity, with substantially elevated WMP concentrations occurring in urban waters following CSO discharges.

CSO discharge can carry bacteria, intestinal worms, protozoa, and viruses. Contact, inhalation, or ingestion of CSO discharge can cause diarrhea and nausea, as well as a variety of infections, including ear, respiratory, and skin/wound.[71] In worst-case scenarios, people exposed to these discharges can also contract life-threatening diseases, including cholera, dysentery, infectious hepatitis, and severe gastroenteritis.

New Jersey currently has individual CSO permits covering 209 outfalls in 21 jurisdictions. Because combined sewer systems are common in older, urban areas, there tends to be significant overlap with communities that are already environmentally overburdened. In New Jersey, CSO-permitted areas include known overburdened communities like Newark, Elizabeth, Patterson, Camden, and Trenton. An estimated 23 billion gallons of a mixture of raw sewage and stormwater are dumped annually into New Jersey's waterways because of these CSOs.[72] Over time, as the urban population density in these areas have increased, with more demand placed on infrastructure, CSO events have also increased.[73] Increased frequency and intensity of storms driven by climate change make matter worse. While the goal of CSO permits is to reduce or eliminate the CSOs by implementing Nine Minimum Controls (NMC) and developing a Long Term Control Plan (LTCP), plan estimates will cost billions of dollars over many years to implement.

[67] https://www.nj.gov/dep/dwq/cso-basics.htm
[68] New Jersey Department of Environmental Protection (NJDEP) (2020), 2020 New Jersey Scientific Report of Climate Change, June 30, 2020, Chapter 4.2 Precipitation, see https://www.nj.gov/dep/climatechange/docs/nj-scientific-report-2020.pdf#page=56.
[69] DeGaetano, A. 2021. Projected Changes in Extreme Rainfall in New Jersey based on an Ensemble of Downscaled Climate Model Projections. Prepared for NJ Department of Environmental Protection. Trenton, NJ.
[70] P. J. Phillips, A. T. Chalmers, J. L. Gray, D. W. Kolpin, W. T. Foreman, and G. R. Wall
Environmental Science & Technology 2012 46 (10), 5336-5343
DOI: 10.1021/es3001294 https://pubs.acs.org/doi/10.1021/es3001294#
[71] Malmassari, J. (2019), The Dangers of Combined Sewere Overflows, Municipal Sewer and Water, April 4, 2019, see https://www.mswmag.com/online_exclusives/2019/04/the-dangers-of-combined-sewer-overflows_sc_003d9.
[72] https://sewagefreenj.org/challenge/
[73] Fu, X., Goddard, H., Wang, X., & Hopton, M. E. (2019). Development of a scenario-based stormwater management planning support system for reducing combined sewer overflows (CSOs). Journal of environmental management, 236, 571–580. https://doi.org/10.1016/j.jenvman.2018.12.089.

Stressor Value Calculation Method

- Obtained New Jersey's CSO GIS file.
- Applied ArcMap's Spatial Join tool to match rows based on their relative spatial locations to determine which block group had at least one CSO.
- Any block group with at least one CSO outfall is above the GeoPC.

May cause potential public health impacts

Stressors in this category are indicators of indirect environmental and public health impacts, often referred to as quality-of-life impacts, borne by New Jersey's overburden communities. These include the physical and mental stress of living in proximity to a multitude of commercial and industrial sites, poor water quality, the effects of aging housing stock on health, and impact of limited access to natural features (e.g., urban forests) and high quality recreational and open space resources (e.g., parks, wildlife areas).

The inverse of this last stressor is an abundance of impervious surface (e.g., roadways, parking lots, sidewalks), which has increased inland flooding in our urban areas. Flooding will only get worse as sea levels rise and climate-driven storms become more frequent and intense. Beyond the metrics of environmental or public health stress are social considerations, such as education and employment levels, which act as "threat multipliers" in our overburdened communities, further straining their resources and making environmental and public health threats more difficult to prevent or manage.

Drinking Water

Description

In 2003, the UN Committee on Economic, Social and Cultural Rights declared access to clean water a human right, noting that it was indispensable for leading a life of human dignity, and a prerequisite for the realization of other human rights.[74] A 2017 review of the Environmental Protection Agency's (EPA) Safe Drinking Water Information System (SDWIS) federal reporting estimated that 63 million Americans had exposure to potentially unsafe water in the past decade.[75] Unclean water can cause serious and costly health issues, and studies have found that poor and minority communities in the U.S. are disproportionally affected by polluted water sources.

Indicator and Measurement Unit(s)

Most New Jersey residents get their drinking water through a public water system, with only 11percent of residents using private wells.[76] State and Federal regulations require periodic water quality monitoring and violation notifications for community water supplies. The State collects this information and annually reports to the EPA on violations of the national primary drinking water regulations with respect to Maximum Contaminant Level (MCL), Action Level Exceedances (ALE) and Treatment Techniques (TT).

While private well owners are responsible for monitoring the quality of their water and maintaining their wells, the NJ Private Well Testing Act (PWTA) requires testing and disclosure of water quality during real estate transactions on properties with potable private wells. It further requires landlords to test their well water once every 5 years. The data generated by the PWTA is provided to the homeowners/tenants and sent to the NJDEP. About 25% of potable wells in New Jersey have been tested through the PWTA. The counts of

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[74] UN Committee on Economic, Social and Cultural Rights (CESCR), General Comment No. 15: The Right to Water (Arts. 11 and 12 of the Covenant), 20 January 2003, E/C.12/2002/11, available at: https://www.refworld.org/docid/4538838d11.html [accessed 9 May 2022].
[75] https://www.epa.gov/ground-water-and-drinking-water/drinking-water-data-and-reports
[76] Dieter CA, Maupin MA, Caldwell RR, et al. Estimated Use of Water in the United States in 2015.; 2018. https://doi.org/10.3133/cir1441.

community drinking water violations or exceedances, or percent of PWTA exceedances were used as the indicator for drinking water quality throughout the State.

Rationale

Drinking water can become contaminated at the water source as well as in the distribution system after treatment. Contamination can come from naturally occurring chemicals and minerals, land uses such as fertilizers, pesticides, and road salt; manufacturing processes, and more; as well as contaminants leaching into the treated water as it passes through the distribution system. Contaminated drinking water can lead to gastrointestinal illness, reproductive problems, and neurological disorders. Specific contaminants that can cause various health concerns include:

- 1,2,3-Tricloropropane, a persistent manmade substance found in soil fumigants, industrial processes, and paint removers, is a potent carcinogen and mutagen.
- Arsenic, primarily from naturally occurring minerals in bedrock aquifers of Northern and Central New Jersey, can increase the risk of lung, bladder, or skin cancer.
- Ethylene Dibromide and 1,2-Dibromo-3-chloropropane, used as pesticides, are also potent carcinogens and mutagens.
- E. Coliform, infectious microorganisms found in human and animal feces, can cause nausea, vomiting and diarrhea.
- Radionuclides, such as radium, uranium, and radon, come from the decay of natural rock. Radium can increase the risk of bone or sinus cancer; uranium can affect kidney function; and radon can cause lung cancer.
- Mercury, either naturally occurring or from septic tanks, landfills, industrial facilities, or hazardous waste sites, may result in nervous system or kidney damage.
- Nitrates from the breakdown of human and animal wastes and chemical fertilizers, decrease the blood’s ability to carry oxygen to organs throughout the body, particularly in infants.
- Volatile organic compounds from septic tanks, gas stations, landfills, and dry cleaning, industrial and hazardous waste facilities affect the liver, kidney, nervous system, or heart; and increase the risk of cancer.

Existing studies have found associations between poor drinking water quality and key environmental justice indicators such as poverty, race/ethnicity indicators. Public water systems that serve communities with lower median incomes, lower rates of home ownership, and higher proportions of Hispanic or non-white residents are associated with higher levels of nitrate and arsenic. Health-based violations of the SDWA are more common in poor communities with higher proportions of Hispanic or African American residents, while the effects of race and ethnicity were not apparent in more affluent communities. [77]

A 2018 study found most initial drinking water violations occurred among systems serving very small (less than or equal to 3300 inhabitants) and small (3301 to 10,000 inhabitants) populations, and lower socioeconomic status and minority groups are associated with an increased odd ratio for initial and repeat drinking water violations.[78] There are a wide range of natural, built, and sociopolitical factors that can cause and perpetuate these disparities in water quality, reliability, and infrastructure, including poorer source

[77] Schaider, L.A., Swetschinski, L., Campbell, C. *et al.* Environmental justice and drinking water quality: are there socioeconomic disparities in nitrate levels in U.S. drinking water?. *Environ Health* **18,** 3 (2019). https://doi.org/10.1186/s12940-018-0442-6 https://link.springer.com/article/10.1186/s12940-018-0442-6

[78] McDonald, Y. J., & Jones, N. E. (2018). Drinking Water Violations and Environmental Justice in the United States, 2011-2015. American journal of public health, 108(10), 1401–1407. https://doi.org/10.2105/AJPH.2018.304621.

water quality due to closer proximity to pollution sources and diminished technical, managerial, and financial capacity to properly manage drinking water.[79]

Stressor Value Calculation Method

Obtained the appropriate source data:

- 3-year (2019-2021) sum of Maximum Contaminant Level (MCL) and/or Treatment Techniques (TT) violations and/or Action Level Exceedances from annual drinking water violation Public Drinking Water reports.
- All private wells tested conducted under the Private Well Testing Act Data from Sept. 2002 to Dec. 2018 (census block tab) with at least one exceedance of a primary standard (arsenic, mercury, radionuclides (gross alpha indicator), e. coli, and VOCs).

For Community Drinking Water data:

- Created a drinking water purveyor polygon file using a attribute join to link the Public Drinking Water data to the Public Drinking Water Purveyor GIS file using purveyor ID number.
- Applied the Intersect geoprocessing tool to determine the geometric intersection between the 2020 NJ census block grouphttps://www2.census.gov/geo/tiger/TIGER_DP/2019ACS/ - :~:text=ACS_2019_5YR_BG_34.gdb.zip,50M file and the drinking water purveyor polygon file such that only the common features are represented in the output coverage.
- Applied the Dissolve geoprocessing tool to the output coverage to select the drinking water area with the maximum size area in the each block group.
- Use attribute join to link the violation records to the maximum area data.
- For a block group served by a public drinking water system, any drinking water violation or exceedance is above the GeoPC.

For PWTA violations, see GeoPC discussion above.

For those block groups served by both a public water system and 5 or more private wells, if both the public water and PWTA stressors are above the GeoPC, the values were not summed, but instead the block group was given an overall value of 1 (yes) for combined drinking water stressor.

Potential Lead Exposure

Description

Lead-based paint and lead contaminated dust are the most hazardous sources of lead for U.S. children.[80] Lead-based paints were banned for use in U.S. housing in 1978. Therefore, all houses built before 1978 are likely to contain some lead-based paint. The deterioration of this paint elevates levels of lead-contaminated house dust that can be either ingested or inhaled by residents. Children under the age of 6 years old are most at risk because they are growing so rapidly and tend to put their hands or other objects which may be contaminated with lead dust into their mouths. Children living at or below the poverty line or children of color who live in older housing are at even greatest risk.

Indicator and Measurement Unit(s)

Age of housing (percent of houses older than 1950 in the block group) is used as a surrogate for potential lead paint exposure.

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[79] Schaider, L.A., Swetschinski, L., Campbell, C. *et al.* Environmental justice and drinking water quality: are there socioeconomic disparities in nitrate levels in U.S. drinking water?. *Environ Health* **18,** 3 (2019). https://doi.org/10.1186/s12940-018-0442-6.

[80] https://www.cdc.gov/nceh/lead/prevention/children.htm

Rationale

Lead is a heavy metal widely used in industrial processes and consumer products. When absorbed into the human body, lead can have damaging effects on the brain and nervous system, kidneys, and blood cells. Lead exposure is particularly hazardous for pre-school children because it can disrupt brain development, causing lowered intelligence, hyperactivity, attention deficits, developmental problems, and decreased hearing. There is no safe level of lead in the blood; even trace amounts can damage brain cells.[81] International pooled analysis of children 6 to 24 months of age observed a loss of 1.88 intelligence quotient (IQ) points for each doubling of blood lead levels beginning at 2 micrograms per deciliter (µg/dL), and recent meta-analysis demonstrated that even slight increases in blood lead levels below 3 µg/dL are still significantly associated with a greater risk of presenting with symptoms of attention-deficit/hyperactivity disorder (ADHD) among children 5 to 12 years of age.

The U.S. Centers for Disease Control and Prevention (CDC) estimates that children with blood lead levels at or above the blood lead reference value of 3.5 µg/dL represent the top 2.5 percent of U.S. children aged one to five tested for lead in their blood (when compared to children who are exposed to more lead than most children).[82] Infants and preschool-aged children are at a higher exposure risk primarily due to their increased body surface area, increased heart and respiratory rates, the ingestion and inhalation of contaminated dust or soil from greater hand-to-mouth activity, pica, crawling, and their low stature to the ground.

A 2020 study found that black race is the second strongest predictor for increased blood lead during early childhood after the risk of living in pre-1950 housing.[83] Statistically, black racial disparity continues to significantly persists within each of the other examined risk factors, such as poverty, education, and presences of smokers in the home, even after correcting for those other risk factors and variables. the most pronounced disparities were observed for Black children two to three years of age, those living in poverty or older housing built from 1950 to 1977, and those with a primary guardian who had not received a high school diploma or GED.

Stressor Value Calculation Method

- Obtained New Jersey American Community Survey (ACS) summary data (New Jersey_Tracts_Block_Groups_Only.zip) and isolated the Housing Age field data.
- Used the following data fields from Table Summary File Sequence 113 (e2019nj0113000):
    - 'B25034_001': Total Housing
    - 'B25034_010': Built 1940 to 1949
    - 'B25034_011': Built 1939 or earlier
- Indicator calculated as:
    - Built before 1950 = Built1940to1949 + Built1939orearlier
    - Percent calculated as (Built before 1950/Total Housing) *100

[81] Yeter, D., Banks, E. C., & Aschner, M. (2020). Disparity in Risk Factor Severity for Early Childhood Blood Lead among Predominantly African-American Black Children: The 1999 to 2010 US NHANES. *International Journal of Environmental Research and Public Health*, *17*(5), 1552. MDPI AG. Retrieved from http://dx.doi.org/10.3390/ijerph17051552.

[82] https://www.cdc.gov/nceh/lead/docs/lead-levels-in-children-fact-sheet-508.pdf

[83] Yeter, D., Banks, E. C., & Aschner, M. (2020). Disparity in Risk Factor Severity for Early Childhood Blood Lead among Predominantly African-American Black Children: The 1999 to 2010 US NHANES. International Journal of Environmental Research and Public Health, 17(5), 1552. MDPI AG. Retrieved from http://dx.doi.org/10.3390/ijerph17051552.

Lack of Recreational Open Space

Description

As the most densely populated state in the Nation with a still growing population, New Jersey's open space is a target for increasing development. However, recognizing the environmental, social, and economic benefits of open space, New Jersey's government agencies and nonprofit land trusts have preserved 34 percent of the State's land (including farmland), an amount nearly equivalent to the percentage of developed land (33 percent). Open space protects water resources; preserves biodiversity and wildlife habitats; creates greenways; enhances urban centers; and supports recreational opportunities. In addition, publicly available open space encourages walking, biking, and other outside physical activity that, according to the CDC, helps people live longer and have lower risks for heart disease, stroke, type 2 diabetes, depression, and some cancers.

Indicator and Measurement Unit(s)

The population per acre of open space (i.e., municipal, county, and nonprofit parkland open space and parkland encumbered by the NJDEP Green Acres Program and reported in the Recreational Open Space Inventory (ROSI) database) within one quarter mile (approximately equivalent to a 10-minute walk) of the block group.

Rationale

Open space and parkland are proven to benefit people's health. Trees filter the air and provide shade on hot days; wetlands and marshes clean water and protect communities from floods and storm surges; parks provide safe havens where children can play and connect, and trails allow people to exercise outdoors. However, access to nature is unequal for lower-income communities and communities of color compared to affluent white communities.

A recent report from the Center for American Progress and the Hispanic Access Foundation found that communities of color experience "nature deprivation" at three times the rate of white Americans. According to the report, 74% of communities of color live in nature-deprived areas, with Black communities experiencing the highest levels of deprivation.[84] Similarly, 2019 study by the University of British Columbia examined 10 U.S. cities, including New York, Chicago, and Houston, and found that Latino and Black communities have less access to urban nature than white communities.[85] Urban residents with lower access to open space and parklands are also those who are most likely to experience poor public health outcomes that could be mitigated by adequate exposure to urban open space.

A growing body of evidence shows that access to green space in urban areas brings considerable benefits to the health and well-being of city residents. These benefits may include improved cognitive development andA growing body of evidence shows that access to green space in urban areas brings considerable benefits to the health and well-being of city residents. These benefits may include improved cognitive development

[84] Rowland-Shea, J., Doshi, S., Edberg, S., & Fanger R. (2020), The Nature Gap: Confronting Racial and Economic Disparities in the Destruction and Protection of Nature in America, Center for American Progress, July 2020, see https://americanprogress.org/wp-content/uploads/2020/07/The-Nature-Gap4.pdf?_ga=2.198324143.1881431880.1652201468-2089605842.1637606711

[85] Lorien Nesbitt, Michael J. Meitner, Cynthia Girling, Stephen R.J. Sheppard, Yuhao Lu, Who has access to urban vegetation? A spatial analysis of distributional green equity in 10 US cities, Landscape and Urban Planning, Volume 181, 2019,Pages 51-79,ISSN 0169-2046, https://doi.org/10.1016/j.landurbplan.2018.08.007.

and functioning[86], reduced severity of ADHD[87], reduced obesity[88], and positive impacts on mental health[89]. The article published in the December 2008 issue of the American Journal of Preventive Medicine reported that children living in inner city neighborhoods with higher "greenness" experienced lower weight gains compared to those in areas with less green space. This is critical, as childhood obesity can lead to Type 2 diabetes, asthma, hypertension, sleep apnea and emotional distress. Obese children are likely to become obese adults, experiencing more cardiovascular disease, high blood pressure and stroke and incurring higher healthcare costs. Finally, the impact of urban open space and parkland exposure on the health and well-being of marginalized communities may become even more critical as climate change worsens, raising temperatures and increasing flooding.

Stressor Value Calculation Method

- Obtained New Jersey's Open Space polygon GIS files.
- Determined residential land use areas in each block group by selecting residential land use from land use land cover and applied the Intersect geoprocessing tool to determine the geometric intersection between that data and the 2020 NJ census block grouphttps://www2.census.gov/geo/tiger/TIGER_DP/2019ACS/ -:~:text=ACS_2019_5YR_BG_34.gdb.zip,50M file such that only the common features are represented in the output coverage.
- Used the ArcMap buffer tool to add ¼ mile buffers to the residential land use areas for each block group.
- Applied the Dissolve geoprocessing tool to the output coverage to aggregate features based on number of acres of open space within ¼ mile of the block group.
- Used this information to calculate population density by dividing the population in the block group by the number of open space acres within ¼ mile.

Lack of Tree Canopy

Description

Tree canopy refers to the layer of tree leaves, branches, and stems that provide tree coverage of the ground when viewed from above.[90] The amount of tree canopy coverage is typically a reflection of a variety of factors, including intentional planning and investment. Tree canopies have numerous benefits, particularly in urban settings, including reducing summer peak temperatures and air pollution, enhancing property values, providing wildlife habitat, and providing aesthetic benefits. In addition, carbon sequestration, the process by which atmospheric carbon dioxide is taken up by trees, grasses, and other plants through photosynthesis and stored as carbon in biomass (trunks, branches, foliage, and roots) and soils, helps to offset carbon dioxide

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[86] de Keijzer C, Gascon M, Nieuwenhuijsen MJ, Dadvand P. Long-Term Green Space Exposure and Cognition Across the Life Course: a Systematic Review. Curr Environ Health Rep. 2016 Dec;3(4):468-477. https://doi.org/10.1007/s40572-016-0116-x. .

[87] Faber Taylor, A, Kuo, F.E. (Ming). Could Exposure to Everyday Green Spaces Help Treat ADHD? Evidence from Children's Play Settings. Applied Psychology: Health and Wellbeing, Vol. 3 Issue 3, Nov. 2011: 281-303. https://doi.org/10.1111/j.1758-0854.2011.01052.x.

[88] "Neighborhood Greenness and 2-Year Changes in Body Mass Index of Children and Youth" by Janice F. Bell, PhD, MPH, Jeffrey S. Wilson, PhD, and Gilbert C. Liu, MD, MS. The commentary is "Decrease in Activity From Childhood to Adolescence: Potential Causes and Consequences" by Nicholas J. Wareham, MBBS, PhD, Kirsten Corder, PhD, and Esther M. F. van Sluijs, PhD. Both appear in the American Journal of Preventive Medicine, Volume 35, Issue 6 (December 2008).

[89] Rugel E. and Ward H. Green Space and Mental Health: Pathways, Impacts and Gaps. National Collaborating Centre for Environmental Health. Mar. 25, 2015, see https://ncceh.ca/documents/evidence-review/green-space-and-mental-health-pathways-impacts-and-gaps.

[90] https://www.nrs.fs.fed.us/urban/utc/

emissions in the atmosphere from deforestation, forest fires, and fossil fuel combustion.[91] Studies throughout the United States have repeatedly shown that most communities are losing tree canopy through a wide range of threats, including insects, disease, natural disasters and development.[92]

Indicator and Measurement Unit(s)
The spatially weighted average of lack of tree canopy within the block group.

Rationale
Urban Tree Canopy (UTC) cover is widely regarded as an environmental good or amenity.[93] UTC cover as an environmental amenity includes direct perceived benefits, or ecosystem services, to people and neighborhoods where UTC cover is found, including regulation of regional climate and water cycles. In addition to UTC, "greenness", as an indicator of vegetation cover, has been associated with reductions in childhood obesity rates, decreasing cognitive fatigue, improve worker attitudes on the job, and reduce stress as well as feelings of anger, depression, or anxiety. UTC cover is also associated with improved aesthetics, noise reduction, and stronger social cohesion and community empowerment. Therefore, lack of UTC cover denies those benefits to the community.

A 2015 study found that high-income neighborhoods in selected cities are more likely than low-income neighborhoods to have high tree canopy cover. An earlier 2011 study show that white areas in Miami-Dade County had greater tree density, greater tree and shrub cover, more tree diversity, and the greatest amount of energy savings due to trees.[94] However, Hispanic areas had greater individual tree leaf area index (LAI), more trees in excellent condition, more impervious surfaces, and more air pollution removal than the other two areas groups.

African American areas had the lowest tree density and LAI, lowest tree and shrub cover and diversity, and received the least amount of ecosystem services in terms of air pollution removal and energy savings. However, African Americans had the greatest amount of potential planting space for trees and the greatest percentage of street trees. The results of this study show that even when some urban forest structure indicators (i.e., leaf area) are not strikingly different among areas, the ecosystem services provided by trees can be limited and inequitable, suggesting the uneven distribution of UTC cover might be influenced by differing levels of control over the physical environment due to housing tenure.

Stressor Value Calculation Method

- Obtained the 2016 US Forest Service "Analytical" Tree Canopy Cover (TCC) Dataset (file name CONUS 2016 – zip) which is already a raster file.
- Created a mirror image raster file by subtracting this file from 100 to represent Lack of Tree Canopy Cover.
- Erased water and salt marsh land uses in Land Use/Land Cover 2015 from 2020 NJ census block group.
- Apply Zona Statistics as a Table function in ArcMap Spatial Analyst using the Lack of Tree Canopy raster file as the input raster and the block groups with water and salt marshes removed as the

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[91] https://www.fs.fed.us/ecosystemservices/carbon.shtml
[92] https://www.nrs.fs.fed.us/urban/utc/
[93] Schwarz K, Fragkias M, Boone CG, Zhou W, McHale M, et al. (2015) Trees Grow on Money: Urban Tree Canopy Cover and Environmental Justice. PLOS ONE 10(4): e0122051. https://doi.org/10.1371/journal.pone.0122051.
[94] Flocks, J.; Escobedo, F.; Wade, J.; Varela, S.; Wald, C. Environmental justice implications of urban tree cover in Miami-DadeCounty, Florida. Environ. Justice 2011, 4, 125–134, see https://www.researchgate.net/publication/228268481_Environmental_Justice_Implications_of_Urban_Tree_Cover_in_Miami-Dade_County_Florida.

feature zone to determine the spatially weighted average for each block group as the indicator for percent of lack of tree cover.

Impervious Surface

Description

Impervious surfaces are areas covered in materials that do not allow water to soak into soil, such as buildings, sidewalks, and roadways. These areas capture heat, creating what is known as the "heat-island effect", worsen flooding impacts, transport surface pollutants that impact water quality, and intensify the impacts of drought by preventing groundwater refresh from occurring. Essentially an inverse of UTC cover, research shows that precent of impervious surface is positively associated with residential density and negatively associated with household income, meaning its typically higher in lower income areas that have less heat-adaptive capacity (e.g., no air conditioning, rental properties without authority to take adaptive steps such as tree planting).[95]

Indicator

Percent of impervious surface in a block group.

Rationale

Impervious surfaces create several environmental and public health threats, including exacerbating heat impacts, worsening flooding, transporting surface pollutants into water sources deteriorating water quality, and intensifying droughts by preventing groundwater refresh from occurring. Each of these threats impacts overburdened communities more acutely. For example, various studies have looked at the characteristics of populations in certain urban settings that are more vulnerable to heat-related mortality. Fine-scale, remotely sensed data shows that impervious surfaces are important predictors of intra-urban variation in temperature, and the degree of impervious surfaces generally increases with population density. [96]

Several authors have also found that the extent of impervious surface is greater in neighborhoods with low socioeconomic status and a high proportion of minority residents, although these studies have been limited to a single U.S. city or state. A 2006 study of neighborhood microclimates in Phoenix that looked at population, community, and biophysical characteristics to simulate an outdoor human thermal comfort index (HTCI) (an indicator of heat stress) as a function of local climate variables found that lower socioeconomic and ethnic minority groups were more likely to live in warmer neighborhoods with greater exposure to heat stress.[97] Further, the study found that the vulnerability of these warmer neighborhoods was exacerbated by a resident's lack of adequate social and material resources to cope with extreme heat.

Studies that have looked at the connection between water quality and the percentage of land cover in a watershed have correlated high stream concentrations of inorganic nitrogen and phosphorus, two of the three main ingredients in artificial fertilizer spread, with both urban and agricultural land use.[98] A 2003 study from the University of Connecticut indicated that the percent of impervious land in a watershed is

[95] Drescher M. (2019). Urban heating and canopy cover need to be considered as matters of environmental justice. Proceedings of the National Academy of Sciences of the United States of America, 116(52), 26153–26154. Advance online publication. https://doi.org/10.1073/pnas.1917213116.

[96] Jesdale, B. M., Morello-Frosch, R., & Cushing, L. (2013). The racial/ethnic distribution of heat risk-related land cover in relation to residential segregation. Environmental health perspectives, 121(7), 811–817. https://doi.org/10.1289/ehp.1205919.

[97] Sharon L. Harlan, Anthony J. Brazel, Lela Prashad, William L. Stefanov, Larissa Larsen, Neighborhood microclimates and vulnerability to heat stress, Social Science & Medicine, Volume 63, Issue 11, 2006, Pages 2847-2863, ISSN 0277-9536, https://doi.org/10.1016/j.socscimed.2006.07.030.

[98] https://news.climate.columbia.edu/2010/07/13/no-more-pavement-the-problem-of-impervious-surfaces/

significantly related to all water characteristics[99], and some studies suggest that paving over anything above 10 to 20 percent of the landscape negatively impacts water quality. For comparison, estimates of the percentage of impervious surface in urban areas range from 50 percent of moderately dense suburban dwellings to over 94 percent in Mid-Manhattan West. Flooding exacerbates water contamination, particularly in areas where CSOs are overwhelmed resulting in human contact with raw sewage.

Stressor Value Calculation Method

Due to the size of the impervious surface files, obtained each county file separately off DEP's Open Data site and then combine into a complete state file. Searched for "Impervious Surface" to find the county files.

- Erased water and salt marsh land uses in Land Use/Land Cover 2015 from 2020 NJ census block group.
- Applied the Intersect geoprocessing tool to determine the geometric intersection between the block groups with water and salt marsh land uses removed and the building footprint data file to link the amount of impervious surface to each block group.
- Applied the Dissolve geoprocessing tool to aggregate features to calculate acres of impervious surface each block group.
- Calculated the percent impervious surface as acres of impervious surface/acres in block group excluding water and salt marshes.

Flooding (Urban Land Cover)

Description

According to the United States Geological Survey, 1,368 square miles, or 15% of New Jersey's total area is made up of water.[100] The 2019 State hazard mitigation plan estimates that 18.65% of the State is in a flood hazard area.[101] Both estimates of New Jersey's watercourses and flood hazard areas likely underestimate potential flooding across the State. Flood damage is, and will continue to be, the most frequent and costly natural hazard in New Jersey. Flooding, particularly in urban areas with large impervious surfaces that prevent water absorption, results in property loss, disruptions in electricity transmission that cause problems for critical infrastructure such as water treatment plants and hospitals, and damage to roads impeding aid, emergency care, and access to food.

Flooding can also result in loss of life. 2020's Tropical Storm Ida claimed the lives of 30 New Jerseyeans, second only to 2012's Superstorm Sandy for storm-related deaths. According the 2019 State Hazard Mitigation Plan, with $5.8 billion in total flood insurance claims, New Jersey ranks third in the nation in claims paid since 1978 in Special Flood Hazard Areas (SFHA). The flood-related hazards most likely to affect New Jersey are riverine (inland) flooding and coastal flooding.[102] Flooding can occur days after a large storm, or it can happen much more quickly, such as when streams are subject to flash flooding. The quick timing of flash flooding increases the risk. Sea-level rise and increases in rain event frequency and intensity driven by climate change have already increased flooding in New Jersey and will continue to do so. This risk of flooding also increases during periods of drought when the soil is too dry to absorb large amounts of rain in a short period of time.

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[99] Center for Watershed Protection (2003), Impacts of Impervious Cover on Aquatic Systems, March 2003, see https://clear.uconn.edu/projects/TMDL/library/papers/Schueler_2003.pdf

[100] http://ready.nj.gov/mitigation/pdf/2019/mit2019_section4_State_Profile.pdf

[101] https://nj.gov/njoem/mitigation/pdf/2019/mit2019_section5-6_Flood.pdf

[102] New Jersey Department of Environmental Protection (NJDEP) (2020), 2020 New Jersey Scientific Report of Climate Change, June 30, 2020, Chapter 4.2 Precipitation, see https://www.nj.gov/dep/climatechange/docs/nj-scientific-report-2020.pdf#page=56.

Indicator and Measurement Unit(s)
Percent of urban land area prone to flooding in a block group.

Rationale
While most EJ and flood-related research has focused on post-flood conditions, more recent studies are taking a pre-flood approach and focusing on vulnerable social groups living in floodprone areas [103, 104, 105, 106] . Other research has framed flood risks in the U.S. and elsewhere as a question of environmental inequality and injustice [107, 108, 109]to better understand the why poor and marginalized communities are often more severely impacted than other communities.

The awareness of flood risk and knowledge of how best to respond in the event of a flood varies by socio-economic group, with those lower socio-economic groups having lower awareness of risk than those in higher socio-economic groups.[110] . In addition, poorer people are more likely to occupy housing which by its nature is is less resilient to flooding (e.g., older and mobile homes) and less able to afford products which can be installed to protect homes against some sorts of flood.[111] Defending the home in this way is also rarely available to those who rented properties.

Research shows that the health impact of flooding varies with preexisting health status, which is often worse in underprivileged neighborhoods. These impacts range from the immediate risk of injury and death to diverse symptoms associated with the proximity of flood water and living in damp accommodations (exacerbation of asthma, skin rashes, gastroenteritis[112] to longer term psychological problems including panic

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[103] Chakraborty et al., Social and Spatial Inequities in Exposure to Flood Risk in Miami, Florida, Natural Hazards Review, Vol, 15, Issue 3, August 2014, https://doi.org/10.1061/(ASCE)NH.1527-6996.0000140
[104] Fielding, J. and Burningham, K. (2005) Environmental inequality and flood hazard, Local Environment, Vol. 10, Issue 4, https://doi.org/10.1080/13549830500160875
[105] Maantay, J., & Maroko, A. (2009). Mapping Urban Risk: Flood Hazards, Race, & Environmental Justice In New York". Applied geography (Sevenoaks, England), 29(1), 111–124. https://doi.org/10.1016/j.apgeog.2008.08.002
[106] Mahbubur Meenar, Richard Fromuth & Manahel Soro (2018) Planning for watershed-wide flood-mitigation and stormwater management using an environmental justice framework, Environmental Practice, 20:2-3, 55-67, https://doi.org/10.1080/14660466.2018.1507366.
[107] Bullard, R.D. and Wright B. (2009), Race, Place, and the Environment in Post-Katrina New Orleans, Chapter 1, DOI: 10.4324/9780429497858-1, see https://www.taylorfrancis.com/chapters/edit/10.4324/9780429497858-1/race-place-environment-post-katrina-new-orleans-robert-bullard-beverly-wright.
[108] Dixon, J. and Ramutsindela, M., (2006) Urban resettlement and environmental justice in Cape Town, Cities, Volume 23, Issue 2, 2006, Pages 129-139, ISSN 0264-2751, https://doi.org/10.1016/j.cities.2005.08.003
[109] Ueland, J. and Warf, B. (2006), Racialized Topographies: Altitude and Race in Southern Cities, Geographic Review, Vol. 96, Issue 1, https://doi.org/10.1111/j.1931-0846.2006.tb00387.x
[110] Fielding, J. and Burningham, K. (2005) Environmental inequality and flood hazard, Local Environment, Vol. 10, Issue 4, https://doi.org/10.1080/13549830500160875
[111] Environment Agency (2009) 'Prepare Your Property for Flooding: A Guide for Householders and Small Businesses', see http://publications.environment-agency.gov.uk/pdf/GEHO1009BRDL-e-e.pdf
[112] Ohl, Christopher & Tapsell, S.M.. (2000). Flooding and human health. BMJ (Clinical research ed.). 321. 1167-8. 10.1136/bmj.321.7270.1167, https://doi.org/10.1136/bmj.321.7270.1167.

attacks, agoraphobia, depression, tiredness, stress, and anxiety[113] [114] [115] [116](. Specifically, garbage and sewage as well as other contaminant caught in flood waters raise the risk of waterborne illness. A flood can also uproot trees, float motor vehicles, and collapse other structures in its path, turning debris into projectiles that lead to further damage downstream. Flood water can also seep into buildings, affecting sewer pipes and causing indoor mold growth.

Stressor Value Calculation Method

- Obtain the Flooding (Urban Land Cover) Layer. This is a unique new GIS file that includes the acres of urban land use flooded in each block group by combining aspects of three existing GIS data sources (NJ Land Use 2015 (Urban type) Source Data, Total Climate Adjusted Flood Elevation, and FEMA 0.2% (500 Year) Flood Hazard Areas Source Data) as follows:
    - Combined two FEMA flooding data layers to determine a Future Coastal and Inland Flooding Potential Layer.
    - Intersected the Future Coastal and Inland Flooding Potential Layer with urban land 2020 NJ census block group.data to create Urban Flooding Layer.

The Urban Flooding Layer is not designed to inform obligations and requirements under the DEP's DLRP rules.

- Determined acres of urban land use in each block group using Land Use/Land Cover 2015
- Joined the Flooding (Urban Land Cover Layer with urban land use to determine flooded urban land use in each block group
- Calculated percent of urban flooding by dividing the flooded urban area by the total urban area in the block group.

Density/Proximity Stressors

Description

Overburdened communities often coexist with numerous commercial facilities and industrial sites, both large and small. While the potential emission impacts from these sites (e.g., air emissions, water pollution, toxic releases etc.) are captured by other EJ stressors, the mere presence of multiple pollution sources within a block group is itself a stressor. The Ironbound section of Newark, for example, is home to multiple garbage incinerators and waste transfer stations, two fossil fuel power plants, numerous factories and warehouses, chemical refineries, the largest fat rendering plant in the U.S., a large sewage treatment plant, and a EPA Superfund site. This density of pollution sources becomes its own psychological stress on the community. In addition, these facilities add other indirect stressors to the community, such as noise, odors, dust, and increased truck traffic, that impinge on the residents' quality of life.

Indicator and Measurement Unit(s)

The Department included three specific density/proximity-related stressors solely to help evaluate the impact

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[113] Thrush, D., Burningham, K. & Fielding, J. (2005) Flood Warning for Vulnerable Groups: literature review (Bristol, Environment Agency), see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/290691/scho0505bjbs-e-e.pdf.

[114] Few, Roger & Ahern, Mike & Matthies, Franziska & Kovats, Sari. (2004). Floods, Health and Climate Change: A Strategic Review, see https://www.researchgate.net/publication/228377613_Floods_Health_and_Climate_Change_A_Strategic_Review.

[115] Hajat, Shakoor & Ebi, Kristie & Kovats, S & Menne, Bettina & Edwards, Sally & Haines, Andy. (2003). The human health consequences of flooding in Europe and the implications for public health: a review of the evidence. 1.

[116] Tapsell, S. M., Tunstall, S. M., Penning-Rowsell, E. C. & Handmer, J. W. 1999 The health effects of the 1998 Easter flooding in Banbury and Kidlington. Report to the Environment Agency, Thames region. Flood Hazard Research Centre, Middlesex University, Enfield, see http://eknygos.lsmuni.lt/springer/154/185-196.pdf.

that the volume of facilities has on a community: permitted air sites, NJPDES sites and emergency planning sites.[117] Each indicator is simply the number of applicable sites per square mile and is evaluated individually as part of the CST (meaning an OBC could get a 1 (yes) for each one of these three stressors for a maximum total of 3).
The permitted air sites proximity stressor includes approximately 230 sites that are considered “major” air facility types regulated under the EJ Law (e.g., fossil fuel power plants and large-scale chemical and manufacturing facilities) and a subset of “minor” air sources classified under one of 56 different Standard Industrial Classification (SIC) codes identified as causing the most frequent community complaints or enforcement actions. The minor source list includes approximately 3,500 facilities, including concrete and granite operations, flavors and fragrances, adhesives and paints, gas stations and chemical preparations.

The NJPDES sites proximity stressor includes all major facilities with NJPDES permits and NJPDES Residual Category V sludge processing facilities.

The emergency planning sites proximity stressor includes all registered sites under the Toxic Catastrophe Prevention Act (TCPA) program rules (N.J.A.C. 7:31); the major sites under the Discharge of Petroleum and other Hazardous Substance (DPHS) program rules (N.J.A.C. 7:1E); or the Worker and Community Right to Know (CRTK) rules (N.J.A.C. 7:1G) that are federally required to do *Emergency Response Plans* (ERPs), excluding “battery only” (e.g., locations with industrial batteries used to power forklifts, computer banks, etc.). These batteries, if damaged, could cause occupational concerns for workers on-site, but are unlikely to present any concerns for the community at large since they are enclosed within the facility. As such, “battery only” sites were excluded.

Rationale
The Law recognizes that the concentration of regulated facilities in an overburdened community is a stressor on that community. The facilities identified above can contribute to increased truck traffic, dust, odor, and noise. A 2011 literature review identified several studies that “found that living near hazardous waste sites, industrial sites, cropland with pesticide applications, highly trafficked roads, nuclear plants, and gas stations or repair shops is related to an increased risk of adverse health outcomes”[118].” Moreover, this review found that “[a]lthough their results are mixed, many studies found significant relationships between residential proximity to environmental hazards and adverse health outcomes, such as adverse pregnancy outcomes (including increased risks for central nervous system defects, congenital heart defects, oral clefts, renal dysplasia, limb malformations, chromosomal anomalies, preterm births, low birth weight, small-for-gestational-age births, fetal deaths, and infant deaths), childhood cancers (including leukemia, brain cancer, germ-cell tumors, non-Hodgkin's lymphoma, and Burkitt lymphoma), asthma hospitalizations and chronic respiratory symptoms, stroke mortality, PCB toxicity, end-stage renal disease, and diabetes.”

While another stressor considers the seriousness of the direct emissions and indirect health and safety impacts from increased truck traffic in a community, these vehicles can increase dust, and create odors and noise, that can be equally impactful on a community’s health and wellbeing. In 2021, the New Jersey Clean Air Council examined the health impacts from “fugitive” dust and found that while large dust particles that settle out near the source site are merely a nuisance, fine particles can reach greater distances from the source site and pose significant health problems because they can be “inhaled into the respiratory tract,

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[117] While the solid waste, scrap metal and site remediation facility stressors are also density/proximity based, these are designed to capture the direct emissions from these facilities as well as the indirect impacts such as noise and odor.
[118] Jean D. Brender, Juliana A. Maantay, and Jayajit Chakraborty, 2011, Residential Proximity to Environmental Hazards and Adverse Health Outcomes, American Journal of Public Health 101, S37_S52, https://doi.org/10.2105/AJPH.2011.300183.

affecting the nasal passages, sinuses, and more deeply into the lungs."[119] While exposure to odor resulting from human activity is generally recognized to be a nuisance, persistent malodor exposure is considered an environmental stressor, capable of generating negative impacts for health and well-being due to stress-related symptoms and illnesses, even if the odorous air is not toxic.

A 2019 study extended previous work that identified a relationship between proximity to odor emitting sites and higher levels of odor annoyance in the Waterfront South neighborhood of Camden, especially in comparison to residents of North Camden.[120] Specifically, the study determined that the presence, intensity, and spatial pattern of three primary odor types (waste treatment, industrial activity, diesel/auto emissions) observed in Waterfront South, suggested odor pollution continues to function as an environmental stressor.

The measurement, regulation, and human health impacts from noise pollution are well known. Noise levels deemed acceptable (safe and won't cause hearing loss) by EPA (70 decibels or below over a 24-hour period) and the National Institute for Occupational Safety and Health (NIOSH) (85 decibels or below over a 24-hour period) are well above recommendations made by the European Union (40 decibels at night and 50 decibels during the day). For context, NYC Midtown Manhattan has reach 94 decibels. According to a 2017 study led by the School of Public Health at the University of California at Berkeley, people in poorer and racially segregated neighborhoods live with higher levels of noise than other people.[121] Neighborhoods with median annual household incomes below $25,000 were nearly two decibels louder than neighborhoods with incomes above $100,000, and communities where at least 3 in 4 residents are black had median nighttime noise levels of 46.3 decibels — four decibels louder than communities with no black residents.

Finally, a recent study also found that "[n]egative perceptions of environmental hazards and reported cultural stressors were significantly associated with fair/poor self-rated health among residents in a low-income majority-minority community…"[122] Since poor self-rated health is often related to chronic health conditions and premature mortality, and minority populations are the most likely to report poor health, the study looked at how both resident perception of neighborhood environments and chronic health conditions individually and collectively influence health in a majority-Hispanic urban population.

Stressor Value Calculation Method

- Obtained the appropriate data source GIS file for each proximity stressor:
  - EJ Air Facilities
  - EJ Major Water Facilities
  - EJ Sludge Facilities
  - EJ TCPA Facilities
  - EJ DPCC Facilities
  - EJ CRTK Facilities

  - Combine the EJ Major Water and EJ Sludge Facilities files to get one water sites file for analysis.
  - Combine the EJ TCPA, DPCC, and CRTK Facilities files to get one Emergency Planning file for analysis.

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[119] https://www.nj.gov/dep/cleanair/pdfs/cac2021report.pdf

[120] Kitson, Jennifer, Monica Leiva, Zachary Christman, and Pamela Dalton. 2019. "Evaluating Urban Odor with Field Olfactometry in Camden, NJ" Urban Science 3, no. 3: 93. https://doi.org/10.3390/urbansci3030093.

[121] Joan A. Casey,Rachel Morello-Frosch,Daniel J. Mennitt,Kurt Fristrup,Elizabeth L. Ogburn,and Peter James 2017, Race/Ethnicity, Socioeconomic Status, Residential Segregation, and Spatial Variation in Noise Exposure in the Contiguous United States, Environmental Health Perspectives 125:7 CID: 077017 https://doi.org/10.1289/EHP898.

[122] Ou, J.Y., Peters, J.L., Levy, J.I. et al. Self-rated health and its association with perceived environmental hazards, the social environment, and cultural stressors in an environmental justice population. BMC Public Health 18, 970 (2018). https://doi.org/10.1186/s12889-018-5797-7.

- Applied ArcGIS' Kernel Density function using the each proximity data source file (EJ Air Facilities, EJ Combined Water file and EJ Combined Emergency Planning) separately as the input with the following parameters:
    - Search radius of 5 kilometer (approximately 3 miles), which is consistent with the distance requirements in EPA's EJSCREEN User Guide.
    - Grid size of 100 ft.

      This calculated a raster density file for each proximity stressor.
- Applied Zonal Statistics as a Table function in ArcMap Spatial Analyst using each separate raster density file as the input to determine the spatially weighted average density for each 2020 NJ census block group.as the indicator for proximity to each site.

Social Determinants of Health

The U.S. Department of Health and Human Services defines those conditions in the environments where people live and work that adversely affect health, functioning, and quality-of-life outcomes and risks as social determinants of health or "SDOHs."[123] Three primary SDOHs (low-income households, minority status, and limited English proficiency) comprise the definition of an overburdened community under the New Jersey Environmental Justice Law. However, two other SDOHs (unemployment and education) are often referenced as key "upstream" factors directly tied to low-income/poverty, which in turn impact health and create disparities by shaping the distribution of money, power, and resources. These SDOHs increase social vulnerability, and reduce capacity to anticipate, confront, repair and recovery from externalities such as natural and human-caused disasters, and disease outbreaks.[124]

Unemployment

Description

Unemployment impacts people's health, well-being, and quality-of-life. Many people live in poverty because they cannot find employment. In addition, some workforce participants are "underemployed", including involuntary part-time employment, poverty-wage employment, and/or insecure employment. In either case, these people struggle to afford healthy foods, health care, and safe, affordable housing, and lack the time and resources for a healthy lifestyle (e.g., exercise, mediation, stress reduction).

Indicator and Measurement Unit(s)

Percent unemployed in a block group.

Rationale

Some adults have great difficulty finding and holding jobs even when overall economic conditions are good. These individuals often have low levels of formal education, skills, and other characteristics (e.g., criminal records) that negatively impact their employment prospects.[125] Unfortunately, these individuals are also more likely people of color; that is, Hispanics and black individuals have substantially higher unemployment

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[123] https://www.cdc.gov/socialdeterminants/index.htm

[124] Flanagan, B. E., Hallisey, E. J., Adams, E., & Lavery, A. (2018). Measuring Community Vulnerability to Natural and Anthropogenic Hazards: The Centers for Disease Control and Prevention's Social Vulnerability Index. Journal of environmental health, 80(10), 34–36, see https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7179070/.

[125] Barden, B., Juras, R., Redcross, C., Farrell, M., and Bloom, D. (2018). New Perspective on Creating Jobs – Final Impacts of the Next Generation of Subsidized Employment Programs. Washington, DC: Office of Planning, Research, and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services.
https://www.acf.hhs.gov/sites/default/files/opre/etjd_sted_final_impact_report_2018_508compliant_v2_8232018_b.pdf.

rates than white individuals across both male and female categories.[126] New Jersey's pre-pandemic 2019 data shows more than twice as many unemployed black people as white people.[127] In the first quarter of 2020, that unemployment gap widened slightly to 6.9% black vs. 2.6% white.[128]

These figures align with national data, which shows that for the first quarter of 2020, African Americans had the highest unemployment rate, double that of white and Asian workers. In fact, since the US Bureau of Labor Statistics started collecting data on the African American unemployment rate in 1972, this rate has often been twice that of the white unemployment rate.[129] While some studies determined that the large, persistent black-white unemployment rate gap isn't readily explained by observable characteristics (e.g., education)[130], others showed that African American males who graduated from high school were ~70% more likely to be involuntarily unemployed than their white counterparts with the same educational background.[131] This disparity increased to over 120% for individuals who had completed 4 or more years of college. The Hispanic-white unemployment gap, which is smaller by comparison, is largely explained by lower educational attainment and language barriers.

In addition to providing income, employment can offer other benefits such as health insurance, paid sick leave, and parental leave, all of which affect the health of employed individuals.[132] Health insurance provides access to affordable medical care and financial protection from unexpected health care costs, while paid sick leave allows employees to seek medical care for themselves or dependent family members without losing wages.

Unemployment can also result in negative health consequences.[133] Those who are unemployed can suffer from report depression, anxiety, low self-esteem, demoralization/ worry, and physical pain. Unemployed individuals also have more stress-related illnesses such as high blood pressure, stroke, heart attack, heart disease, and arthritis. In addition, experiences such as perceived job insecurity, downsizing or workplace closure, and underemployment also have implications for physical and mental health.

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[126] Cajner, Tomaz, Tyler Radler, David Ratner, and Ivan Vidangos (2017). "Racial Gaps in Labor Market Outcomes in the Last Four Decades and over the Business Cycle," Finance and Economics Discussion Series 2017-071. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2017.071 .

[127] https://www-doh.state.nj.us/doh-shad/indicator/view/Demographics.Employ.html

[128] https://www.epi.org/indicators/state-unemployment-race-ethnicity-2020q1q2/

[129] Federal Reserve Economic Data, "Unemployment Rate: Black or African American," Federal Reserve Bank of St. Louis, available at https://fred.stlouisfed.org/series/LNS14000006.

[130] https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources/employment#36

[131] Cajner, Tomaz, Tyler Radler, David Ratner, and Ivan Vidangos (2017). "Racial Gaps in Labor Market Outcomes in the Last Four Decades and over the Business Cycle," Finance and Economics Discussion Series 2017-071. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2017.071.

[132] https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources/employment

[133] https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources/employment#36

Stressor Value Calculation Method

- Obtained New Jersey's [American Community Survey (ACS) summary data](#) Summary File Sequence Table 78 e2019nj0078000 and used the following fields:
  - Civilian labor force: B23025_003
  - Unemployed: B23025_005
- Calculated Unemployment as ([unemployed]/[civilian labor force])*100

Education

Description

Insufficient education is a socio-economic factor that contributes directly to unemployment, and indirectly to low-income status. In addition, insufficient education can exacerbate limited English proficiency, which itself contributes to unemployment and poverty.

Indicator and Measurement Unit(s)

Percent without a high school diploma in a block group.

Rationale

A high school diploma is a standard requirement for most jobs and all higher education opportunities. However, disparities in high school completion rates exist among racial and ethnic groups in the United States.[134] According to data for the 2018-2019 school year, 93 percent of Asian/Pacific Islander, 89 percent of white, 82 percent of Hispanic, 80 percent of black, and 74 percent of American Indian/Alaskan Native students attending public high schools graduated within 4 years of beginning the 9th grade.[135] In New Jersey, the Adjusted Cohort Graduation Rate gap between white and black public high school students is more even pronounced at 12 percent (95 percent for while students and 83% for black students).

Education is not only linked to differences in employment type, but also working conditions, income amount and benefits.[136] Individuals with less education have fewer employment choices, driving them into positions with low levels of control, job insecurity, low wages, and limited or no additional benefits. Individuals with less education are also more likely to have jobs that are physically demanding or include exposure to toxins.

Students fail to complete high school for a variety of reasons, including the impacts of poverty, and teen pregnancy and parenthood.[137] Students who do not graduate high school are more likely to self-report overall poor health. They are also more likely to suffer from at least 1 chronic health condition such as asthma, diabetes, heart disease, high blood pressure, stroke, hepatitis, or stomach ulcers. Ultimately, finishing more years of high school, and especially earning a high school diploma, decreases the risk of premature death.

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[134] https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources/high-school-graduation#7

[135] https://nces.ed.gov/programs/coe/indicator/coi

[136] https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources/employment#36

[137] https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources/high-school-graduation#7

Stressor Value Calculation Method

- Obtained New Jersey's [American Community Survey (ACS) summary data] Summary File Sequence table e2019nj0042000 and used the following fields:
  - B15003_001 Total Population 25 years and over
  - B15003_017 Regular high school diploma
  - B15003_018 GED or alternative credential
  - B15003_019 Some college, less than 1 year
  - B15003_020 Some college, 1 or more years, no degree
  - B15003_021 Associate's degree
  - B15003_022 Bachelor's degree
  - B15003_023 Master's degree
  - B15003_023 Master's degree
  - B15003_024 Professional school degree
  - B15003_025 Doctorate degree

- Calculated Population below high school diploma
  - Total Population 25 and over – (sum of fields B15003_017 to B15003_025)

- Calculated Percent Unemployment
  - ([Population below high school diploma]/[Total Population 25 years and over])*100

Appendix A

Coordinates for all Air Quality Monitors Included in the Ozone and PM Stressor Calculations

State_Code	County_Cod	Site_Num	Parameter_	POC	Latitude	Longitude	State_Name
09	001	0017	44201	1	41.003611	-73.585	Connecticut
09	001	0017	44201	1	41.004657	-73.585128	Connecticut
09	001	1123	44201	1	41.399167	-73.443056	Connecticut
09	001	3007	44201	1	41.1525	-73.103056	Connecticut
09	001	9003	44201	1	41.118333	-73.336667	Connecticut
09	005	0005	44201	1	41.821342	-73.297257	Connecticut
10	001	0002	44201	1	38.986672	-75.5568	Delaware
10	003	1007	44201	1	39.5513	-75.732	Delaware
10	003	1010	44201	1	39.817222	-75.563889	Delaware
10	003	1013	44201	1	39.773889	-75.496389	Delaware
10	003	2004	44201	1	39.739444	-75.558056	Delaware
10	005	1002	44201	1	38.6539	-75.6106	Delaware
10	005	1003	44201	1	38.7791	-75.16323	Delaware
34	001	0006	44201	1	39.464872	-74.448736	New Jersey
34	003	0006	44201	1	40.870436	-73.991994	New Jersey
34	007	0002	44201	1	39.934446	-75.125291	New Jersey
34	007	1001	44201	1	39.68425	-74.861491	New Jersey
34	011	0007	44201	1	39.422273	-75.025204	New Jersey
34	013	0003	44201	1	40.720989	-74.192892	New Jersey
34	015	0002	44201	1	39.800339	-75.212119	New Jersey
34	017	0006	44201	1	40.67025	-74.126081	New Jersey
34	019	0001	44201	1	40.515262	-74.806671	New Jersey

Coordinates for all Air Quality Monitors Included in the Ozone and PM Stressor Calculations (Cont.)

State_Code	County_Cod	Site_Num	Parameter_	POC	Latitude	Longitude	State_Name
34	021	0005	44201	1	40.283092	-74.742644	New Jersey
34	021	9991	44201	1	40.3125	-74.8729	New Jersey
34	023	0011	44201	1	40.462182	-74.429439	New Jersey
34	025	0005	44201	1	40.277647	-74.0051	New Jersey
34	027	3001	44201	1	40.787628	-74.676301	New Jersey
34	029	0006	44201	1	40.06483	-74.44405	New Jersey
34	031	5001	44201	1	41.058617	-74.255544	New Jersey
34	041	0007	44201	1	40.92458	-75.067815	New Jersey
36	005	0110	44201	1	40.816	-73.902	New York
36	005	0110	44201	1	40.81618	-73.902	New York
36	005	0133	44201	1	40.8679	-73.87809	New York
36	027	0007	44201	1	41.78555	-73.74136	New York
36	061	0135	44201	1	40.81976	-73.94825	New York
36	071	5001	44201	1	41.52375	-74.21534	New York
36	079	0005	44201	1	41.45589	-73.70977	New York
36	081	0124	44201	1	40.73614	-73.82153	New York
36	085	0067	44201	1	40.59664	-74.12525	New York
36	087	0005	44201	1	41.18208	-74.02819	New York
36	103	0002	44201	1	40.74529	-73.41919	New York
36	103	0009	44201	1	40.82799	-73.05754	New York
36	103	0009	44201	2	40.82799	-73.05754	New York
36	111	1005	44201	1	42.14403	-74.49431	New York
36	119	2004	44201	1	41.05192	-73.76366	New York
42	011	0006	44201	1	40.51408	-75.789721	Pennsylvania
42	011	0011	44201	1	40.38335	-75.9686	Pennsylvania
42	017	0012	44201	1	40.107222	-74.882222	Pennsylvania
42	029	0100	44201	1	39.834461	-75.768242	Pennsylvania
42	045	0002	44201	1	39.835556	-75.3725	Pennsylvania
42	069	0101	44201	1	41.479116	-75.578186	Pennsylvania
42	069	2006	44201	1	41.442778	-75.623056	Pennsylvania
42	077	0004	44201	1	40.611944	-75.4325	Pennsylvania
42	079	1100	44201	1	41.209167	-76.003333	Pennsylvania
42	079	1101	44201	1	41.265556	-75.846389	Pennsylvania
42	089	0002	44201	1	41.08306	-75.32328	Pennsylvania
42	091	0013	44201	1	40.112222	-75.309167	Pennsylvania
42	095	0025	44201	1	40.628056	-75.341111	Pennsylvania
42	095	8000	44201	1	40.692224	-75.237156	Pennsylvania
42	101	0004	44201	1	40.008889	-75.09778	Pennsylvania
42	101	0024	44201	1	40.0764	-75.011549	Pennsylvania
42	101	0048	44201	1	39.991389	-75.080833	Pennsylvania
42	101	1002	44201	1	40.035985	-75.002405	Pennsylvania
36	085	0111	44201	2	40.58027	-74.19832	New York
42	101	0004	44201	2	40.008889	-75.09778	Pennsylvania