Cover Sheet
University Proposal to State

Proposal to:	California Air Resources Board	Due date:	09/25/2024
	1001 I Street, Sacramento, CA 95814	Submitted:	09/25/2024

State agency contact:	Elizabeth Scheehle	Phone #:	
	Chief, Research Division	Email:	

Project title:	Quantifying Greenspace Impacts on Human Health in California				
Funding amount:	$697,493				
Project period:	01/01/2025	to	12/31/2026		
IT Activity/Component?	No	x	Yes		*Explain in coversheet addendum*

University PI:	Peter James	Phone #:	
	University of California, Davis	Email:	
	Public Health Sciences		
	One Shields Ave, Davis, CA 95616		

Authorized University Official:	Samuel Boyes, C&G Analyst	Alternate contact:	Tina Palomino
	One Shields Ave. Davis CA, 95616		

I certify that this proposal is compliant with the State & University Proposal and Administration Manual and that Scope of Work and Proposed Budget Estimate are compliant with University Policy.

Principal Investigator Signature		Authorized Official Signature	
Peter James		Samuel Boyes	
Date:	9/25/24	Date:	9/23/24

EXHIBIT A

SCOPE OF WORK

☒ Contract ☐ Grant

Does this project include Research (as defined in the UTC)? ☒ Yes ☐ No

PI Name: Peter James, Associate Professor, University of California Davis, One Shields Avenue, Davis, CA 95616, pjames@ucdavis.edu

Project Title: Quantifying Greenspace Impacts on Human Health in California

Project Summary/Abstract

As California confronts various pressing challenges—from health disparities and mental health crises to the escalating impacts of climate change—it is increasingly recognized how greenspaces drive health and other related ecosystem services. Trees, shrubs, parks, and other greenspaces offer numerous benefits. They mitigate exposure to air pollution, noise, and extreme heat, offer a setting for physical activity, encourage social interaction, reduce stress, and restore cognition. However, there are still important gaps in the current understanding of how nature affects human health and wellbeing. Working with local communities and large spatial datasets on greenspaces and human health, we the University of California, Davis (UCD or Contractor) will quantify how changing the quantity, distribution, and quality of, as well as access to, greenspaces will impact health for all Californians, including those in underserved communities, and we the Contractor will model the downstream costs or savings of these changes. Ultimately, the Contractor's innovative and integrated approaches will provide insights and methods for driving science-based investment and management of greenspaces to ensure that the benefits of greenspaces reach all people equitably, and improve human health and well-being to face the immense challenge of climate change.

If Third-Party Confidential Information is to be provided by the State:

☐ Performance of the Scope of Work is anticipated to involve use of third-party Confidential Information and is subject to the terms of this Agreement; ***OR***

☐ A separate CNDA between the University and third-party is required by the third-party and is incorporated in this Agreement as Exhibit A7.

Scope of Work

Research increasingly indicates that greenspaces, including street trees, forests, gardens, parks, and other natural vegetation, may benefit health by reducing exposures to air pollution, noise, and extreme heat and mitigating the impacts of these exposures on health. Additionally, greenspaces promote physical activity, encourage social interaction, reduce stress, and restore cognition. Substantial evidence suggests that greenspaces provide benefits, including cooling urban environments and reducing air pollution exposure. Collectively, these health benefits may have massive economic impacts on the state—at least $1.4 billion per year according to a partial accounting of four services provided by urban tree cover in California. However, there are still large knowledge gaps in quantifying how changing the quantity, distribution, and quality of, as well as access to, greenspaces is related to changes in human health, as well as the economic impacts of these changes. Moreover, greenspace is not equally distributed, and underserved and overburdened communities may obtain greater benefits from greenspaces.

Prior research from the California Air Resources Board (CARB) has estimated that increasing greenspace statewide could lead to large benefits for health; however, these analyses were limited using non-specific satellite vegetation indices. More work is required to quantify urban greenspaces based on typologies, numbers of trees, access, location, and tree canopy cover metrics. These future analyses are fundamental to meet CARB's urban greenspace modeling needs. Furthermore, linking these novel greenspace metrics to underserved communities will aid CARB in estimating health equity concerns related to greenspace.

CARB's significant investments in community-driven air quality protection through Assembly Bill (AB) 617 includes several urban greening strategies in Community Emission Reduction Plans (CERPs) around the state. While the CARB California Climate Investment (CCI) program has funded a number of urban greening projects and has calculated the future potential benefits for the projects, there is still a need for a comprehensive statewide monitoring and assessment of the many real benefits from California's urban green spaces that capitalizes on novel high resolution land cover and tree canopy data to estimate the value of CARB programs increasing urban greening, particularly in underserved communities through time and in response to climate and climate action.

With leadership from a team of environmental epidemiologists, plant scientists, environmental economists, environmental geographers, and community engagement experts, and working in concert with a statewide Community Advisory Group and in consultation with CARB, this contract aims to develop methodologies to fill these gaps in quantifying the human health benefits of greenspaces and to support CARB's Nature-Based Solution programs to equitably increase greenspace in California communities. The objectives of this contract are to create a repeatable and transferable process using remotely sensed data that will 1) quantify the health benefits of greenspaces, including downstream economic impacts; 2) estimate how the benefits of greenspace impact underserved communities. This work will be informed by engagement with a Community Advisory Group as well as in consultation with CARB. The contract will develop methodologies that can be applied to both current levels of urban greenness and future projections of urban greening under climate change to assess the health benefits at the state, regional, and local level. The Contractor will also consider the distribution of underserved communities in California and will model how future projections of urban greening efforts will impact these communities. The models will be responsive and adaptable to CARB needs and alternative greening scenarios that CARB develops. The Contractor will produce a model that CARB can modify and run to examine future scenarios after the contract ends.

This contract will support CARB's Nature-Based Solution programs to increase green space in California communities, including through street, neighborhood, and schoolyard greening efforts, including those related to AB 1757 which is designed to increase nature-based solutions and "would require the state board, no later than January 1, 2025, to develop standard methods for state agencies to consistently track greenhouse gas emissions and reductions, carbon sequestration, and, where feasible and in consultation with the Natural Resources Agency and the Department of Food and Agriculture, additional benefits from natural and working lands over time." The Contractor will provide valuable evidence to target and guide the implementation of nature-based solutions to make equitable improvements in health across California, including in underserved communities. California's stunning greenspaces offer more than scenic beauty; this contract will quantify how they actively promote human health.

Project Tasks

Task 1: Develop an Overall Workplan

The Contractor will work to develop an overall workplan for the analysis for the project. The Contractor will work with both CARB and the Community Advisory Group to develop this workplan. The final workplan will contain a clear description of deliverables for each task and a timeline for deliverables including interim milestones.

Task 1 Deliverables: The Contractor will complete an overall workplan for the analysis of the project. This will contain detailed guidelines on how each task will be completed. The workplan will include a list of health outcomes to be considered. This is an early deliverable and will be delivered on three months into the project. Work will proceed on the contract after the approval of the workplan.

Task 2: Literature Review of the Health Impacts of Greenness and the Methods used to Quantify Health Benefits

The Contractor has extensive experience in research on greenness and health, having published multiple prior reviews in the area,[1–6] and the Contractor has pioneered methods in exposure assessment in greenspace epidemiology.[7–9] Building on this expertise, the Contractor will conduct a systematic search of the greenspace and health literature. The Contractor will also examine studies that have evaluated the health-related economic costs and benefits due to greenspace. The Contractor will summarize study findings, including but not limited to those from CARB-funded projects, and will annotate the methodologies applied across studies. In this review, the Contractor will pay close attention to exposure assessment, to ensure that the most accurate and specific metrics of greenspace exposure are identified. The Contractor will also assess bias, for instance whether the authors have adequately controlled for important confounders, such as neighborhood socioeconomic status (SES). The Contractor will also summarize findings for important vulnerable subgroups, including age groups, race/ethnicity, neighborhood SES, linguistic isolation, and urbanicity/population density.

Task 2 Deliverables: The Contractor will provide CARB with a report on the findings of the literature review of health impacts of greenspace and the methods used to quantify health benefits. This will include a table summarizing major findings, methodological approaches, and potential biases and limitations in the literature. The literature review will be delivered six months into the project.

Task 3: Data Collection for Exposure and Health Impact Analysis

The Contractor will first design a data management plan to ensure high-quality data (and metadata) are collected, used, transformed, and reported following robust scientific standards and norms. At a minimum, all data collected and generated will undergo a preliminary validation to ensure their usability, quality, statistical structure, and assumptions that might affect analyses and interpretation. The Contractor has developed a Conceptual Diagram (**Figure 1**) which captures **Tasks 2-5**.

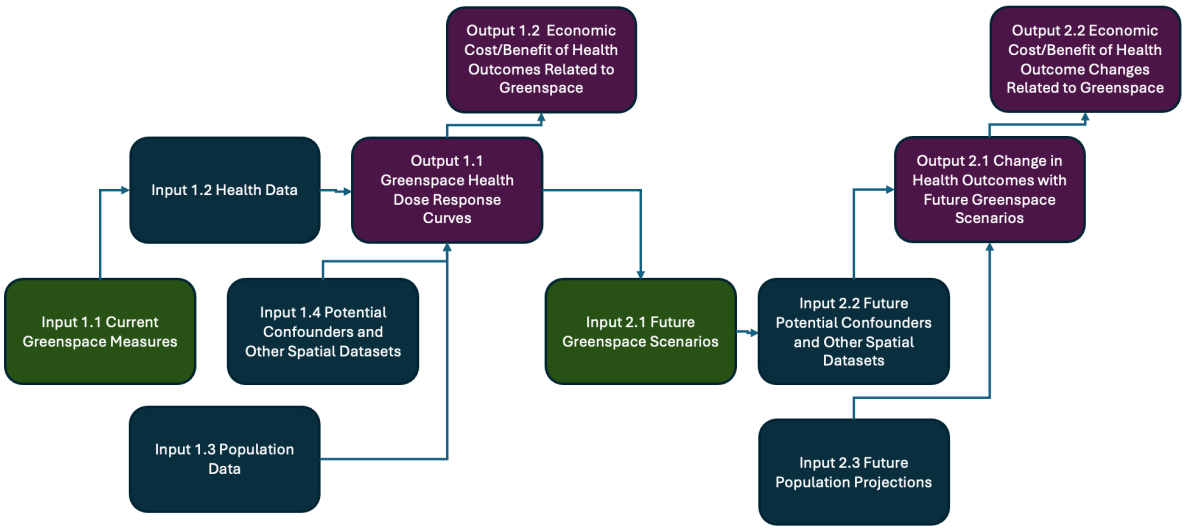


Figure 1. Conceptual Diagram

Greenspace Datasets

Drs. James, Ossola, and Brazil have broad expertise in and have developed spatial analysis and remote sensing approaches to develop exposure metrics, as well as analytic pipelines and code, for greenspace, including satellite data (normalized difference vegetation index (NDVI) and enhanced vegetation index (EVI)),[10] street-view based metrics, tree canopy cover data, high resolution tree canopy height data, tree species maps,[11] park datasets,[12] and biodiversity datasets. The Contractor will leverage our current research on multi-scalar approaches to integrate available greenspace data over time and match to longitudinal health datasets.[13,14] The Contractor will apply spatial analytic approaches to aggregate greenspace metrics up to any spatial scale needed for epidemiologic analyses, using, for example, zonal statistics or other approaches to examine the composition of greenspace within an administrative boundary. The Contractor has also added Dr. Noli Brazil, an expert in spatial analysis, to the study team. The Contractor has held prior symposia on developing greenspace exposure metrics,[15] and have received funding from Recreational Equipment Incorporated (REI) Cooperative Action Fund to create a nationwide nature exposure repository. Together these data can provide both high-resolution accurate measures for landcover and tree cover as these datasets are available down to the 1 meter (m) or smaller resolution, and most metrics are time-varying and collected consistently statewide. The Contractor will build on these datasets and dive deeper into datasets specific to California that might have increased specificity and resolution, including CARB-developed datasets on trees, shrubs, and grass. The Contractor will also focus on spatial datasets that are routinely collected and are open source, in order to continue to monitor changes in greenspace over time (see **Table 1**).

Table 1. Spatial Datasets on Greenspace

Dataset	Construct	Resolution / Scale	Temporal Frequency
Urban Tree Canopy Map of California from USDA Forest Service	Tree canopy cover	1m statewide	Every 5-6 years
CALFIRE high resolution urban tree canopy cover	Tree canopy cover	<1m statewide	Every 5-6 years
National Agriculture Imagery Program	Tree canopy cover	60cm statewide	Every 2-3 years
National Land Cover Dataset	Tree canopy cover	30m statewide	Every 5 years
EVA Tool of Multi-Resolution Land Characteristics	Tree canopy cover change	30m statewide	Every 1-2 years
Statewide Crop Mapping	Agriculture	30m statewide	Every 1-2 years
US Geological Survey Protected Areas Database	Park access	Statewide polygons	Not Time-Varying
California Protected Areas Database	Park lands that are owned in fee and protected for open space purposes by over 1,000 public agencies or non-profit organizations	Statewide polygons	Every 1-2 years
Open Street Maps	Urban Parks	Statewide polygons	Continuously
IUCN Red Lists, the US Endangered Species Act, the California Endangered Species Act (CESA), Global Invasive Alien Species Information Partnership	Biodiversity	Varying scales	Every 10 years or more
Global Biodiversity Information Facility (GBIF)	Biodiversity	Varying scales	Every 1-2 years
Calflora and Calscape	Biodiversity	Varying scales	Every 1-2 years
Landsat Enhanced Vegetation Index	Vegetation	30m statewide	Every 16 days
Landsat Normalized Difference Vegetation Index	Vegetation	30m statewide	Every 16 days

The Contractor will capitalize on numerous spatial datasets on greenspace, with the main focus on tree cover. The Contractor has access to numerous datasets to estimate tree cover at high spatial resolution, but also at high temporal frequency to detect changes over time. For the primary tree cover metric, the Contractor will use available open-source urban tree canopy (UTC)

cover maps that are routinely created by various federal and state agencies (please see the 2018 1m resolution UTC map of California[16] in **Figure 2**) and the new high resolution (<1m) urban tree canopy cover map for 2024 from CALFIRE soon to be released. Data are usually collected every 5-6 years for the entire state of California. UTC maps will be complemented by maps on greenspace derived from the National Agriculture Imagery Program (NAIP) Program.[17] The last NAIP data were collected across the whole state in 2022 at 60 cm resolution, and collections are scheduled every 2-3 years by federal mandate to the USDA, guaranteeing a high-fidelity, high-frequency dataset. At larger resolution, the Contractor will completement UTC data with 30m datasets related to urban land cover by using the National Land Cover Database (NLCD)[18] and the EVA Tool of the Multi-Resolution Land Characteristics (MRLC) Consortium that is able to detect year-by-year land cover change across the state.[19] To account for the fact that many Californians live in peri-agricultural areas, which may expose them to pesticides and allergens, the Contractor will include 30m raster data from the Statewide Crop Mapping by the California Natural Resources Agency, which is updated every 1-2 years.[20]

For park access, the Contractor will use the US Geological Survey Protected Areas Database of the US version 2.1, which is a non-time varying dataset.[12] All land types likely to be used by the general public for outdoor recreation are included in this dataset. This dataset includes smaller parks within cities. It includes only parks accessible to the public and excludes non-accessible public land (e.g., Department of Defense land). It contains data on entrance fees. The Contractor will also examine the California Protected Areas Database, which contains lands that are owned in fee and protected for open space purposes by over 1,000 public agencies or non-profit organizations. For these park datasets, the Contractor will calculate distance to the closest park for every 100m across the state, or can create metrics of park density per Census tract or ZIP code. The Contractor will focus on parks that are designated as "Open Access" meaning they are open to the public. The Contractor will also create metrics of park access focusing on parks that contain playgrounds and/or trails as a marker of amenities accessible within parks. For urban parks, the Contractor will download all parks (places tagged as leisure=park) in California from Open Street Map that are labeled as "public" access.

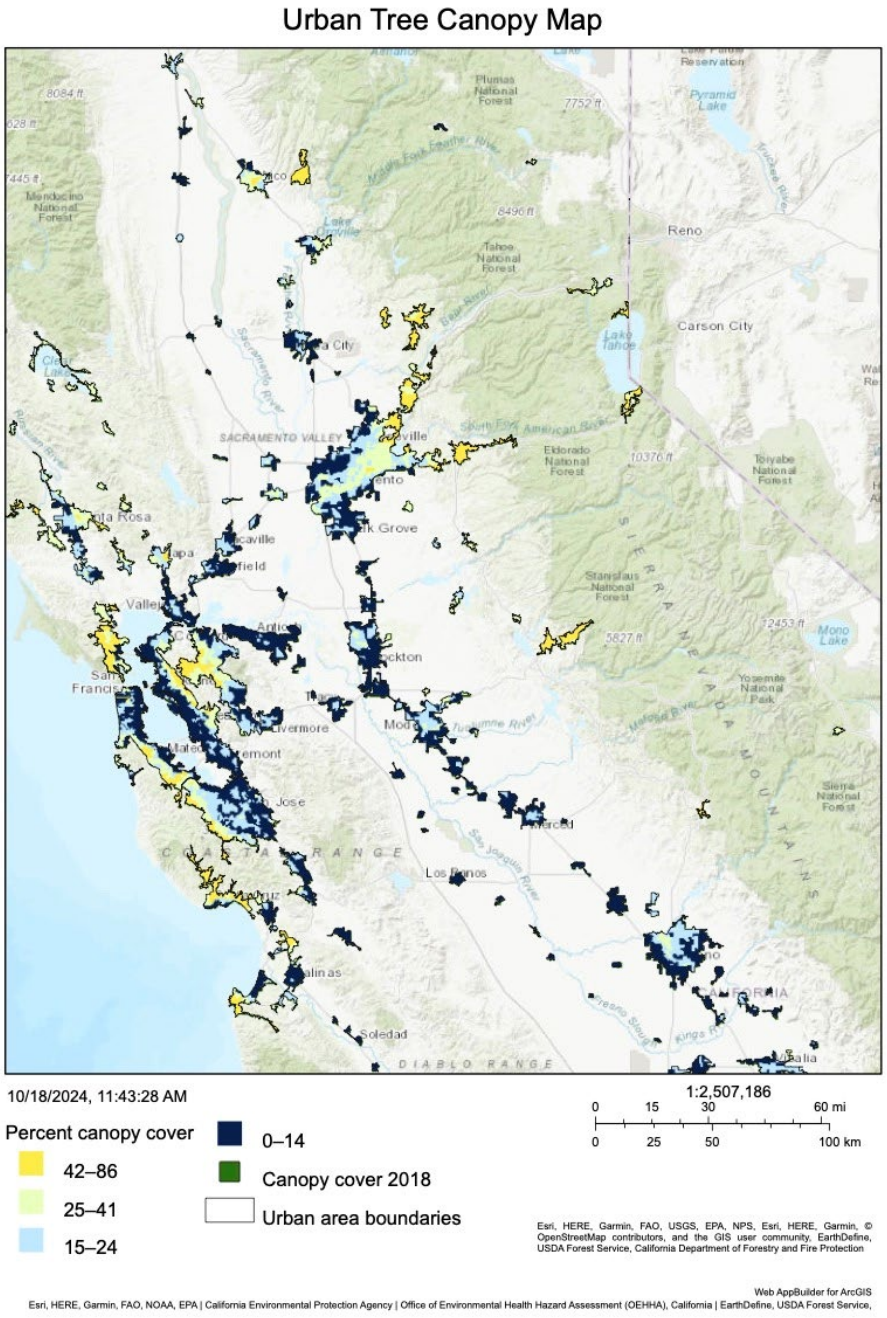


Figure 2. Percent Urban Tree Canopy Cover in Northern California

To account for the effects that urban biodiversity can have on human health, The Contractor will create a

robust set of biodiversity metrics that can be updated regularly over the years (see **Table 1**). These metrics will be calculated at the appropriate resolution to match the spatial extent of public health datasets and outcomes (e.g., ZIP code, census tract, or finer resolution). The Contractor will create an updated list of endangered, rare and protected species by reviewing records from the IUCN Red Lists,[21] the US Endangered Species Act[22] and the California Endangered Species Act (CESA)[23] focused on trees and plants. In doing so, the Contractor assumes that the proximity of humans to these species of conservation interest is a robust proxy/indicator for exposure to habitats with higher biodiversity.[24]

To ensure our analyses are comparable to prior greenspace-health analyses in the published literature, the Contractor will also collect Landsat satellite-based Enhanced Vegetation Index (EVI) and Normalized Difference Vegetation Index (NDVI) data. EVI is a Landsat satellite- based metric of the quantity of ground vegetation which corrects for atmospheric conditions and canopy background noise and is sensitive in areas with dense vegetation. EVI is available for every surface of the globe from 1984 to the present at 30m resolution every 16 days. The Contractor will also examine NDVI, another Landsat satellite-based measure of vegetation that has been widely used in previous studies of greenness and health.[1,4,5] NDVI is also available globally from 1984-present at 30m resolution every 16 days.

To further drill down into greenspace beyond tress, such as shrubs or grass, the Contractor will create a metric by examining NDVI and EVI from all areas with no tree canopy cover in NAIP by incorporating data on building footprints to further refine fine-scale estimates of vegetated vs impervious covers (see **Potential Confounders and Other Spatial Datasets section**). This vegetation will represent non-tree vegetation and will enable the Contractor to isolate potential health impacts of grass and shrubs. See **Figure 3** for more on this pipeline.

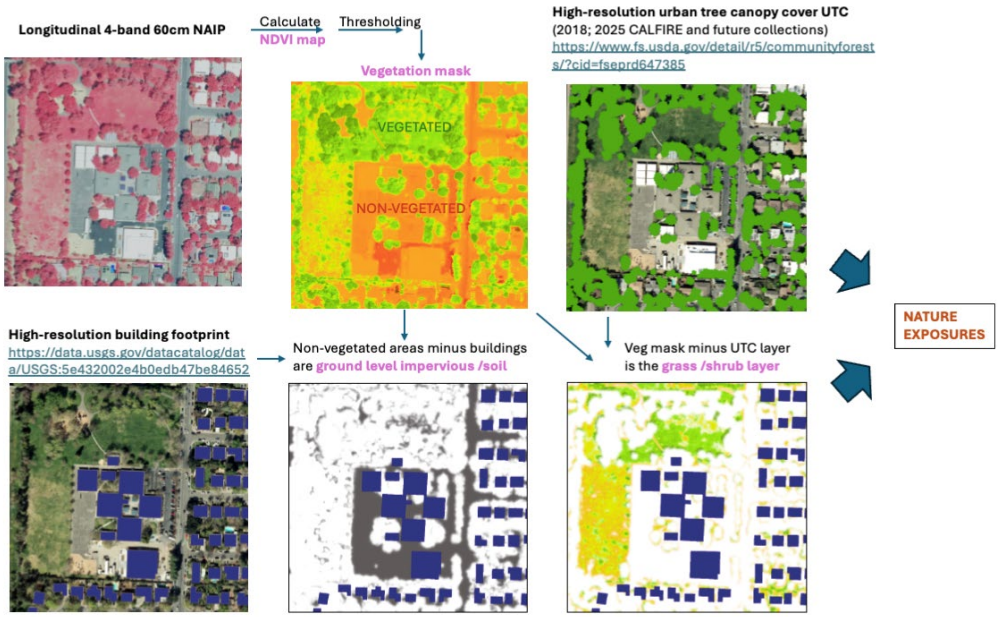


Figure 3. Pipeline to create grass / shrub layers.

Differentiating between grass and shrubs is a complex task. Even applying neural networks to red, green, blue, and near-infrared (RGB-NIR) data from NAIP, identifying grasses/turf is a challenge as their spectral signal depends on irrigation, C3/C4 grass metabolism, and more. In addition, NAIP imagery is collected at various times over a growing season in different years, so it challenging to standardize, particularly the scale of the entire state of California. NAIP collections can be 2-3 months off from year to year, so can represent data well into a summer drought or during a mild spring. A study has demonstrated that distinguishing between shrubs and grass using NDVI is not linear;[25] however, based on this study, for this analysis the Contractor will examine NDVI data in locations with no tree cover (as described above) and will coarsely define NDVI values from 0-0.4 as grass and values above 0.4 to be shrubs. This is because trees and shrubs usually have a higher leaf area index and chlorophyll content which is strongly associated with higher NDVI values, and a prior study in California showed that shrubs showed little seasonality and generally ranged from an NDVI value of 0.4 to 0.7, while grasslands remained around an NDVI value of 0.2-0.4.[26] However, it should be noted that although grass might have a lower leaf area index, larger areas covered in healthy grass might also result in higher mean NDVI values[25] and also would vary by season peaking in February-April,[26] so this approach has limitations. As a secondary focus, the Contractor will examine NLCD data on pixels that are classified as "Shrub/Scrub" v. "Grasslands/Herbaceous"; however, NLCD has limited utility within urban areas, where almost every pixel is classified as "Developed."

To evaluate the quality of open access greenspace, the Contractor will overlay tree canopy data, NDVI, and EVI with the park datasets listed in **Table 1**. For each park, the Contractor will evaluate the percent tree canopy cover and average NDVI

and EVI values as a proxy for greenspace quality within a park.

Health Datasets

Co-I Hertz-Picciotto has substantial experience with publicly available health datasets in California. The Contractor will lean heavily on Dr. Hertz-Picciotto to identify and connect our team to health datasets that can be spatially linked to greenspace metrics. Specifically, California Department of Health Care Access and Information (HCAI) data documents all hospitalizations and emergency department visits throughout the state, and these data are also linked to the ZIP code of the patient's residence. For each visit, the dataset includes the ICD codes for discharge diagnoses, the dates admitted and released, as well as all treatments received and whether they were in the ICU or NICU (neonatal ICU), which can serve as proxies for severity of the condition. Of particular concern with respect to greenspace are cardiovascular, respiratory, renal, cerebrovascular, heat-related, neurologic, and mental health conditions, as well as injuries. The California Department of Public Health (CDPH), Center for Health Statistics and Informatics, Health Information and Research Section provides ZIP code level data on death certificate datafiles and ICD codes for cause of death. California Birth Files will be obtained through the Department of Public Health, Vital Statistics Branch. With California State IRB and Vital Statistics approvals, exact address information of the mother at delivery can be obtained. Other information in these files include: maternal and paternal demographics (age, race/ethnicity and education), maternal smoking (usually based on self-reports), complications of labor and delivery, APGAR scores (an indicator of neonatal stress immediately after delivery), and results of newborn screening tests for abnormal thyroid hormone and a large list of hundreds of inborn errors of metabolism or other mutations. Also available from the Vital Statistics Branch are Death and Fetal Death files, which again can be obtained with exact addresses upon approvals from the State IRB and the Vital Statistics Branch, while ZIP code files are more readily available; these files include date and causes of death, age, and primary occupation for parents. The California Birth Defects Registry includes all congenital malformations, and can be obtained with linkage to birth files at the address level. The California Department of Developmental Services shares residential address info and contains information on both children and adults (all ages) with disabilities that range from autism and intellectual disability to cerebral palsy and other verified conditions, as well as their age at assessment, periodic confirmation of diagnoses, and services or treatments that the person received or is eligible to receive. The California Cancer Registry data contains residential addresses and includes all diagnosed cases of cancer, affected organ, stage, grade, and locations of metastases. CalEnviroScreen (besides environmental data such as air pollution) includes health outcomes such as asthma, cardiovascular disease, and birth weight at census block group or tract resolution. According to the CARB priorities, The Contractor proposes to also incorporate Medicare datasets available at the ZIP code level, which would include, for instance, cardiovascular hospitalizations among Medicare recipients. Similarly, with specific relevance to greening schoolyards, The Contractor is able to access the California Assessment of Student Performance and Progress (CAASPP) data at the school-level and will build upon current tree canopy / green space cover assessments of California's schoolyards that Co-I Ossola is already creating for USDA-Forest Service.[27]

The Contractor will also work with our Community Advisory Group (CAG) to identify further high-quality datasets that might provide health data on important underserved subgroups. Health outcomes will be selected from those observed in the literature (**Task 2**) and will cover some of the following: perinatal (e.g., birth weight for gestational age, pre-term birth, early growth), cancer, cardiovascular disease, mental health (e.g., depression, anxiety), well-being (e.g., happiness), physical activity, sleep, obesity, diabetes, asthma, Alzheimer's Disease, and mortality. The Contractor will focus on the priorities of CARB to select health outcomes. Analyses can be performed for specific subgroups, e.g., by race or ethnicity, which might include Latinx, Black, Native Americans, and multi-racial, or by neighborhood SES. As multiple approvals are needed (from the California Committee for the Protection of Human Subjects for CDPH, the Vital Statistics Advisory Committee, and HCAI), The Contractor will set up the accounts for this contract in advance and initiate these requests as early as feasible. Similar to the above greenspace metrics, the Contractor will work to identify health datasets that are routinely collected and are publicly available, in order to monitor how changes in greenspace exposures impact health outcomes.

Table 2. Health Datasets with Geographic Data

Health Dataset	Outcomes Collected	Resolution / Scale
California Department of Health Care Access and Information (HCAI)	All hospitalizations and emergency department visits, including ICD codes for discharge diagnoses	ZIP code
The California Department of Public Health (CDPH), Center for Health Vital Statistics and Informatics, Vital Statistics Research and Analytics Branch	Death certificate datafiles include date of death and ICD codes for immediate and underlying causes of death	ZIP code / Residential address
California Department of Public Health, Vital	Date of birth, gestational age at delivery, birthweight; parental	Residential

Health Dataset	Outcomes Collected	Resolution / Scale
Statistics, Research and Analytics Branch, Birth Files	demographics (age, race, ethnicity, education), complications of labor and delivery, APGAR scores (an indicator of neonatal stress immediately after delivery), and results of newborn screening tests (positive/negative) for normal ranges of thyroid hormone and a large list of inborn errors of metabolism or other mutations, fetal death	address
California Birth Defects Registry	Congenital malformations	Residential address
California Department of Developmental Services	Disabilities that range from autism and intellectual disability to cerebral palsy and other verified conditions	Residential address
California Cancer Registry	All diagnosed cases of cancer, affected organ, stage, grade, and locations of metastases, as well as mortality following diagnosis	Residential address
CalEnviroScreen	Asthma, cardiovascular disease, birth weight	Census tract
Medicare	Multiple outcomes	ZIP code
California Assessment of Student Performance and Progress (CAASPP)	Test scores	School-level

Population Data

As a denominator to establish rates of disease where appropriate, the Contractor will use population counts derived from the US Census. The Contractor will select the appropriate administrative boundary for the analysis (e.g., Census tract) for the closest temporal match (e.g., 2020 Census for 2020 health data). For each specific health outcome, the Contractor will also select the appropriate population that represents the individuals at risk for a given outcome (e.g., individuals 50 years or older for cardiovascular hospitalizations). Intercensal population estimates for areas in California can be obtained from the California Department of Finance, which provides estimates for population changes between censuses at the county and city level, including breakdowns for census tracts, through their "E-4 Population Estimates for Cities, Counties, and the State" report. The estimates are calculated using a cohort-component method, which takes into account factors like births, deaths, and migration to project population changes between censuses.

Potential Confounders and Other Spatial Datasets

In analyses, The Contractor will adjust for the various factors listed below, that might be correlated with greenspace and may drive health outcomes and therefore could confound the relationship between greenspace and health outcomes. The Contractor also has access to other spatial datasets that might confound greenspace-health associations, including climate, built environment, air pollution, noise, crime, and Census data on SES and degree of segregation.[28] Climate: The Contractor will use the Parameter-elevation Relationships on Independent Slopes Model (PRISM) data,[29] which provide estimates of seven primary climate elements: minimum temperature, maximum temperature, precipitation, mean dew point, minimum vapor pressure deficit, maximum vapor pressure deficit, and total global shortwave solar radiation on a horizontal surface. Data are available at 800m resolution nationwide at monthly and annual resolutions from 1981 to the present. These data provide a more spatially explicit representation of climate exposure than observations from weather stations. Built Environment: The Contractor has access to time-varying walkability index at the Census tract level from 1990 to the present defined as the sum of Z scores of intersection density calculated from Tiger/Line shapefiles of all roads with interstates removed, population density from decennial Census data and American Community Survey data with a linear interpolation for intercensal years, and business density data from commercially available historical business data.[30] To incorporate the building density, the Contractor will include the new 2019-2020 Microsoft Building Footprints dataset,[31] which collect individual building shapes for the entire state. Air Pollution, specifically particulate matter, can be estimated at 1km scale annually from 2000-2016 using existing models,[32] or using CARB models. Moreover, evidence suggest that greenspace may filter particulate air pollution[33] and may attenuate the health impacts of particulate air pollution.[34] While it would be interesting to examine other pollutants, such as volatile organic compounds (VOCs) or pesticides, high spatiotemporal resolution models are not available to conduct these analyses at the scale of the available health data. The Contractor will attempt to incorporate how changes in greenspace might impact the distribution of biogenic VOCs using prior models of the relationship between greenspaces and BVOCs, focusing on isoprene, monoterpenes, sesquiterpenes, and other VOCs, and assuming that BVOCs are emitted under stress-free conditions.[35] The Contractor will work with CARB to explore the possible relationship between BVOCs and greenspace, particularly how it can be inferred from species inventory data. Noise will be estimated using a spatial sound model developed using a tree-based machine learning algorithm by the National Park Service which relies on acoustical data from 1.5 million hours of measurements from 492 urban and rural sites across the US during 2000-2014.[36–38] The resulting non-time-varying model maps sound levels at 270m resolution

nationwide. Crime Risk Index: The Contractor will measure crime risk at the Census tract level across the United States. Crime Index data provides a view of the relative risk of specific crime types. It is not a database of actual crimes, but rather the relative risk in an area compared to the United States in its entirety. It is derived from an extensive analysis of several years of crime reports from the vast majority of law enforcement jurisdictions nationwide. The crimes included in the database are the "Part 1" crimes and include murder, rape, robbery, assault, burglary, theft, and motor vehicle theft. These categories are the primary reporting categories used by the FBI in its Uniform Crime Report (UCR), with the exception of Arson, for which data is very inconsistently reported at the jurisdictional level. Area-level Socioeconomic Status (SES) will be measured based on an index derived from a principal component analysis of Census tract variables, including summed Z scores of: median household income, median home value, % with a college degree, % non-Hispanic White, % non-Hispanic Black, % of foreign-born residents, % of families receiving interest or dividends, % of occupied housing units, and % unemployed.[28] The Contractor will also conduct analyses examining median household income, % foreign born residents, and % of each Census race category separately as potential confounders as well as effect modifiers. Area-level Segregation will be estimated using the Index of Concentration at Extremes (ICE) applied to any Census year,[39,39] which captures homogeneity of a given Census tract with respect to, for example, income and race.[40] The Contractor will work closely with CARB to ensure that this work builds on and is complementary to existing efforts, and appropriately advances the field.

Defining Underserved Populations

To define Underserved Populations, the Contractor will initially focus on continuous measures of area-level socioeconomic status and area-level segregation, as described in the above section. The Contractor will examine individual components of median household income, median home value, % with a college degree, % non-Hispanic White, % non-Hispanic Black, % of foreign-born residents, % of families receiving interest or dividends, % of occupied housing units, and % unemployed, and will also examine the composite index of the summed Z scores of these components. The Contractor will also derive area-level segregation metrics and create measures of ICE for race, income, and race and income combined. For all of these components and the composite index, as well as the segregation metrics, the Contractor will create deciles of each metric across the state at the Census tract level, and will examine how associations between greenspace and health differ between tracts that are underserved (e.g., lowest decile of the composite SES index).

The Contractor will also conduct analyses to compare decile-based approaches to other commonly used definitions of underserved populations, such as those used in CalEnvironScreen metrics based on Senate Bill 535 Designations of Disadvantaged Communities; the Climate and Economic Justice Screening Tool's definition of Disadvantaged Communities; or CARB's California Climate Investments Priority Populations definition of Disadvantaged Communities.

Task 3 Deliverables: In coordination with CARB, the Contractor will provide a catalog of greenspace and health datasets that are updated regularly, are open-source or made open-source, and can be linked to health datasets to conduct epidemiologic analyses. The Contractor will also provide CARB with estimates for secondary datasets, including area-level SES and climate data, that can be used in analyses going forward.

Task 4: Development of Methodology to Quantify Health Benefits of Current and Future Urban Green Space Levels in California

Building from the literature review in **Task 2** and data compiled in **Task 3**, and in consultation with CARB staff, the Contractor will develop robust and replicable methodologies to estimate dose-response curves to quantify how current and future urban greenspace metrics are associated with differences in health outcomes. Analyses will be developed for application at a statewide, regional, or local level. These methods will build on prior work modeling health effects of greenspace from UCD,[41] but will also build upon and update the U.S. EPA Environmental Benefits Mapping and Analysis Program-Community Edition (BenMAP-CE)[42] platform. Thus, the Contractor's approach is informed by but will update the existing approaches by developing high resolution models at the ZIP code, Census tract, or address level to estimate the changes in health outcomes from different urban greenspace scenarios in California.

Specifically, the Contractor will conduct analyses examining current greenspace conditions using the datasets listed in **Table 1** above as our exposures and the datasets listed in **Table 2** as our outcomes. First, the Contractor will take each exposure listed in **Table 1** and will create metrics of current greenspace conditions aggregated up to an appropriate scale for epidemiologic analyses when paired with the datasets in **Table 2** (although it should be noted that the Contractor will provide CARB with the highest resolution data possible for all greenspace metrics). This will likely be ZIP code or Census tract. This will entail zonal statistics for all raster datasets (e.g., averaging values for all pixels within a Census tract) or creating area-weighted averages for vector datasets (e.g., percentage of open access park land within a Census tract). For health datasets that contain residential address information, the Contractor will create appropriate exposure metrics based on the literature reviewed in Task 1. For instance, the Contractor could create exposure data based on a 500m buffer around each address, or could examine distance to the nearest open access park. The Contractor will also attempt to examine the spatial distribution of greenspace within this scale (e.g., whether greenspace is distributed equally across a ZIP code). The Contractor will then spatially and temporally link these exposure metrics with the health datasets in **Table 2** by either extracting raster values to point data, spatially joining vector data to point data, or by merging greenspace and health data according to FIPS codes for Census tracts or ZIP codes. The Contractor will pay attention to the year of greenspace and health data collection to ensure that Census geographies are temporally matched. The Contractor will then analyze data using the appropriate statistical approach for each outcome (e.g., Poisson for count outcomes such as hospitalizations, linear regression for continuous outcomes such as birth weight). For each outcome, the Contractor will examine each exposure in individual models, as well as in models with multiple exposures in the same model. The Contractor will use dimension reduction approaches, such as principal components analysis, or mixture models, such as Bayesian Kernal Machine Regression, to identify which exposure metrics seem to drive the variability in health outcomes. The Contractor will take an exposomic approach[59] to account for other correlated exposures that might confound greenspace associations, including air pollution, climate, noise, built environments, and population density. An exposomic framing entails estimating the impact of the totality of environmental exposures across the lifecourse. As such, analyses will be adjusted for factors in the **Potential Confounders and Other Spatial Datasets Section** above, as well as individual-level factors where available given the health dataset. The Contractor acknowledges that spatial factors, such as air pollution and heat, could be both potential mediators and confounders for the greenspace-health relationships (see **Figure 4**). Therefore, the Contractor will estimate dose response curves in models with and without air pollution and temperature included. For BVOCs, the Contractor will incorporate potential increases in BVOC exposures under future greenspace scenarios, and will incorporate these health effects in dose-response curves. For each outcome, the Contractor will provide the strength of each dose-response curve with 95% confidence intervals, as well as explore nonlinear relationships. The Contractor will also explore effect modification by area-level age, SES, racial/ethnic composition, segregation, and population density (as explained in the **Potential Confounders and Other Spatial Datasets Section** above) to identify if relationships between greenspace and health outcomes differ in underserved communities. The Contractor will also explore effect modification by climate exposures to identify if relationships between greenspace and health outcomes differ by these environmental factors. Models will gauge how different factors might affect the statistical estimates and interpretation of the various scenarios. Factors will include climate zones (e.g., coast vs inland), climate change velocity, and population growth scenarios, among others. If statistically significant effect modification is identified, the Contractor will provide stratum-specific dose response curves. These dose response relationships for each exposure-outcome relationship under current greenspace conditions will then serve as the model to use in future greenspace projections.

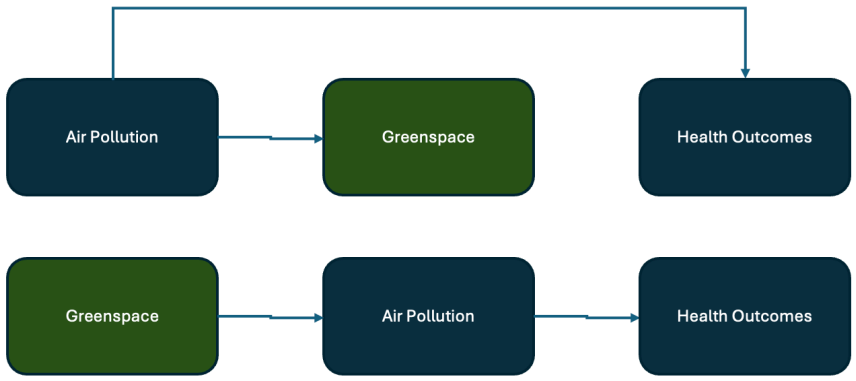


Figure 4. Directed Acyclic Graph (DAG) of how air pollution could be a confounder (top) or mediator (bottom) of the greenspace health relationship.

Below the Contractor provides examples of potential methodologies for hospitalizations (CVD and heat-related illnesses), birth outcomes (birth weight and pre-term birth) and mortality (all-cause).

Hospitalizations

Study Population

For hospitalizations, the Contractor will access a Research Dataset from the California Department of Health Care Access and Information (HCAI) data on Patient Discharges for all hospitalizations and emergency department visits throughout the state. These data contain the ZIP code of the patient's residence, as well as ICD codes for diagnoses. The Contractor will pull data from 2012-2024.

Outcomes

For cardiovascular outcomes, the Contractor will focus on hospital admissions with a primary discharge diagnosis of cardiovascular disease (ICD-9: 390–459, ICD-10: I00–I99). For secondary outcomes, the Contractor will use hospital admissions with a primary discharge diagnosis of coronary heart disease (ICD-9: 410–414, ICD-10: I20–I25), and cerebrovascular disease (ICD-9: 430–438, ICD-10: I60–I69).

For heat-related illnesses, the Contractor will look at hospital admissions with a primary discharge of heatstroke and sunstroke (ICD-9-CM: 992.0, ICD-10: T67.0) or heat exhaustion (ICD-9-CM: 992.3-992.5, ICD-10: T67.3-T67.5).

Exposure Assessment

Each greenspace listed above in the **Greenspace Datasets Section** will be aggregated up to the ZIP code level and temporally linked by year, and season where applicable (e.g., NDVI), to each hospitalization. The Contractor will make the assumption that the ZIP code at the time of hospitalization is representative of longer term greenspace exposure.

Covariates

HCAI contains data on birthdate, race, ethnicity, homelessness indicators, preferred language, and expected source of payment. The Contractor will use these data to adjust for age, as well as for proxies for individual-level demographics and socioeconomic status. The Contractor will also include variables on climate, built environment, air pollution, noise, crime, and area-level socioeconomic status and segregation as potential confounders and effect modifiers. The Contractor will use population counts from the US Census, focusing on individuals 50 years or older for cardiovascular hospitalizations, and total numbers of individuals for heat-related illnesses.

Statistical Analysis

The Contractor will use a Bayesian hierarchical approach, with a spatially uncorrelated conditionally autoregressive (CAR) random effect and a spatially unstructured random effect for each space-time unit to account for correlation among neighboring spatial units (ZIP codes). The Contractor will the use Poisson regression for counts of each hospitalization outcome relative to the total population count for each space-time unit (i.e., year for a ZIP code). Because ZIP codes change shape across years, the Contractor will apply misalignment models that account for changes in area over time. Models will include all covariates listed in the above **Covariates Section**. The Contractor acknowledges that spatial factors, such as air pollution and heat, could be both potential mediators and confounders for the greenspace-health relationships. Therefore, the Contractor will estimate dose response curves in models with and without air pollution and temperature included. For future greenspace scenarios, the Contractor will incorporate potential increases in BVOCs into dose response curves. The Contractor will examine models containing multiple greenspace constructs (see **Table 1**) in the same model and will examine Variance Inflation Factors to ensure there is no collinearity. In the presence of collinearity, the Contractor will use dimension reduction approaches, such as principal components analysis, or mixture models, such as Bayesian Kernal Machine Regression, to identify which exposure metrics seem to drive the variability in health outcomes. The final model will provide a risk ratio for hospitalization per IQR increase in each greenspace metric, which will serve as a dose-response curve for examining future greenspace scenarios. The Contractor will also examine nonlinear relationships between greenspace and hospitalizations, and, if statistically significant nonlinearity is observed, will incorporate these nonlinearities into dose response curves. The Contractor will also examine potential effect modification by the factors listed in the above **Covariates Section** through interaction terms and stratified analyses. If statistically significant effect modification is observed, the Contractor will provide stratum-specific estimates for dose-response curves for modeling future greenspace scenarios.

Birth Outcomes

Study Population

The Contractor will use the Vital Statistics Birth Statistical Master File from the California Department of Public Health to identify all births occurring in California from January 1, 2001-December 31, 2024. Maternal addresses of residence on birth certificates will be geocoded to the address level. The Contractor will exclude all births will addresses outside of California, multiple gestations, and infants with known birth defects. Gestational age will be estimated from information on last menstrual period.

Outcomes

The Contractor will estimate birth weight in grams from each birth certificate. Preterm birth will be defined as a live birth before 37 weeks of gestation.

Exposure Assessment

Each greenspace listed above in the **Greenspace Datasets Section** will be linked to each birth using 300m and 1200m radial buffers around each residential address. Data will be temporally linked by gestational period, using the months since last menstrual period to define trimester-specific exposures. For annual greenspace data, the Contractor will create weighted exposures for pregnancies that span across years.

Covariates

The Contractor will adjust for maternal age, as occupation and smoking from birth record data. The Contractor will also include variables on climate, built environment, air pollution, noise, crime, and area-level socioeconomic status and segregation as potential confounders and effect modifiers.

Statistical Analysis

For birth weight, the Contractor will conduct multi-level linear regression, with births nested within their respective hospital and a random effect (at the intercept) at the hospital level will be specified. Models will include all covariates listed in the above **Covariates Section**. The Contractor acknowledges that spatial factors, such as air pollution and heat, could be both potential mediators and confounders for the greenspace-health relationships. Therefore, the Contractor will estimate dose response curves in models with and without air pollution and temperature included. For future greenspace scenarios, the Contractor will incorporate potential increases in BVOCs into dose response curves. The Contractor will examine models containing multiple greenspace constructs (see **Table 1**) in the same model and will examine Variance Inflation Factors to ensure there is no collinearity. In the presence of collinearity, the Contractor will use dimension reduction approaches, such as principal components analysis, or mixture models, such as Bayesian Kernal Machine Regression, to identify which exposure metrics seem to drive the variability in health outcomes. The final model will provide a coefficient for the difference in birth weight in grams per IQR increase in each greenspace metric, which will serve as a dose-response curve for examining future greenspace scenarios. The Contractor will also examine nonlinear relationships between greenspace and birth weight, and, if statistically significant nonlinearity is observed, will incorporate these nonlinearities into dose response curves. The Contractor will also examine potential effect modification by the factors listed in the above **Covariates Section** through interaction terms and stratified analyses. If statistically significant effect modification is observed, the Contractor will provide stratum-specific estimates for dose-response curves for modeling future greenspace scenarios.

For preterm birth the Contractor will conduct multi-level Poisson regression models, with births nested within their respective hospital and a random effect (at the intercept) at the hospital level will be specified. Models will include all covariates listed in the above **Covariates Section**. The Contractor acknowledges that spatial factors, such as air pollution and heat, could be both potential mediators and confounders for the greenspace-health relationships. Therefore, the Contractor will estimate dose response curves in models with and without air pollution and temperature included. For future greenspace scenarios, the Contractor will incorporate potential increases in BVOCs into dose response curves. The Contractor will examine models containing multiple greenspace constructs (see **Table 1**) in the same model and will examine Variance Inflation Factors to ensure there is no collinearity. In the presence of collinearity, the Contractor will use dimension reduction approaches, such as principal components analysis, or mixture models, such as Bayesian Kernal Machine Regression, to identify which exposure metrics seem to drive the variability in health outcomes. The final model will provide a risk ratio for preterm birth per IQR increase in each greenspace metric, which will serve as a dose-response curve for examining future greenspace scenarios. The Contractor will also examine nonlinear relationships between greenspace and preterm birth, and, if statistically significant nonlinearity is observed, will incorporate these nonlinearities into dose

response curves. The Contractor will also examine potential effect modification by the factors listed in the above **Covariates Section** through interaction terms and stratified analyses. If statistically significant effect modification is observed, the Contractor will provide stratum-specific estimates for dose-response curves for modeling future greenspace scenarios.

Mortality

Study Population

The Contractor will use the Vital Statistics Death Data Files from the California Department of Public Health to identify deaths. The data files contain the ZIP code of the individual at the time of death. The Contractor will pull data from 2012-2024.

Outcomes

The Contractor will examine all non-accidental causes of mortality, with the option of examining cause-specific mortality.

Exposure Assessment

Each greenspace listed above in the **Greenspace Datasets Section** will be aggregated up to the ZIP code level and temporally linked by year, and season where applicable (e.g., NDVI), to each hospitalization. The Contractor will make the assumption that the ZIP code at the time of death is representative of longer term greenspace exposure.

Covariates

The Contractor will adjust for age, education, race, ethnicity, occupation from death files. The Contractor will also include variables on climate, built environment, air pollution, noise, crime, and area-level socioeconomic status and segregation as potential confounders and effect modifiers.

Statistical Analysis

The Contractor will use a Bayesian hierarchical approach, with a spatially uncorrelated conditionally autoregressive (CAR) random effect and a spatially unstructured random effect for each space-time unit to account for correlation among neighboring spatial units (ZIP codes). The Contractor will the use Poisson regression for counts of each death relative to the total population count for each space-time unit (i.e., year for a ZIP code). Because ZIP codes change shape across years, the Contractor will apply misalignment models that account for changes in area over time. Models will include all covariates listed in the above **Covariates Section**. The Contractor acknowledges that spatial factors, such as air pollution and heat, could be both potential mediators and confounders for the greenspace-health relationships. Therefore, the Contractor will estimate dose response curves in models with and without air pollution and temperature included. For future greenspace scenarios, the Contractor will incorporate potential increases in BVOCs into dose response curves. The Contractor will examine models containing multiple greenspace constructs (see **Table 1**) in the same model and will examine Variance Inflation Factors to ensure there is no collinearity. In the presence of collinearity, the Contractor will use dimension reduction approaches, such as principal components analysis, or mixture models, such as Bayesian Kernal Machine Regression, to identify which exposure metrics seem to drive the variability in health outcomes. The final model will provide a risk ratio for death per IQR increase in each greenspace metric, which will serve as a dose-response curve for examining future greenspace scenarios. The Contractor will also examine nonlinear relationships between greenspace and mortality, and, if statistically significant nonlinearity is observed, will incorporate these nonlinearities into dose response curves. The Contractor will also examine potential effect modification by the factors listed in the above **Covariates Section** through interaction terms and stratified analyses. If statistically significant effect modification is observed, the Contractor will provide stratum-specific estimates for dose-response curves for modeling future greenspace scenarios.

Economic Outcomes

The Contractor will also develop methodologies to quantify the economic impact of differences in health outcomes related to greenspace-health dose response curves. A key initial step will be to review published efforts to estimate and collate greenspace values to identify methods or initial values suitable for our context. Notable examples include Center for Neighborhood Technology and American Rivers,[43] and Watts and Wolf[44] and Nowak and Greenfield.[45] Initially the Contractor will also explore the possibility of adapting BenMAP,[42] which is free and open-source, specifically for the economic valuation of health impacts. In California this tool has been used by the South Coast Air Quality Management District for their Socioeconomic Analysis of air quality improvements.[46] This will entail drawing on a mix of figures specific to California as well as other national figures adjusted for California as illustrated in the valuation of illnesses in California.[47]

Initial work will focus on a select set of values more precisely and robustly estimated as a core to build on in the medium- to long-term. The Contractor will provide annual estimates where possible, and where data exist, will quantify economic

impact of differences in health outcomes, for instance, valuing mortality using the value of a statistical life (VSL) and morbidity using cost-of-illness (COI), e.g., including health care expenses (e.g., costs of avoided hospitalizations), and productivity losses.[45,48] Metrics that reflect a population's willingness-to-pay (WTP) for a given benefit—like VSL, which reflects WTP for mortality risk reductions—will be favored when available; however, when not available the Contractor will employ alternative measures of costs (like COI) which capture some direct costs but not all impacts to welfare, e.g., "pain and suffering, loss of satisfaction and leisure time."[42] For avoided mortality, valuation parameters used to convert outcomes into dollar values (VSL) are well-established in the literature (using hedonic and stated preference methods) and typically not tailored to specific applications. The value of morbidity reduction (avoided COI), will rely at least in part on estimates from other contexts using the approach of benefits transfer (BT). BT is used when it is "not feasible…to conduct original research for all necessary inputs"[46] and facilitates valuing a range of outcomes relatively quickly but at the expense of specificity to a given locale. The Contractor will seek to hone COI estimates to reflect California- or county-specific levels for health care expenses and/or loss of earnings.

Modeling Future Greenspace Scenarios

To estimate future greenspace scenarios, the Contractor will consult with CARB to develop scenarios with exposure data that is consistent to the exposure metrics identified in **Task 3**. The number of future greenness scenarios to be analyzed for quantified health outcomes will be determined by CARB and will include scenarios for 25 years and approximately 4 scenarios for each year, but will be up to 400 in total so the method to quantify health outcomes should be designed to quickly analyze these scenarios. The Contractor will also consider using data from partnerships with groups like Ten Strands,[49] Green Schoolyards America,[50] and other members of the Community Advisory Group (**Task 6**) to account for upcoming for urban greening interventions, including Urban and Community Forestry Projects funded by the Inflation Reduction Act.[51] Additional datasets currently used in UCD labs (CHELSA Global Climatologies 1km resolution to 2041-2060 and 2061-2080,[52] Swiss Federal Institute for Forest, Snow and Landscape Research WSL, updated every 2-3 years) will complement open data in **Task 3** to create more realistic and robust projections of health impacts in relation to green space change. Co-I Ossola's lab can predict future climate for any location/green space/etc. on earth based on an ensemble of climate model and greenhouse gas emission scenarios. The lab has already produced climate models for all 10,000+ schools across California, as well as projections for all community gardens in the US. The Contractor's analyses and projects confirm that several regions across California will face much greater climate impacts compared to others (e.g., inland versus coast). Thus, it is imperative to account for these climate projections to 1) assess the current relationship between greenspace and health, as well as their economic cost/benefit, and 2) find and prioritize opportunities for future allocations of greenspace at multiple scales across California.

Once projections for future greenspace scenarios are obtained, the Contractor will plug these greenspace scenarios, along with best estimates for the other factors listed in the **Potential Confounders and Other Spatial Datasets Section** into models developed for current greenspace. As stated above, for future greenspace scenarios, the Contractor will incorporate potential increases in BVOCs into estimates to account for potential negative health impacts of changes in greenspace. The Contractor will build a model that incorporates interaction terms for any effect modification that was identified above. The Contractor will also model economic impacts of changes in greenspace and subsequent changes in health outcomes into economic models described above to estimate a cost or savings for predicted changes in health outcomes.

Mapping Exposures and Outcomes

The methods described above will be able to produce maps of California showing the levels, access, and types of greenspace available across the state. The maps will also describe how health impacts of greenspace vary by area-level age, SES, racial/ethnic composition, segregation, and population density (as explained in the **Potential Confounders and Other Spatial Datasets Section** above).

Task 4 Deliverables: Models of current greenness for the state of California will be developed at the finest spatial scale possible for all of California using open access datasets that can be used to produce maps of greenness in the state. The models will be able to differentiate between different types of greenness, such as trees compared to shrubs and grasslands. The models will also be able to assess the accessibility of the greenness. The models will be combined with datasets which measure area-level SES and area-level segregation to produce maps of greenness that show the differences between the quality and openness of greenness by SES and segregation for all of California. The Contractor will work closely with CARB staff on the methodology used and the linking of the datasets. Maps of greenness will be built such that they can be

periodically updated into the future. This deliverable will be due before the contract proceeds to develop the health outcomes relationships in Task 4.

The Contractor will then provide a model methodology to estimate impacts of current and future greenspace scenarios on health, as well as the economic benefits. This model will be transferable and reusable over time. The Contractor will examine at least four health outcomes. Methods and results for mortality, birth outcomes, and heat-related outcomes will be delivered by month 16 of the project.

Task 5: Quantification of Health Benefits for Current and Future Projected Levels of Greenness in California

Using data from **Task 3** and the methodologies developed in **Task 4**, the Contractor will run the models to quantify health benefits of current and future greenspace levels in California, leveraging the Contractor's expertise in greenspace epidemiology . Again, throughout the project UCD will identify greenspace and health datasets that are routinely updated so that in order to evaluate changes over time in a longer-term monitoring framework. Building on associations observed in **Task 2**, data from **Task 3**, and methodology developed in **Task 4**, the Contractor will create stratum-specific estimates that account for potential effect modification by area-level age, SES, racial/ethnic composition, segregation, and population density, as well as climate scenarios. Using the models developed in **Task 4**, the Contractor can run analyses to provide statewide estimates for expected effect of overall differences in greenspace on differences in health outcomes, as well as regional and local levels. This will provide the Contractor with an estimate for the health outcomes that are affected by greenspace under current greenspace scenarios in California. The Contractor will also use the methodologies above to quantify the economic impacts of the difference in these health outcomes observed by level of greenspace.

Next, the Contractor will take estimates for projections of greenspace scenarios and add those estimates into models to quantify how changes in greenspace might lead to changes in health outcomes. The Contractor will also incorporate changes in estimates for the factors listed in the **Potential Confounders and Other Spatial Datasets Section** into our models to quantify how the interaction between these factors might impact projected health benefits of greenspace. Again, the Contractor will run analyses to provide statewide estimates, as well as regional and local estimates, for the expected effect of changes in greenspace on changes in health outcomes based on predicted greenspace scenarios. This will provide an estimate for the health outcomes that would be affected by greenspace under future greenspace scenarios in California. The Contractor will also use the methodologies above to quantify the expected economic impacts of the expected changes in these health outcomes by applying similar methodologies to those explained in **Task 4**.

Task 5 Deliverables: The Contractor will provide quantitative estimates of the health benefits, and downstream economic benefits, of greenspace under current and future greenspace scenarios. Estimates will be provided at the state, region, and local level, and will account for current and projected changes in other spatial factors, including underserved populations and climate changes. The number of future greenness scenarios to be analyzed for quantified health outcomes will be determined by CARB and will include scenarios for 25 years and approximately 4 scenarios for each year, but will be up to 400 in total so the method to quantify health outcomes should be designed to quickly analyze these scenarios

Task 6: Community Focused Advisory Group

A Community Advisory Group (CAG) will be recruited and facilitated in collaboration with the UC Davis Center ***T***owards ***H***ealth, ***R***esilience and ***E***nvironmental ***E***quity (THREE)[53] Community Engagement Core to supplement and expand the expertise of the research team, in particular in the areas of equity-oriented research methodologies, ground truthing of health modeling, modeling for equitable benefits distribution, and research-to-policy and translation of research into community action. The Contractor anticipates the CAG will be made up of the following: 4-6 representatives from AB617 communities with urban greening strategies in their Community Emission Reduction Plans (this currently includes confirmed partners in South Central Fresno, Stockton, and Shafter with invitations to groups in El Centro-Heber-Calexico Corridor, and Southeast LA), and 2-4 representatives from community-based organizations with a focus on urban greening at either a local or statewide level. The Contractor has confirmed partnerships with TreePeople, Ten Strands, Green Schoolyards America, Central California Environmental Justice Network, Little Manila Rising, and the West Modesto Community Collaborative. The Contractor will also benefit from technical advice from the USDA's Urban Forestry Program. This contract will also benefit feedback from Center THREE's larger and highly-engaged Community Advisory Committee (CAC), the co-chairs of which are members of the Center's executive Leadership Group, and which includes both community- based organizations and relevant state agencies. CARB is represented on CAC, as is the California Department of Public Health, Department of Pesticide Regulation, Department of Toxic Substances Control, Office of Environmental Health Hazard Assessment, and the State Water Board. Following best practices in Community-Engaged Research, the committee will

advise and support both the academic and community team members as needed, facilitate CAG meetings with an emphasis on open communication, mutual benefit, and accountability, and help ensure that both the outcomes and process components of the research are accessible, equitable, and culturally appropriate.

The Contractor will hold five virtual CAG meetings over the two-year funding period. The first (Year 1, Quarter 1) will focus on relationship building, discussion of methodology and priorities, and the development of an MOU documenting the collective agreements of academic and community team members in areas such as decision-making, communication, timelines, roles and responsibilities, data ownership, and authorship of publications and communications. This initial meeting will be followed by three 90-minute working meetings held virtually in Year 1, Quarter 3; and Year 2, Quarters 2 and 4. These meetings will provide opportunities for CAG feedback and revision at each stage of the project. At each of these touch points, the CAG will provide input and feedback on ways to make the research more reflective of local knowledge, relevant to local conditions and useful to inform community and policy action. For example, at the model development stage, the CAG will contribute to the selection of priority exposures and health outcomes, as well as the economic outputs of focus. The CAG will also provide feedback on projections for changes in greenspace and help ground truth model outputs, particularly in terms of whether there may be different dynamics at play in underserved communities. The CAG will also provide feedback on the ways in which the research team interprets and communicates its data and contribute to mid-course design modifications if needed. At dissemination stage, the CAG will provide guidance on the strategic communication and translation process into policy and community action, and the development of next steps for research and policy. The process design will draw on promising practices on the role of community research advisory boards that center community-based expertise and integrate this into the design and function of the research process, outputs, and outcomes.[54]

These meetings will be planned and conducted in collaboration with Center THREE's Community Engagement Core and CARB staff, and CAG contributions (feedback, comments, revisions) will be documented thoroughly in the final report. In addition, at the end of the project the team will host a virtual meeting open to the general public to share the results of the study and receive feedback that can be used to inform future research, policies and programs by the research team, CARB and other public agencies. CAG members will be compensated for their expertise in working and preparation time in parity with the compensation of academic team members. This equity in compensation is necessary both to ensure that the project has access to critical area of expertise and community connections as well as to align with environmental justice values that the communities most affected by an issue must play leadership roles in any research or policy designed to address it. As the Environmental Justice movement motto goes: "We speak for ourselves!"[55]

In the context of this proposal, in addition to the overall institutional support that will be provided by Center THREE, our Community Engagement Core Co-Directors will lead in the recruitment and facilitation of the CAG, leveraging decades-long relationships with key organizations in California's Central Valley and beyond. Center THREE's Community Engagement Core has a strong track record of successfully facilitating mutually-beneficial community-university collaborations, and will bring their considerable expertise to ensuring that this project's CAG is integrated as a full partner at every stage of the research process, from methodology development, to ground truthing modeling, to interpreting and communicating results.[56–58]

Task 6 Deliverables: Meeting minutes from all CAG meetings, along with steps the Contractor has taken to incorporate guidance from the CAG into the approach.

Task 7: Meeting, Reporting, Methods Transfer, and Preparation of Draft and Final Report

The Contractor will work closely with CARB staff on all Tasks, meeting regularly with them and providing appropriate deliverables before moving onto the next Task. The Contractor will share all code, documentation, and analyses with CARB staff and will ensure successful execution of the methods developed during this contract on CARB IT systems. Additionally, all data and code necessary to update these procedures will be provided to CARB staff in clean, understandable, and well documented formats with the appropriate tutorials and meta-data. The Contractor will produce a draft final report nine (9) months before project ends. The Contractor will release both a complex technical report and a version for lay audiences.

Task 7 Deliverables: The Contractor will provide CARB with code, documentation, and the final models. The Contractor will provide a draft final report nine months before the project ends, as well as a final report with a complex technical version and a version for lay audiences.

Meetings

A. Initial meeting. Before work on the contract begins, the Principal Investigator and key personnel will meet with the CARB Contract Project Manager and other staff to discuss the overall plan, details of performing the tasks, the project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.

B. Progress review meetings. The Principal Investigator and appropriate members of his or her staff will meet with CARB's Contract Project Manager at quarterly intervals to discuss the progress of the project. This meeting may be conducted by phone.

C. Community Engagement and/or Technical Advisory Committee Meetings (If Applicable). For community engagement efforts, including meetings with a Technical Advisory Committee (TAC), the Contractor must co-create meeting materials, including presentation slides, flyers, and speaking notes with CARB staff. The Contractor will work with CARB to understand policies and agree to accurately represent those policies or defer for follow-up. CARB will participate in community meetings and TAC meetings, unless mutually agreed upon with CARB and the PI, in cases where it could impact community engagement efforts negatively.

D. Technical Seminar. The Contractor will present the results of the project to CARB staff and a possible webcast at a seminar at CARB facilities in Sacramento or El Monte.

CONFIDENTIAL HEALTH DATA AND PERSONAL INFORMATION

CARB will not be provided access to and will not receive any confidential health data or other confidential personal information under this contract. Further, CARB will have no ownership of confidential health data or other confidential personal information used in connection with this contract. The entities conducting the research in this contract will follow all applicable rules and regulations regarding access to and the use of confidential health data and personal information, including the Health Insurance Portability and Accountability Act (HIPAA) and requirements related to the Institutional Review Board (IRB) process. CARB will not be a listed entity with authorized access to confidential information pursuant to the IRB process for this contract.

HEALTH AND SAFETY

Contractors are required to, at their own expense, comply with all applicable health and safety laws and regulations. Upon notice, Contractors are also required to comply with the state agency's specific health and safety requirements and policies. Contractors agree to include in any subcontract related to performance of this Agreement, a requirement that the subcontractor comply with all applicable health and safety laws and regulations, and upon notice, the state agency's specific health and safety requirements and policies.

GENERATIVE ARTIFICIAL INTELLIGENCE (GENAI) TECHNOLOGY USE & REPORTING

During the term of the contract, Contractor must notify the State in writing if their services or any work under this contract includes, or makes available, any previously unreported GenAI technology, including GenAI from third parties or subcontractors. Contractor shall immediately complete the GenAI Reporting and Factsheet (STD 1000) to notify the State of any new or previously unreported GenAI technology. At the direction of the State, Contractor shall discontinue the use of any new or previously undisclosed GenAI technology that materially impacts functionality, risk or contract performance, until use of such GenAI technology has been approved by the State.

Failure to disclose GenAI use to the State and submit the GenAI Reporting and Factsheet (STD 1000) may be considered a breach of the contract by the State at its sole discretion and the State may consider such failure to disclose GenAI and/or failure to submit the GenAI Reporting and Factsheet (STD 1000) as grounds for the immediate termination of the contract. The State is entitled to seek any and all relief it may be entitled to as a result of such non-disclosure.

The State reserves the right to amend the contract, without additional cost, to incorporate GenAI Special Provisions into the contract at its sole discretion and/or terminate any contract that presents an unacceptable level of risk to the State.

Conclusion

In the proposed project, the Contractor will work closely with CARB to develop evidence-based methodologies to quantify the health benefits of both current and projected levels of greenspace at the state, regional, and local level, and the Contractor will also develop approaches to estimate potential economic impacts of greenspaces. The Contractor will employ cutting-edge greenspace datasets to estimate exposure and will integrate important correlated spatial data into analyses to reduce confounding bias. This work will focus on underserved communities at every stage of analysis to ensure the equitable benefits of access to greenspace, and the eventual reduction of health disparities. This project will provide fundamental evidence for CARB's Nature-Based Solution programs to increase greenspace across California communities and will help to drive decision-making on which nature-based approaches (e.g., planting and maintaining trees) will be most effective, and where to implement them for the largest impact. Ultimately, this essential project will create vital tools to improve human health, to reduce health disparities, promote environmental justice, and to confront the climate crisis.

TreePeople

September 20, 2024

Peter James, ScD
Associate Professor
Director of the Center for Occupational and Environmental Health
Division of Environmental and Occupational Health
Department of Public Health Sciences
University of California, Davis School of Medicine
Member, UC Davis Environmental Health Sciences Center - THREE

Dear Dr. James,

This letter is to enthusiastically endorse the proposal "Quantifying Greenspace Impacts on Human Health and Ecosystem Services in California" for a CARB FY2024-2025 Urban Green Spaces Project, led by you at UC Davis alongside your highly qualified team. It was a pleasure learning about your project this week at the Convening of the Coalition for Outdoor Learning, with other California health professionals, greenspace leaders, and education experts, hosted at TreePeople.

At TreePeople, we have been working for the past 51 years to inspire, engage and support people to take action for our environment by planting and caring for trees in the schools, neighborhoods, and the mountains of southern California. We are active in the policy, research, and design and construction dimensions of urban forests, greening schoolyards, mountain forestry and conservation, and outdoor learning – championing these efforts alongside state and regional agencies, administrators, local governments, and school districts. TreePeople's environmental and equity educators also serve 24,000 students each year in service learning projects, access to nature, stewardship and conservation opportunities, green workforce programs with paid internships, and we are now launching a new, original curriculum for the 17 urban campuses we are currently greening in collaboration with three southern California school districts thanks to funding from CALFIRE.

Our work in improving community health through natural resources management and education within communities burdened with extreme heat, noise and air pollution, poverty, and historical redlining will be vastly improved through evidence-based results on health improvements such as what you propose. Through the determination of downstream costs or savings resulting from the type of work we do, your research has great potential to provide actionable guidance on our greenspace priorities. The addition of data analytics to the type of work we do on the ground will provide powerful direction on greenspace optimization and resilience. TreePeople will be able to implement such results to ensure our work has the highest impact and that our government-funded projects benefit the most people, especially in communities most in need of improved health outcomes. Even more important, other organizations like TreePeople on the frontlines of developing urban greenspaces can align around the evidence for best practices urgently needed in this era of rapid climate change. We see that some of our collaborators have also joined in supporting this project. Along with them, we believe that the UC Davis Team has a set of skills, experiences and tools – unique to California – that will serve CARB extremely well in advancing your research goals and core mission.

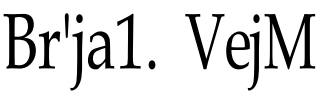
TreePeople recognizes the urgent need to support your uniquely qualified team of environmental epidemiologists, plant scientists, environmental economists, and community engagement experts. We

continually seek to be better champions of urban nature-based solutions, which is precisely why your long term research results will help our work in southern California as well as California's actions to mitigate climate change and protect vulnerable communities.

Sincerely,

Dustin L. Herrmann, PhD
Principal Scientist

Katie Mills, PhD
Director of Education and
Outdoor Equity



Bryan Vejar
Associate Director of
Community Forestry

green schoolyards america

September 23, 2024

Dear Dr. James,

Green Schoolyards America is delighted to serve on the Community Advisory Group for the proposal "Quantifying Greenspace Impacts on Human Health and Ecosystem Services in California" that is being considered for a CARB FY2024-2025 Urban Green Spaces Project Solicitation led by UC Davis.

Green Schoolyards America is dedicated to changing the paradigm for the design, use, and management of school grounds across CA and the US. We are collaborating with CAL FIRE, the California Department of Education, and Ten Strands on the California Schoolyard Forest System ®, a statewide initiative to increase tree canopy on public school grounds across California to shade and protect pre-K-12 students from extreme heat and rising temperatures due to climate change. As part of the Advisory Group, Green Schoolyards America can provide insights and guidance on schoolyard greening efforts across the state, schoolyard tree canopy at all CA schools, greening policy, and existing tree planting challenges and opportunities on school grounds.

Green Schoolyards America is also advising on a USFS study aimed at measuring cooling and microclimate benefits and ecosystems services provided by urban trees across California's schoolyards (Evaluating tree cooling performance in California schoolyards, Challenge Cost Share Agreement, Pacific Southwest Research Station, USDA Forest Service, 23-CS-11272123-031), which Dr Ossola, a Co-PI on this proposal, is also collaborating on.

We are excited about the data the CARB study will provide as they will further support our efforts to better understand the impacts of greening on student health and ecosystems across California's schools.

Sincerely,

Rachel Pringle Vice President

Green Schoolyards America

LITTLE MANILA RISING

September 20, 2024

Peter James, ScD, Associate Professor
Director of the Center for Occupational and Environmental Health Division of Environmental and Occupational Health
Department of Public Health Sciences
University of California, Davis School of Medicine
Member, UC Davis Environmental Health Sciences Center - THREE (Toward Health, Resilience, and Environmental Equity)

Dear Dr. James,

On behalf of Little Manila Rising, we would be honored to serve on the Community Advisory Group for your proposal "Quantifying Greenspace Impacts on Human Health and Ecosystem Services in California."

> The proposed project leverages the institutional expertise and resources of *Little Manila Rising, where I serve as Climate Action Director alongside Nicolas Tamayo, Urban Forestry Director*. Our organization serves the South Stockton community, developing equitable solutions to the effects of historical marginalization, institutionalized racism, and harmful public policy.
>
> Nicolas and I are interested in the work of the UC Davis Environmental Health Sciences Center - THREE (Toward Health, Resilience, and Environmental Equity) because it aligns well with our mission to engage the community in local climate action planning and research efforts, along with direct services offered to our residents through programs like Stockton Rising (Transformative Climate Communities program), South Stockton's Community Air Protection Program (AB 617), and other areas of our work that explore the climate and health nexus.

As a member of the Community Advisory Group for this proposal, we will collaborate with the research team in the areas of equity-oriented research methodologies, ground truthing of health and ecosystems services modeling, modeling for equitable benefits distribution, and research-to-policy translation. We bring particular expertise in developing community-driven climate mitigation and adaptation strategies and are deeply connected to the community of Stockton and South Stockton, in particular. We look forward to working with the team and its research partners, and to the success of the program!

Kindly,

Jasmine Peterson Climate Action Director

Central California Environmental Justice Network

September 24, 2024

Peter James, ScD
Associate Professor
Director of the Center for Occupational and Environmental Health
Division of Environmental and Occupational Health
Department of Public Health Sciences
University of California, Davis School of Medicine
Member, UC Davis Environmental Health Sciences Center - THREE
(Toward Health, Resilience, and Environmental Equity)

Dear Dr. James,

As the Executive Director for the Central California Environmental Justice Network (CCEJN), I am delighted to serve on the Community Advisory Group for your proposal "Quantifying Greenspace Impacts on Human Health and Ecosystem Services in California."

The proposed project will greatly benefit the population that CCEJN serves in South-Central Fresno, where we are implementing an Urban Greening Project with funding from the California Air Resources Board (CARB) as part of the implementation of one of the strategies included in the Community Emission Reduction Plan (CERP) for the South-Central Fresno AB617 community. Furthermore, the proposed project is aligned with the work that CCEJN has being leading since 2000 to advance health equity and environmental justice in the San Joaquin Valley.

Personally, I have collaborated in various projects with members of the UC Davis Environmental Health Sciences Center - THREE (Toward Health, Resilience, and Environmental Equity)'s, including: an Evaluation of the Implementation of AB617 in Fresno and Shafter; a participatory pesticide monitoring study in thee counties of the Central Valley; and I have been part of the Community Stakeholder
Advisory Committee (CSTAC) since 2017.

As a member of the Community Advisory Group for this proposal, I will collaborate with the research team in the areas of equity-oriented research methodologies, ground truthing of

health and ecosystems services modeling, modeling for equitable benefits distribution, and research-to-policy translation. We bring expertise in developing community-driven climate mitigation and adaptation strategies and are deeply connected to both urban and rural communities across the Central Valley, but with a special emphasis in urban greening projects in South-Central Fresno.

I look forward to working with the team and its research partners, and to the success of the program

Sincerely,

Nayamin Martinez, MPH
Executive Director
Central California Environmental Justice Network

Ten Strands
Connecting Education, Environment, and Community

September 23, 2024

Peter James, ScD Associate Professor
Director of the Center for Occupational and Environmental Health University of California, Davis School of Medicine

Dear Dr. James,

I am writing in enthusiastic support of your proposal, "Quantifying Greenspace Impacts on Human Health and Ecosystem Services in California." Your leadership and expertise are crucial to the success of this project, and we will be delighted to serve on the Community Advisory Group when it is funded.

The proposed project fits squarely within Ten Strands' mission and highest priorities, especially as we work closely with you and your colleagues to launch the California Campaign for Outdoor Learning. Ten Strands is focused on supporting environmental literacy and outdoor learning for all of California's six million TK-12 students, beginning with those most negatively impacted by health inequity, the pandemic, climate change, and environmental injustice. The Campaign builds on the shoulders of our National COVID-19 Outdoor Learning Initiative, where we built the foundation of connections between student health, academic achievement, and time spent in safe, healthy outdoor spaces connected with nature. Your contributions to shaping goals for the Campaign's health outcomes have been indispensable, and we are eager to collaborate with you and your team in as many ways as possible.

As a member of the Community Advisory Group for this proposal, Ten Strands will collaborate with the research team in the areas of equity-oriented research methodologies, designing and understanding high-quality outdoor experiences, ground-truthing of health and ecosystems services modeling, and research-to-policy translation. We bring particular expertise understanding and interacting with local communities and school systems throughout California.

We look forward to working with your team and its research partners, and to the success of the program.

Sincerely,

Karen Cowe CEO Ten Strands

WEST4)1 MODESTO

Comm nity Collaborative

August 12, 2024

Peter James, ScD Associate Professor
Director of the Center for Occupational and Environmental Health Division of Environmental and Occupational Health
Department of Public Health Sciences
University of California, Davis School of Medicine
Member, UC Davis Environmental Health Sciences Center - THREE (Ioward Health, Resilience, and Environmental Equity)

Dear Dr. James,

We would be delighted to serve on the Community Advisory Group for your proposal "Quantifying Greenspace Impacts on Human Health and Ecosystem Services in California."

The proposed project leverages the institutional expertise and resources of West Modesto Community Collaborative, where I serve as the Chief Executive Officer. Founded in 1991 by a coalition of concerned citizens working in public service and education, WMCC (formerly The Stanislaus Multi-Cultural Community Health Coalition) has always focused on creating access to and awareness of issues impacting health. We provide outreach services focused on health, safety, and education for all individuals in our community, either through direct engagement or advocacy

I have collaborated with members of the **UC Davis Environmental Health Sciences Center - THREE (Ioward .!:::!.ealth, Resilience, and .!;_nvironmental .!;_quity)'s** for several years now, beginning with ORALE COVID-19! an Initiative to Increase COVID-19 Vaccination in Yolo, Madera, Fresno, Stanislaus Counties in California (Nuno, Hertz-Picciotto), which was funded as a supplement to the Center's P30 grant from the National Institute for Environmental Health Sciences. Since that time, I have collaborated with EHSC-THREE Director Dr. Hertz-Picciotto on several proposals addressing the health impacts of climate change on the communities we serve, in particular the impacts of extreme heat exposure.

WEST MODESTO COMMUNITY COLLABORATIVE
601 S. Martin Luther King Drive
Modesto, CA 95351
(209) 522-6902

WEST(I).1 MODESTO

Comm1.tnity Collaborative

As a member of the Community Advisory Group for this proposal, I will collaborate with the research team in the areas of equity-oriented research methodologies, ground truthing of health and ecosystems services modeling, modeling for equitable benefits distribution, and research-to-policy translation. We bring particular expertise in developing community-driven climate mitigation and adaptation strategies and are deeply connected to both urban and rural communities in and around Modesto.

We look forward to working with the team and its research partners, and to the success of the program

Sincerely,

Perf

elJo Munoz, I'v1A. PhD MPH
Chief rxecutive Officer
West Modesto Community Collaborative

WEST MODESTO COMMUNITY COLLABORATIVE

601 S. Martin Luther King Drive
Modesto, CA 95351
(209) 522-6902

United States Department of Agriculture | Forest Service | Pacific Southwest Research Station | 1323 Club Dr. Vallejo, CA 94592

August 12, 2024

Dear CARB Colleagues and Selection Panel,

This letter is to enthusiastically endorse the proposal "Quantifying Greenspace Impacts on Human Health and Ecosystem Services in California" for a CARB FY2024-2025 Urban Green Spaces Project Solicitation led by Dr Peter James at UC Davis.

Our research team is actively collaborating with Dr Ossola, a Co-PI on this proposal, on a large collaborative effort aimed at measuring cooling and microclimate benefits and ecosystems services provided by urban trees across CA's schoolyards (*Evaluating tree cooling performance in California schoolyards*, Challenge Cost Share Agreement, Pacific Southwest Research Station, USDA Forest Service, 23-CS-11272123-031).

The collaboration with Dr Ossola's lab includes a large team of federal scientists, and researchers, postdocs and students based at UC Davis, UC Berkeley, and UCLA. Our team is forming a strong collaborative network with CALFIRE, our NGO partners (Green Schoolyards America among others), and many school districts and practitioners across the state.

We believe that that our schoolyard project could be a unique springboard for Dr James and Dr Ossola's proposal, and nicely complement current efforts supported by our Pacific Southwest Research Station. We are currently not investigating public health benefits of urban trees but the addition of robust scientific knowledge on this issue could provide a more complete and nuanced understating on how to better prioritize tree planting across our communities to serve CA's future generations.

We believe that the UC Davis Team has a set of skills, experiences and tools – unique to California – that will serve CARB extremely well in advancing your research goals and core mission.

Sincerely,

Lara Roman, PhD, Research Ecologist
USDA Forest Service
Pacific Southwest Research Station
lara.roman@usda.gov

Natalie van Doorn, PhD, Research Urban Ecologist USDA Forest Service
Pacific Southwest Research Station
natalie.vandoorn@usda.gov

DELIVERABLES

As listed in Task 7 and as outlined in the Project Schedule, the Contractor will work closely with CARB staff on all Tasks, meeting regularly with them and providing appropriate deliverables before moving onto the next Task. The Contractor will share all code, documentation, and analyses with CARB staff, and will ensure successful execution of the methods developed during this contract on CARB IT systems. The Contractor will produce quarterly progress reports, and the Contractor will produce a draft final report nine months before project ends.Tthe Contractor will release a Final Report at the end of the project, which will incorporate a one-page Public Outreach Document that will be widely used to communicate, in clear and direct terms, the key research findings from the study to the public. The Final Report will also include an Equity Implications Section that will summarize how the research results inform disparate impacts of greenspace policies, regulations, or programs on underserved communities. The Final Report will be copy-edited before being sent to CARB for review and the Principal Investigator shall attest that the Final Report has been reviewed and approved.

DATA MANAGEMENT PLAN

All datasets will be downloaded and hosted on UC Davis servers. In particular, the Contractorwill use the Farm Computing Node to process large spatial datasets and to conduct analyses linking greenspace metrics to health and ecosystem services datasets. UCD will work with CARB to ensure that all data and algorithms for this project are either open source or have been developed by the UCD team in such a way that the Contractorcan transfer the data to CARB. For instance, UCD can process greenspace metrics at the Census tract or ZIP code level to enable transfer to CARB for their maintenance, manipulation, and redistribution. UCD will also provide CARB with workflow documentation so that they can understand our process and replicate it if need be.

PROJECT SCHEDULE

Task 1: Develop an Overall Workplan
Task 2: Literature Review of the Health Impacts of Greenness and the Methods used to Quantify Health Benefits
Task 3: Data Collection for Exposure and Health Impact Analysis
Task 4: Development of Methodology to Quantify Health Benefits of Current and Future Urban Green Space Levels in California
Task 5: Quantification of Health Benefits for Current and Future Projected Levels of Greenness in California
Task 6: Community Focused Advisory Group
Task 7: Meeting, Reporting, Methods Transfer, and Preparation of Draft and Final Report

	Month																							
Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1			d																					
2						d																		
3												d												
4																d								
5																					d			
6			c						c									c						c d
7																								d
	m		pm			pm			pm			pm			dr m			pm			pm			fr m

p = Quarterly progress report
dr = Deliver draft final report (to be submitted six months prior to contract expiration)
fr = Deliver final report
m = Meeting with CARB staff
c = Community Advisory Group Meetings
d = Deliverable for Task

DESCRIPTION OF EXISTING FACILITIES

The University of California, Davis (UC Davis) provides an exceptionally rich environment for multidisciplinary investigations. UC Davis is geographically the largest of the ten campuses of the UC system (approximately 5,300 acres), second largest in overall budget, and third largest in student enrollment. UC Davis is one of only 63 universities admitted to the prestigious Association of American Universities.

UC Davis is a global community seeking solutions to some of our most pressing challenges. Located near the California state capital, UC Davis has more than 38,000 students, and the full-time equivalent of 4,100 faculty and other academics. The university offers interdisciplinary graduate study and 102 undergraduate majors and 96 graduate groups and programs in four colleges and six professional schools. Of the 38,000 students, 6,600 are enrolled in graduate and/or professional degree programs including 1,000 in health sciences programs.

UC Davis currently has more than 23% of undergraduate students identifying as Hispanic. In May 2018 UC Davis met all the eligibility requirements for designation as a Hispanic Serving Institution (HSI). Once designated an HSI, UC Davis will be one of only nine other campuses that are considered R1 universities, meaning they have the highest level of research activity for undergraduate and graduate students.

UC Davis is a dynamically growing major research institution. With $1.07 billion in extramural research awards in fiscal year 2021-22, UC Davis is one of the nation's leading research universities. UC Davis is recognized for its leadership in the biological sciences. In the past several years, UC Davis has established important curricula and infrastructure relevant to interdisciplinary translational research. This includes an NIH- funded Clinical and Translational Science Center (CTSC), its three associated training programs, and numerous other training programs that serve researchers from the pre-doctoral through the junior faculty level.

The University of California has been designated by the Internal Revenue Service as a 501(c)(3) non-profit organization.

Computer Facilities

The Division of Information and Educational Technology (IET) provides computing, communications and media resources and services in support of research and instruction. IET supports 120,000 computing accounts, 3,600 wireless access points on a secure and encrypted wireless network that covers most major campus areas, and the UC Davis Data Center. All UC Davis faculty have access to the campus high-speed data network, which includes a dedicated research network supporting 10 Gbps connections to research systems on campus and directly attached to the campus border allowing the transfer of large data sets to regional, national and international partners; two border routers supporting multiple 10Gbps links to internal and external networks – one on the Davis campus and one at the UC Davis Medical Center – that provide high-speed connections to CENIC, Internet2, the National Lambda Rail, ESNet and other regional and national research networks; high-speed optical network that provides multiple 10 Gbps links between the main Davis campus and the UC Davis Medical Center in Sacramento; four 10 Gbps connections to CENIC; and extension of the campus fiber optic backbone into research spaces allowing 10 Gbps connections to the campus research and production network. Campus network security services include VPN, firewall and host level security management services, and intrusion detection, prevention, and security alert services. In addition, authentication passphrases meet NIST 800-63-1 specifications and allow access to information resources held by federal government agencies and other academic institutions.

Library

The General Library at UC Davis is one of the premier research libraries in North America. In addition to Peter J. Shields Library, there are four other General Library Facilities: the Physical Sciences Library, the Loren D. Carlson Health Sciences Library, the Agricultural and Resource Economics Library, and the Medical Center Library in Sacramento. The combined collects of the various General Library facilities total more than

2.6 million volumes, and more than 41,000 periodical and journal titles are received annually. The MELVYL @ System, an online catalog of books and journals, can be used to access the collections of UC Davis and

the other nine UC campuses. The libraries also offer access to databases and numerous other electronic resources, both on-site and via the UC Davis Network.

Intellectual resources

The environment for the proposed studies at UC Davis has multiple unique aspects that will contribute to the successful completion of the project. The overall atmosphere at UC Davis promotes collaboration across diverse disciplines as evidenced by the number of funded joint program projects.

Department of Public Health Sciences

The Department of Public Health Sciences is a clinical and basic research department in the UC Davis School of Medicine. Our mission is to improve the health of people through population-based approaches by carrying out educational programs, research, public service, and policy development. The focus of our effort is on health promotion and disease prevention, occupational and environmental health, health care delivery, gerontology, ethical issues, reproductive, rural, minority, and international health. In 2023, the department ranked seventh in the Blue Ridge Institute rankings of NIH funding to departments of public health.

The Department of Public Health Sciences (PHS) in the School of Medicine manages a unique computing infrastructure, providing robust and secure services for research, administrative, and teaching purposes. The department supports several physical locations, all interconnected via high-speed networking connections, and all protected by a perimeter security firewall and intrusion detection and prevention system. The computing data facility, located at the UC Davis Data Center, houses 50+ PHS managed server hosts in a mixed Windows Server, FreeBSD, Solaris, and Linux environments, specializing in HIPAA compliant systems, cluster systems for data analysis, virtualization services, and infrastructure services such as file serving, remote access, print serving, and research collaboration services. All server systems are connected via 1000Mb connections.

Client desktop systems are situated in several physical locations across the UC Davis Campus and in Sacramento, all interconnected using Microsoft Active Directory technologies. All desktop systems are connected via 100Mb or 1000Mb connections. All desktop systems comply with secure computing policies, requiring users to have least privilege, proper protection from viruses, spyware/malware, and local software firewall technologies. The PHS network currently supports approximately 20 network printers. Mobile computing and secure remote access are also supported, also secure iPhone mobile computing and secure Android and Windows Mobile computing are supported.

All computing data stored on file servers, computational hosts, and infrastructure devices is protected and backed up regularly to our external computing facility located at Center for Health and the Environment, part of the UC Davis Campus. Our external computing facility can also perform as a backup computing infrastructure site in case of a failure at our main computing site at the Campus Data Center.

The department has approximately 10,000 square feet of office space on the UC Davis campus, an additional 6,400 square feet off campus in South Davis, and a 3,000 square foot office suite at the UC Davis Medical Center in Sacramento. In addition, faculty and research staff members have designated space at the UC Davis M.I.N.D. Institute and CTSC in Sacramento, and the Center for Health and the Environment in South Davis.

The Department's Research Support Unit provides accounting, purchasing, human resources, and pre- and post-award research administration services to all PHS faculty, postdocs, and students.

Division of Epidemiology

The Division of Epidemiology conducts research in areas ranging from age-related diseases, women's health, cancer,

children's health and development, and occupational health risks, to behavioral sciences and economic impact of occupational illness and injury. We develop and use research methods to understand patterns and etiology of disease, developmental disorders, and injury and disability in populations. We currently have research projects assessing vascular contributions to dementia risk, epidemiology of age-related dementia, health disparities in dementia, lifestyle and environmental factors related to endocrine changes and symptoms of menopause in a multi-ethnic cohort, environmental exposures affecting childhood neurodevelopment, and traumatic injuries incurred during military service, among many others.

Division of Biostatistics

The Division of Biostatistics in the Department of Public Health Sciences supports basic and clinical research in the School of Medicine and conducts research on biostatistical methodology. The division is housed on the Davis campus, adjacent to the Genome Center and other basic science buildings, and includes space for faculty, staff, and postdoctoral fellows. Biostatistics also has office space and a shared meeting room in the Clinical and Translational Science Center facility at the UC Davis Medical Center campus in Sacramento, facilitating collaboration with researchers there. Major equipment for the Division includes: 1) Silicon Mechanics HPC: 4 node computing cluster, with 96GB of memory for each node. The computing cluster connects to a 12TB disk array. An 8TB disk array provides data protection. 2) Sun Microsystems T5400 Enterprise, 4 x Sun Sparc 16 core processors, 3) Silicon Mechanics Rackform R422: 4 x Intel Xeon E7- 4830v3 CPU, 2.10 GHz 22nm, 1TB RAM; Storform D55J.v3 with 24 x Seagate 8TB Enterprise Capacity 3.5 HDD V.5 drive set. In addition, the Division of Biostatistics supports NQuery and Epi-stat software for sample size and power calculations.

Division of Environmental and Occupational Health

The Division's unique strengths lie in environmental and occupational health research including exposure assessment, environmental and occupational epidemiology, and translational efforts. Research addresses a wide range of disease and disabilities, including respiratory, neurologic, reproductive, and developmental outcomes, as well as cancer and cardiovascular health. Our proximity to the San Joaquin Valley provides us opportunities to work with agricultural communities, both occupational and community exposures and risks. The Division has a close relationship with the M.I.N.D. Institute and a strong program on environmental contributions to autism. There are several Centers associated with the Division, specifically the Environmental Health Sciences Center, the Center for Occupational and Environmental Health, the TENDR Program, and the Medical Surveillance Program. Research addresses environmental exposure to indoor air quality, ambient air pollution, green spaces, built environments, pesticides, heat exposure, environmental tobacco smoke, endocrine disruptors, heavy metals, and other toxicants in the environment and workplace. We work closely with the numerous strong toxicology programs, a strength of UC Davis. Additional focuses include community engagement, health disparities, environmental justice, health effects of environmental disasters, and health impacts of climate change.

Division of Health Informatics

The Division of Health Informatics provides consultation and conducts research in clinical informatics data sharing, computable phenotyping, knowledge management and terminology standardization, participant- centric data policy and bioethics. Current research projects include the development of mobile platforms for health informatics.

Division of Health Policy and Management

The Division of Health Policy and Management conducts research and teaching in health policy and management, and health economics. Current projects and collaborations include a program to measure cardiovascular disease (CVD) in California and to provide training to State managers and staff on health economics related to CVD, quality of end-of-life care, and quality and outcomes of care in mental health services.

Data Management

The UC Davis Department of Public Health Sciences offers a vast array of sophisticated data management services. The PHS Systems Development Team works closely with investigators, gathering requirements and

providing customized systems and solutions that best fit the protocol and needs of studies. All management solutions are built on existing, stable, and secure systems architecture, permeating a common, easily maintainable, extremely extensible, and highly secure quality throughout all services offered. This team has created research study subject tracking systems with extensive query capabilities, developed computer- assisted surveys both for interviewer administered and self-administered forms, and facilitated adaptation of the Freezerworks application to our biorepository inventory. All data systems developed in house are based on Open Standards.

Security and Backups

Security at all levels is taken very seriously. Application servers, which house and run the main systems reside on a secure network, protected by network intrusion systems, multiple firewalls, and access logging and auditing. Servers are scanned daily to reveal potential configuration issues. All updates to servers, their daily scans, and Internet traffic to and from are all logged and examined by IT staff. Potential intrusions are placed in a blacklist.

Backups occur daily, differential backups occur during the week and full backups happen once a week. Backups are stored on a secure medium and transferred off-site to a secondary secure location.

Power backup and redundancy help ensure maximum uptime for all systems. Data redundancy using state of the art hard drive and RAID technologies allow for maximum uptime of data access, and easy repair by administrators in the event of a disk failure. A disaster recovery plan is in place, which is reviewed and updated every 6 months.

All access to the main MySQL data repositories is limited to only a validated Web service or local system. All communication with the data repositories is logged and audited.

REFERENCES

1. Jimenez MP, DeVille NV, Elliott EG, et al. Associations between Nature Exposure and Health: A Review of the Evidence. *Int J Environ Res Public Health*. 2021;18(9):4790. doi:10.3390/ijerph18094790

2. Holland I, DeVille NV, Browning MHEM, et al. Measuring Nature Contact: A Narrative Review. *Int J Environ Res Public Health*. 2021;18(8):4092. doi:10.3390/ijerph18084092

3. Labib SM, Browning MHEM, Rigolon A, Helbich M, James P. Nature's contributions in coping with a pandemic in the 21st century: A narrative review of evidence during COVID-19. *Sci Total Environ*. 2022;833:155095. doi:10.1016/j.scitotenv.2022.155095

4. James P, Banay RF, Hart JE, Laden F. A Review of the Health Benefits of Greenness. *Curr Epidemiol Rep*. 2015;2(2):131-142. doi:10.1007/s40471-015-0043-7

5. Fong KC, Hart JE, James P. A Review of Epidemiologic Studies on Greenness and Health: Updated Literature Through 2017. *Curr Environ Health Rep*. 2018;5(1):77-87. doi:10.1007/s40572-018-0179-y

6. McPhearson T, Frantzeskaki, Ossola A, et al. Global synthesis and regional insights for mainstreaming urban nature-based solutions. *PNAS*. Published online In Press.

7. Jimenez MP, Suel E, Rifas-Shiman SL, et al. Street-view greenspace exposure and objective sleep characteristics among children. *Environmental Research*. 2022;214:113744. doi:10.1016/j.envres.2022.113744

8. Qi M, Xu C, Zhang W, et al. Mapping urban form into local climate zones for the continental US from 1986–2020. *Sci Data*. 2024;11(1):195. doi:10.1038/s41597-024-03042-4

9. Klompmaker JO, Mork D, Zanobetti A, et al. Associations of street-view greenspace with Parkinson's disease hospitalizations in an open cohort of elderly US Medicare beneficiaries. *Environ Int*. 2024;188:108739. doi:10.1016/j.envint.2024.108739

10. James P, Hart JE, Banay RF, Laden F. Exposure to Greenness and Mortality in a Nationwide Prospective Cohort Study of Women. *Environ Health Perspect*. 2016;124(9):1344-1352. doi:10.1289/ehp.1510363

11. Global Urban Tree Inventory (GUTI, vers. 1.0). Published online August 2, 2020. doi:10.6084/m9.figshare.12062634.v1

12. Browning MHEM, Rigolon A, Ogletree S, et al. The PAD-US-AR dataset: Measuring accessible and recreational parks in the contiguous United States. *Sci Data*. 2022;9(1):773. doi:10.1038/s41597-022-01857-7

13. Yeager R, Keith RJ, Riggs DW, et al. Intra-neighborhood associations between residential greenness and blood pressure. *Science of The Total Environment*. 2024;946:173788. doi:10.1016/j.scitotenv.2024.173788

14. Ossola A, Hopton ME. Measuring urban tree loss dynamics across residential landscapes. *Science of The Total Environment*. 2018;612:940-949. doi:10.1016/j.scitotenv.2017.08.103

15. Radcliffe Symposium on Grafting Ecology and Epidemiology: Embedding cutting-edge metrics of nature into public health. Grafting Ecology and Epidemiology: Embedding cutting-edge metrics of nature into public health. Accessed August 9, 2024. https://sites.harvard.edu/grafting-ecology-and-epidemiology/

16. Urban Tree Canopy in California. Accessed September 23, 2024. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd645759.html

17. National Agriculture Imagery Program - NAIP Hub Site. Accessed September 23, 2024. https://naip-usdaonline.hub.arcgis.com/

18. National Land Cover Database | U.S. Geological Survey. Accessed September 23, 2024. https://www.usgs.gov/centers/eros/science/national-land-cover-database

19. EVA Tool. Accessed September 23, 2024. https://www.mrlc.gov/eva/

20. Statewide Crop Mapping - California Natural Resources Agency Open Data. Accessed September 23, 2024. https://data.cnra.ca.gov/dataset/statewide-crop-mapping

21. The IUCN Red List of Threatened Species. IUCN Red List of Threatened Species. Accessed September 23, 2024. https://www.iucnredlist.org/en

22. Endangered Species | Species | U.S. Fish & Wildlife Service. Accessed September 23, 2024. https://www.fws.gov/program/endangered-species

23. Threatened and Endangered Species. Accessed September 23, 2024. https://wildlife.ca.gov/Conservation/CESA

24. Increasing taxonomic diversity and spatial resolution clarifies opportunities for protecting US imperiled species - Hamilton - 2022 - Ecological Applications - Wiley Online Library. Accessed December 6, 2024. https://esajournals.onlinelibrary.wiley.com/doi/10.1002/eap.2534

25. Martinez A de la I, Labib SM. Demystifying normalized difference vegetation index (NDVI) for greenness exposure assessments and policy interventions in urban greening. *Environ Res*. 2023;220:115155. doi:10.1016/j.envres.2022.115155

26. Gamon JA, Field CB, Goulden ML, et al. Relationships Between NDVI, Canopy Structure, and Photosynthesis in Three Californian Vegetation Types. *Ecological Applications*. 1995;5(1):28-41. doi:10.2307/1942049

27. California Schoolyard Trees. Published online April 23, 2024. Accessed August 12, 2024. https://research.fs.usda.gov/psw/projects/schoolyard-trees

28. DeVille NV, Iyer HS, Holland I, et al. Neighborhood socioeconomic status and mortality in the nurses' health study (NHS) and the nurses' health study II (NHSII). *Environ Epidemiol*. 2023;7(1):e235. doi:10.1097/EE9.0000000000000235

29. Daly C, Halbleib M, Smith JI, et al. Physiographically sensitive mapping of climatological temperature and precipitation across the conterminous United States. *Intl Journal of Climatology*. 2008;28(15):2031-2064. doi:10.1002/joc.1688

30. Rundle AG, Chen Y, Quinn JW, et al. Development of a Neighborhood Walkability Index for Studying Neighborhood Physical Activity Contexts in Communities across the U.S. over the Past Three Decades. *J Urban Health*. 2019;96(4):583-590. doi:10.1007/s11524-019-00370-4

31. Microsoft US Building Footprints. Published online September 21, 2024. Accessed September 23, 2024. https://github.com/microsoft/USBuildingFootprints

32. Di Q, Wei Y, Shtein A, et al. Daily and Annual PM2.5 Concentrations for the Contiguous United States, 1-km Grids, v1 (2000 - 2016). Published online 2021. doi:10.7927/0RVR-4538

33. Greenwald R, Sarnat JA, Fuller CH. The impact of vegetative and solid roadway barriers on particulate matter concentration in urban settings. *PLoS One*. 2024;19(1):e0296885. doi:10.1371/journal.pone.0296885

34. Riggs DW, Yeager R, Conklin DJ, et al. Residential proximity to greenness mitigates the hemodynamic effects of ambient air pollution. *Am J Physiol Heart Circ Physiol*. 2021;320(3):H1102-H1111. doi:10.1152/ajpheart.00689.2020

35. Ren Y, Qu Z, Du Y, et al. Air quality and health effects of biogenic volatile organic compounds emissions from urban green spaces and the mitigation strategies. *Environmental Pollution*. 2017;230:849-861. doi:10.1016/j.envpol.2017.06.049

36. Mennitt D, Sherrill K, Fristrup K. A geospatial model of ambient sound pressure levels in the contiguous United States. *J Acoust Soc Am*. 2014;135(5):2746-2764. doi:10.1121/1.4870481

37. Mennitt DJ, Fristrup KM. Influence factors and spatiotemporal patterns of environmental sound levels in the contiguous United States. *Noise Control Engineering Journal*. 2016;64(3):342-353. doi:10.3397/1/376384

38. Casey JA, Morello-Frosch R, Mennitt DJ, Fristrup K, Ogburn EL, James P. Race/Ethnicity, Socioeconomic Status, Residential Segregation, and Spatial Variation in Noise Exposure in the Contiguous United States. *Environ Health Perspect*. 2017;125(7):077017. doi:10.1289/EHP898

39. Krieger N, Feldman JM, Kim R, Waterman PD. Cancer Incidence and Multilevel Measures of Residential Economic and Racial Segregation for Cancer Registries. *JNCI Cancer Spectr*. 2018;2(1):pky009. doi:10.1093/jncics/pky009

40. Iyer HS, Hart JE, James P, et al. Impact of neighborhood socioeconomic status, income segregation, and greenness on blood biomarkers of inflammation. *Environ Int*. 2022;162:107164. doi:10.1016/j.envint.2022.107164

41. Brochu P, Jimenez MP, James P, Kinney PL, Lane K. Benefits of Increasing Greenness on All-Cause Mortality in the Largest Metropolitan Areas of the United States Within the Past Two Decades. *Front Public Health*. 2022;10:841936. doi:10.3389/fpubh.2022.841936

42. Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE) | US EPA. Accessed October 22, 2024. https://www.epa.gov/benmap

43. The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental and Social Benefits. Center for Neighborhood Technology. January 21, 2011. Accessed September 24, 2024. https://cnt.org/publications/the-value-of-green-infrastructure-a-guide-to-recognizing-its-economic-environmental-and

44. Watts A, Wolf K, Grado SC, Measells M. Nearby nature—A cost-effective prescription for better community health? *Science Findings 203 Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station 5 p*. Published online March 24, 2022. Accessed September 24, 2024. https://research.fs.usda.gov/treesearch/55592

45. Nowak DJ, Greenfield EJ. US Urban Forest Statistics, Values, and Projections. *Journal of Forestry*. 2018;116(2):164-177. doi:10.1093/jofore/fvx004

46. Final 2012 Air Quality Management Plan - February 2013. Accessed October 22, 2024. https://www.aqmd.gov/home/air-quality/air-quality-management-plans/air-quality-mgt-plan/final-2012-air-quality-management-plan

47. Leigh JP, Cone JE, Harrison R. Costs of occupational injuries and illnesses in California. *Prev Med*. 2001;32(5):393-406. doi:10.1006/pmed.2001.0841

48. A framework for the quantification and economic valuation of health outcomes originating from health and non-health climate change mitigation and adaptation action. Accessed October 22, 2024. https://www.who.int/publications/i/item/9789240057906

49. Ten Strands: Environmental Literacy for All California Students. Ten Strands. Accessed August 9, 2024. https://tenstrands.org/

50. Green Schoolyards America. Accessed August 9, 2024. https://www.greenschoolyards.org/

51. Urban and Community Forestry Grants - 2023 Grant Awards. US Forest Service. September 6, 2023. Accessed August 6, 2024. https://www.fs.usda.gov/managing-land/urban-forests/ucf/2023-grant-funding

52. Chelsa Climate. Chelsa Climate. Accessed September 23, 2024. https://chelsa-climate.org/

53. Home | Environmental Health Sciences Center. March 29, 2024. Accessed August 9, 2024. https://environmentalhealth.ucdavis.edu/

54. Matthews AK, Anderson EE, Willis M, Castillo A, Choure W. A Community Engagement Advisory Board as a strategy to improve research engagement and build institutional capacity for community-engaged research. *J Clin Transl Sci*. 2018;2(2):66-72. doi:10.1017/cts.2018.14

55. From the Ground Up. NYU Press. Accessed October 22, 2024. https://nyupress.org/9780814715376/from-the-ground-up/

56. London JK, Haapanen KA, Backus A, Mack SM, Lindsey M, Andrade K. Aligning Community-Engaged Research to Context. *Int J Environ Res Public Health*. 2020;17(4):1187. doi:10.3390/ijerph17041187

57. Haapanen KA, London JK, Andrade K. Creating the Current and Riding the Wave: Persistence and Change in Community-Engaged Health Sciences Research. *Social Sciences*. 2023;12(5):312. doi:10.3390/socsci12050312

58. Silva M, Capps S, London JK. Community-Engaged Research and the Use of Open Access ToxVal/ToxRef In Vivo Databases and New Approach Methodologies (NAM) to Address Human Health Risks From Environmental Contaminants. *Birth Defects Res*. 2024;116(9):e2395. doi:10.1002/bdr2.2395

EXHIBIT A1

DELIVERABLES

Deliverable	Description	Due Date
Racial equity/implicit bias training	The Principal Investigator and key personnel must demonstrate that they have taken, or will take, cultural competency training, implicit bias training, or racial equity training, whichever is administered at their institution. Training certificates or certificates of completion completed within one (1) year prior to the agreement start date will be accepted. If the training has not been completed within one (1) year prior to the agreement start date, then the Principal Investigator and key personnel must demonstrate that they have scheduled the training within 30 days of the agreement start date and shall complete the training within 90 days of the agreement start date.	Within 90 days of the agreement start date.
Initial Meeting	Principal Investigator and key personnel will meet with CARB Contract Project Manager and other staff to discuss the overall plan, details of performing the tasks, project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.	Month 1
Task 1	Contractor will complete an overall workplan for the analysis of the project. This will contain detailed guidelines on how each task will be completed. The workplan will include a list of health outcomes to be considered. The Workplan will be delivered three months into the project.	Month 3
Task 2	Contractor will provide a report on the findings of the literature review of health impacts of greenspace and the methods used to quantify health benefits. This will include a table summarizing major findings, methodological approaches, and potential biases and limitations in the literature. The literature review will be delivered six months into the project.	Month 6
Task 3	Contractor will provide greenspace and health datasets that are updated regularly, are open-source or made open-source, and can be linked to health datasets to conduct epidemiologic analyses. The Contractor will also provide secondary datasets, including area-level SES and climate data, that can be used in analyses going forward.	Month 12

Task 4	Models of current greenness for the state of California will be developed at the finest spatial scale possible for all of California using open access datasets that can be used to produce maps of greenness in the state. The models will be able to differentiate between different types of greenness, such as trees compared to shrubs and grasslands. The models will also be able to assess the accessibility of the greenness. The models will be combined with datasets which measure area-level SES and area-level segregation to produce maps of greenness that show the differences between the quality and openness of greenness by SES and segregation for all of California. The Contractor will work closely with CARB staff on the methodology used and the linking of the datasets. Maps of greenness will be built such that they can be periodically updated into the future. This deliverable will be due before the contract proceeds to develop the health outcomes relationships in Task 4.	Month 14
	Contractor will then provide model methodologies to estimate impacts of current and future greenspace scenarios on health, as well as the economic benefits. This will include approaches to calculate dose response curves that can be used in estimating health and economic benefits of greenspaces. The Contractor will examine at least four health outcomes. Methods and results for mortality, birth outcomes, and heat-related outcomes will be delivered by month 16 of the project.	Month 16
Task 5	Contractor will provide a report with quantitative estimates of the health benefits (dose response curves), and downstream economic benefits, of greenspace under current and future greenspace scenarios. The number of future greenness scenarios to be analyzed for quantified health outcomes will be determined by CARB and will include scenarios for 25 years and approximately 4 scenarios for each year, but will be up to 400 in total so the method to quantify health outcomes should be designed to quickly analyze these scenarios	Month 21
Task 6	Contractor will provide meeting minutes from all CAG meetings, along with reports on steps taken to incorporate guidance from the CAG into the approach.	Month 24
Task 7	Contractor will provide code, documentation, and the final models for all tasks listed above. Contractor will provide a draft final report nine months before the project ends, as well as a final report with a complex technical version and a version for lay audiences.	Month 24
Progress Reports & Meetings	Quarterly progress reports and meetings throughout the agreement term, to coincide with work completed in quarterly invoices.	Quarterly
Draft Final Report	Draft version of the Final Report detailing the purpose and scope of the work undertaken, the work performed, the results obtained and conclusions, and a Public Outreach Document and an Equity Implications Section. The Draft	Nine (9) months prior to agreement end date.

	Final Report shall be submitted in an Americans with Disabilities Act compliant format.	
Data	Data compilations first produced in the performance of this Agreement by the Principal investigator or the University's project personnel.	Two (2) weeks prior to agreement end date.
Technical Seminar	Presentation of the results of the project to CARB staff and a possible webcast at a seminar at CARB facilities in Sacramento or El Monte. The Technical Seminar slides shall be submitted in an Americans with Disabilities Act compliant format.	On or before agreement end date.
The following Deliverables are subject to paragraph 19. Copyrights, paragraph B of Exhibit C		
Final Report	Written record of the project and its results. The Final Report shall be submitted in an Americans with Disabilities Act compliant format. The Public Outreach Document and Equity Implications Section, as described in Exhibit A1, Section 2, shall be incorporated into the Final Report.	Two (2) weeks prior to agreement end date.

1. Reports and Data Compilations

A. With respect to each invoice period University shall submit, to the CARB Contract Project Manager, one (1) electronic copy of the progress report. When emailing the progress report, the "subject line" should state the contract number and the billing period. Each progress report must accompany a related invoice covering the same billing period. Each progress report will begin with the following disclaimer:

> *The statements and conclusions in this report are those of the University and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products*.

B. Each progress report will also include:

1. A brief summary of the status of the project, including whether the project is on schedule. If the project is behind schedule, the progress report must contain an explanation of reasons and how the University plans to resume the schedule.

2. A brief narrative account of project tasks completed or partially completed since the last progress report.

3. A brief discussion of problems encountered during the reporting period and how they were or are proposed to be resolved.

4. A brief discussion of work planned, by project task, before the next progress report. and

5. A graph or table showing percent of work completion for each task.

C. Nine (9) months prior to Agreement expiration date, University will deliver to CARB an electronic copy of the draft final report in both PDF and Microsoft Word formats. The draft

final report will conform to Exhibit A1, Section 2 – Research Final Report Format.

D. Within forty-five (45) days of receipt of CARB's comments, University will deliver to CARB's Contract Project Manager an electronic copy of the final report incorporating all reasonable alterations and additions. Within two (2) weeks of receipt of the revised report, CARB will verify that all CARB comments have been addressed. Upon acceptance of the amended final report approved by CARB in accordance to Exhibit A1, Section 2 – Research Final Report Format, University will within two (2) weeks, deliver to CARB an electronic copy of the final report in both PDF and Microsoft Word formats.

E. As specified in Exhibit A1, Section 2, Final Report will be submitted in an Americans with Disabilities Act compliant Format.

F. Together with the final report, University will deliver a set of all data compilations as specified in Exhibit A1 – Schedule of Deliverables.

G. University's obligation under this Agreement shall be deemed discharged only upon submittal to CARB of an acceptable final report in accordance to Exhibit A1, Section 2 – Research Final Report Format, all required data compilations, and any other project deliverables.

2. Research Final Report Format

The research contract Final Report (Report) is as important to the contract as the research itself. The Report is a record of the project and its results and is used in several ways. Therefore, the Report must be well organized and contain certain specific information. The CARB's Research Screening Committee (RSC) reviews all draft final reports, paying special attention to the Abstract and Executive Summary. If the RSC finds that the Report does not fulfill the requirements stated in this Exhibit, the RSC may not recommend release, and final payment for the work completed may be withheld. This Exhibit outlines the requirements that must be met when producing the Report.

Note: In partial fulfillment of the Final Report requirements, the Contractor shall submit a copy of the Report in PDF format and in a word-processing format, preferably in Word – Version 6.0 or later. The electronic copy file name shall contain the CARB contract number, the words "Final Report", and the date the report was submitted.

Accessibility. To maintain compliance with California Government Code Sections 7405 and 11135, and Web Content Accessibility Guidelines, Assembly Bill No. 434, the final Report must be submitted in an Americans with Disabilities Act compliant format. The Final Report will be posted on the CARB website and therefore must be in an accessible format so that all members of the public can access it.

Watermark. Each page of the draft Report must include a watermark stating "DRAFT." The revised report should not include any watermarks.

Title. The title of the Report should exactly duplicate the title of the contract. However, minor changes to the title may be approved provided the new title does not deviate from the old title. These minor changes must be approved in writing by the contract manager. Significant changes to the title would require a formal amendment.

Page size. All pages should be of standard size (8 ½" x 11") to allow for photo-reproduction.

Corporate identification. Do not include corporate identification on any page of the Final Report, except the title page.

Unit notation. Measurements in the Reports should be expressed in metric units. However, for the convenience of engineers and other scientists accustomed to using the British system, values may be given in British units as well in parentheses after the value in metric units. The expression of measurements in both systems is especially encouraged for engineering reports.

Section order. The Report should contain the following sections, in the order listed below: Title page

Disclaimer

Acknowledgment (1)

Acknowledgment (2) Table of Contents List of Figures

List of Tables Abstract

Public Outreach Document Executive Summary Equity Implications Section Body of Report References

List of inventions reported and copyrighted materials produced Glossary of Terms, Abbreviations, and Symbols

Appendices

Page numbering. Beginning with the body of the Report, pages shall be numbered consecutively beginning with "1", including all appendices and attachments. Pages preceding the body of the Report shall be numbered consecutively, in ascending order, with small Roman numerals.

Title page. The title page should include, at a minimum, the contract number, contract title, name of the principal investigator, contractor organization, date, and this statement:

"Prepared for the California Air Resources Board and the California Environmental Protection Agency"

Disclaimer. A page dedicated to this statement must follow the Title Page:

The statements and conclusions in this Report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

Acknowledgment (1). Only this section should contain acknowledgments of key personnel and organizations who were associated with the project. The last paragraph of the acknowledgments must read as follows:

This Report was submitted in fulfillment of [CARB contract number and project title] by [contractor organization] under the [partial] sponsorship of the California Air Resources Board. Work was completed as of [date].

Acknowledgment (2). Health reports should include an acknowledgment to the late Dr. Friedman. Reports should include the following paragraph:

This project is funded under the CARB's Dr. William F. Friedman Health Research Program. During Dr. Friedman's tenure on the Board, he played a major role in guiding CARB's health research program. His commitment to the citizens of California was evident through his personal and professional interest in the Board's health research, especially in studies related to children's health. The Board is sincerely grateful for all of Dr. Friedman's personal and professional contributions to the State of California.

Attestation. A page dedicated to this attestation statement must follow the Acknowledgement(s). The Principal Investigator (PI) must digitally sign below the following statement:

> The Final Report for CARB Agreement No. [contract number] titled "[Enter project title]" has been copy-edited for grammar, style, and format and is reviewed and approved by the Principal Investigator (PI), [title and name of PI] of [Contractor Name]. The signature below attests that the PI has completed a thorough review of this Final Report and approves it for submission to the California Air Resources Board.

PI Signature
Date

Table of Contents. This should list all the sections, chapters, and appendices, together with their page numbers. Check for completeness and correct reference to pages in the Report.

List of Figures. This list is optional if there are fewer than five illustrations.

List of Tables. This list is optional if there are fewer than five tables.

Abstract. The abstract should tell the reader, in nontechnical terms, the purpose and scope of the work undertaken, describe the work performed, and present the results obtained and conclusions. The purpose of the abstract is to provide the reader with useful information and a means of determining whether the complete document should be obtained for study. The length of the abstract should be no more than about 200 words. Only those concepts that are addressed in the executive summary should be included in the abstract.

Example of an abstract:

A recently developed ground-based instrument, employing light detecting and ranging (lidar) technology, was evaluated, and found to accurately measure ozone concentrations at altitudes of up to 3,000 meters. The novel approach used in this study provides true vertical distributions of ozone concentrations aloft and better temporal coverage of these distributions than other, more common methods, such as those using aircraft and ozonesonde (balloon) techniques. The ozone and aerosol measurements from this study, in conjunction with temperature and wind measurements, will provide a better characterization of atmospheric conditions aloft and the processes involved in the formation of unhealthful ozone concentrations than can be achieved with traditional ground-based monitors.

Public Outreach Document. The public outreach document is a one-page document that will be widely used to communicate, in clear and direct terms, the key research findings from the study to the public. CARB will be translating the document into other languages. This document must adhere to the following guidelines:

- Single space, limited to one-page or about 500 words.
- Use narrative form and active voice.
- Incorporate a graphic that it is easy to interpret and captures the results' central message.
- Avoid jargon and technical terms. Use a style and vocabulary level comparable to that of sixth grade reading level.
- The document should contain a title and the following five sections: Issue/s, Main Question, Key Research Findings, Conclusion/s, and More Information. Guidance on how to write these sections is described below.

TITLE: Adopt a short, non-technical title to make the topic clear and concise. The title will likely differ from the original title of the contract.

ISSUE/S: In one to two paragraphs, describe why the project was needed. In this section, identify the problem leading to this study and what the study was set to accomplish to help address the problem. Reference any history that is relevant such as a regulation, legislation, program, law, or other. Without going into detail and disclosing the research findings,

mention the methods used in the study and how it informed the results.

MAIN QUESTION: Present a concise central research question driving this project.

KEY RESEARCH FINDING/S: This section covers the key research findings. List key points and or findings.

CONCLUSION/S: In one to two paragraphs, discuss how the results could be used. Mention its relevance to policies, rules, regulations, legislations, or CARB programs. Include suggestions for next steps, additional research, or other actions.

MORE INFORMATION: In two to three short sentences provide specifics about the study. This section should include the full title of the study, sponsor, authors, and where the full report can be found (the final report will be posted on the CARB website). In addition to a direct contact to gain more information (author and CARB contract manager).

Executive Summary. The function of the executive summary is to inform the reader about the important aspects of the work that was done, permitting the reader to understand the research without reading the entire Report. It should state the objectives of the research and briefly describe the experimental methodology[ies] used, results, conclusions, and recommendations for further study. All of the concepts brought out in the abstract should be expanded upon in the Executive Summary. Conversely, the Executive Summary should not contain concepts that are not expanded upon in the body of the Report.

The Executive Summary will be used in several applications as written; therefore, please observe the style considerations discussed below.

Limit the Executive Summary to two pages, single spaced.

Use narrative form. Use a style and vocabulary level accessible to the general audience. Assume the audience is being exposed the subject for the first time.

Do not list contract tasks in lieu of discussing the methodology. Discuss the results rather than listing them.

Avoid jargon.

Define technical terms.

Use passive voice if active voice is awkward.

Avoid the temptation to lump separate topics together in one sentence to cut down on length. The Executive Summary should contain four sections: Background, Objectives and

Methods, Results, and Conclusions, described below.

THE BACKGROUND SECTION. For the Background, provide a one-paragraph discussion of the reasons the research was needed. Relate the research to the Board's regulatory functions, such as establishing ambient air quality standards for the protection of human health, crops, and ecosystems; the improvement and updating of emissions inventories; and the development of air pollution control strategies.

THE OBJECTIVES AND METHODS SECTION. At the beginning of the Objectives and Methods section, state the research objectives as described in the contract.

Include a short, one or two sentences, overview of what was done in general for this research.

The methodology should be described in general, nontechnical terms, unless the purpose of the research was to develop a new methodology or demonstrate a new apparatus or technique. Even in those cases, technical aspects of the methodology should be kept to the minimum necessary for understanding the project. Use terminology with which the reader is likely to be familiar. If it is necessary to use technical terms, define them. Details, such as names of manufacturers and statistical analysis techniques, should be omitted.

Specify when and where the study was performed if it is important in interpreting the results. The findings should not be mentioned in the Objectives and Methods section.

THE RESULTS SECTION. The Results section should be a single paragraph in which the main findings are cited, and their significance briefly discussed. The results should be presented as a narrative, not a list. This section must include a discussion of the implications of the work for the Board's relevant regulatory programs.

THE CONCLUSIONS SECTION. The Conclusions section should be a single short paragraph in which the results are related to the background, objectives, and methods. Again, this should be presented as a narrative rather than a list. Include a short discussion of recommendations for further study, adhering to the guidelines for the Recommendations section in the body of the Report.

Equity Implication Section. The equity implications section should summarize how the research results inform disparate impacts of policies, regulations, or programs on priority communities. [1] This section should summarize how sociodemographic factors were examined in this research. Given the data used or collected, which populations are excluded or overrepresented? How were relevant communities engaged in the research effort and/or how were existing data gaps identified and ground-truthed during the research project? If ground-truthed data were found to not accurately reflect the lived experiences of community members, what future research projects could address this disconnect. The research results should inform existing or future CARB programs and the equity implications section should discuss how the research results may inform programs to close disparities in health outcomes, pollutant exposure or climate adaptation, etc., for priority communities.

This section should be limited to a maximum of two (2) pages, single spaced and shall include the following sections.

HISTORICAL ANALYSIS. Provide an overview of the inequities and disparities observed in the existing data or data gathered during the research and how it ties to historic policies. For example, what is the root-cause of the disparity being experienced by the community or population central to this research?

MATERIALS AND METHODS. Describe how this research project examines racial equity. Some methods can include but are not limited to: examining the potential for existing data to address racial inequalities, ground-truthing existing data, engaging priority communities, assessments for racial and ethnic subgroups in the development of data and approaches, identifying data gaps and filling those gaps.

RESULTS AND DISCUSSION. Describe how the results improve our understanding of the equity issues identified or interventions to address those inequalities .

---

[1] Priority communities here encompasses various terms CARB uses such as priority populations[2], communities of concern[3], protected classes[4], or disadvantaged communities[5].
[2] Priority Populations — California Climate Investments
[3] Referenced from the California Public Utilities Commission Environmental and Social Justice Plan an effort resulting from California's Capitol Collaborative on Race & Equity.
[4] Protected Classes | California State Senate
[5] SB-535-Designation-Final.pdf (ca.gov) ; California Climate Investments to Benefit Disadvantaged Communities | CalEPA; CalEnviroScreen 4.0 | OEHHA

Body of Report. The body of the Report should contain the details of the research, divided into the following sections:[6]

INTRODUCTION. Clearly identify the scope and purpose of the project. Provide a general background of the project. Explicitly state the assumptions of the study.

Clearly describe the hypothesis or problem the research was designed to address. Discuss previous related work and provide a brief review of the relevant literature on the topic.

MATERIALS AND METHODS. Describe the various phases of the project, the theoretical approach to the solution of the problem being addressed, and limitations to the work.

Describe the design and construction phases of the project, materials, equipment, instrumentation, and methodology.

Describe quality assurance and quality control procedures used. Describe the experimental or evaluation phase of the project.

RESULTS. Present the results in an orderly and coherent sequence. Describe statistical procedures used and their assumptions. Discuss information presented in tables, figures, and graphs. The titles and heading of tables, graphs, and figures, should be understandable without reference to the text. Include all necessary explanatory footnotes. Clearly indicate the measurement units used.

DISCUSSION. Interpret the data in the context of the original hypothesis or problem. Does the data support the hypothesis or provide solutions to the research problem? If appropriate, discuss how the results compare to data from similar or related studies. What are the implications of the findings?

Identify innovations or development of new techniques or processes. If appropriate, discuss cost projections and economic analyses.

SUMMARY AND CONCLUSIONS. This is the most important part of the Report because it is the section that will probably be read most frequently. This section should begin with a clear, concise statement of what, why, and how the project was done. Major results and conclusions of the study should then be presented, using clear, concise statements. Make sure the conclusions reached are fully supported by the results of the study. Do not overstate or overinterpret the results. It may be useful to itemize primary results and conclusions. A simple table or graph may be used to illustrate.

RECOMMENDATIONS. Use clear, concise statements to recommend (if appropriate) future research that is a reasonable progression of the study and can be supported by the results and discussion.

References. Use a consistent style to fully cite work referenced throughout the Report and references to closely related work, background material, and publications that offer additional information on aspects of the work. Please list these together in a separate section, following the body of the Report. If the Report is lengthy, you may list the references at the end of each chapter.

List of inventions reported and publications produced. If any inventions have been reported, or publications or pending publications have been produced as a result of the project, the titles,

[6] Note that if the research employs multiple distinct methods, analyses, etc., the final report can include separate materials/methods, results, and discussion sections to allow for coherent discussion of each set of analyses and findings. However, the executive summary and conclusions sections should synthesize the collective findings of the entire study.

authors, journals or magazines, and identifying numbers that will assist in locating such information should be included in this section.

Glossary of terms, abbreviations, and symbols. When more than five of these items are used in the text of the Report, prepare a complete listing with explanations and definitions. It is expected that every abbreviation and symbol will be written out at its first appearance in the Report, with the abbreviation or symbol following in parentheses [i.e., carbon dioxide (CO2)]. Symbols listed in table and figure legends need not be listed in the Glossary.

Appendices. Related or additional material that is too bulky or detailed to include within the discussion portion of the Report shall be placed in appendices. If a Report has only one appendix, it should be entitled "APPENDIX". If a Report has more than one appendix, each should be designated with a capital letter (APPENDIX A, APPENDIX B). If the appendices are too large for inclusion in the Report, they should be collated, following the binding requirements for the Report, as a separate document.

The contract manager will determine whether appendices are to be included in the Report or treated separately. Page numbers of appendices included in the Report should continue the page numbering of the Report body. Pages of separated appendices should be numbered consecutively, beginning at “1”.

3. Other Deliverables

A. Any other deliverables shall be provided in a mutually agreed upon format unless the deliverable format is already specified in Exhibit A.

EXHIBIT A2

KEY PERSONNEL

Last Name, First Name	**Institutional Affiliation**	**Role on Project**
Principal Investigator (PI):		
James, Peter	UC Davis	PI
Co-Investigators:		
Brazil, Noli	UC Davis	Co-I
Capps, Shosha	UC Davis	Co-I
Hertz-Picciotto	UC Davis	Co-I
London, Jonathan K	UC Davis	Co-I
Ossola, Alessandro	UC Davis	Co-I
Springborn, Michael	UC Davis	Co-I

EXHIBIT A3

AUTHORIZED REPRESENTATIVES

The following individuals are the authorized representatives for the State and the University under this Agreement. Any official Notices issued under the terms of this Agreement shall be addressed to the Authorized Official identified below, unless otherwise identified in the Agreement.

State Agency Contacts	**University Contacts**
Agency Name: **CARB**	University Name: The Regents of the University of California (Davis Campus)
Contract Project Manager (Technical)	***Principal Investigator (PI)***
Name: Nargis Jareen Address: Research Division 1001 I Street, 5th Floor Sacramento, CA 95814 Telephone: (916) 327-3951 Email: nargis.jareen@arb.ca.gov	Name: Peter James Address: One Shields Ave, Davis, CA 95616 Telephone: 530-752-5676 Email: pjames@ucdavis.edu Designees to certify invoices under Section 14 of Exhibit C on behalf of PI: 1. James Ringo, Director, jaringo@ucdavis.edu 2. Mario Reina-Guerra, Associate Director, mreinaguerra@ucdavis.edu 3. Tammy Castelli, Supervisor, tacastelli@ucdavis.edu

Authorized Official (contract officer) Name: Alice Kindarara, Branch Chief Address: Acquisitions Branch 1001 I Street, 5th Floor Sacramento, CA 95814 ***Send notices to (if different):*** Name: Mariah Figueroa Address: Research Division 1001 I Street, 7th Floor Sacramento, CA 95814 Telephone: (279) 208-7882 Email: Mariah.Figueroa @arb.ca.gov	***Authorized Official*** Name: Samuel Boyes Address: Sponsored Programs, Office of Research 1850 Research Park Drive Davis, CA 95618 ***Send notices to (if different):*** Name: Address: Telephone: 530-752-5458 Fax: Email: proposals@ucdavis.edu
Administrative Contact Name: Mariah Figueroa Address: Research Division 1001 I Street, 7th Floor Sacramento, CA 95814 Telephone: (279) 208-7882 Email: Mariah.Figueroa @arb.ca.gov	***Administrative Contact*** Name: Tina Palomino Address: Public Health Sciences One Shields Ave, Davis CA 95616 Telephone: 530-752-0366 Email: tlpalomino@ucdavis.edu
Financial Contact/Accounting Name: Accounts Payable Address: P.O. Box 1436 Sacramento, CA 95814 Email: AccountsPayable@arb.ca.gov **Send courtesy copy to:** rd.invoices@arb.ca.gov	***Authorized Financial Contact/Invoicing*** Name: Contract and Grant Accounting Address: One Shields Ave Davis, CA 95616 Telephone: Email: efa@ucdavis.edu Designees for invoice certification in accordance with Exhibit C – University Terms and Conditions, Section 14 on behalf of the Financial Contact: 1. James Ringo 2. Mario Reina-Guerra 3. Tammy Castelli

EXHIBIT A4

USE OF INTELLECTUAL PROPERTY & DATA

If either Party will be using any third-party or pre-existing intellectual property (including, but not limited to copyrighted works, known patents, trademarks, service marks and trade secrets) "IP" and/or Data with restrictions on use, then list all such IP/Data and the nature of the restriction below. If no third-party or pre-existing IP/Data will be used, check "none" in this section.

A. State: Preexisting Intellectual Property (IP)/Data to be provided to the University from the State or a third party for use in the performance in the Scope of Work.

☒ None or ☐ List:

Owner (State Agency or 3rd Party)	Description	Nature of restriction:

B. University: Restrictions in Preexisting IP/Data included in Deliverables identified in Exhibit A1, Deliverables.

☒ None or ☐ List:

Owner (University or 3rd Party)	Description	Nature of restriction:

C. Anticipated restrictions on use of Project Data.

If the University PI anticipates that any of the Project Data generated during the performance of the Scope of Work will have a restriction on use (such as subject identifying information in a data set), then list all such anticipated restrictions below. If there are no restrictions anticipated in the Project Data, then check "none" in this section.

☒ None or ☐ List:

Owner (State Agency or 3rd Party)	Description	Nature of restriction:

EXHIBIT A5

RÉSUMÉ / BIOSKETCH

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: James, Peter

eRA COMMONS USER NAME (credential, e.g., agency login): PETERJAMES

POSITION TITLE: Associate Professor, Department of Public Health Sciences, University of California, Davis School of Medicine, Davis, California

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Pennsylvania, Philadelphia, PA	BA	05/2002	Environmental Science / History and Sociology of Science
Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland	MS	05/2007	Environmental Health Sciences
Harvard T.H. Chan School of Public Health (HSPH), Boston, Massachusetts	ScD	02/2012	Environmental Health / Epidemiology

A. Personal Statement

Trained in environmental health and epidemiology, I have focused my research on the causal effects of spatial factors, including nature, the built environment, noise, air pollution, and socioeconomic factors, on physical activity, body mass index, mental health, cognitive function, cancer, and cardiovascular disease. I have over fifteen years of experience working with prospective cohorts and developing spatial metrics of exposure to nature to study their impact on chronic disease risk. I have published on disparities in access to nature across the United States using multiple metrics of nature access. Recently, I have developed novel metrics of greenspace exposure through the application of deep learning algorithms to over 350 million street view images nationwide. And I have a recently funded grant to establish nationwide metrics of exposure to nature. As Principal Investigator on this grant, I will apply my expertise as an epidemiologist studying nature and health to lead research on quantifying the health benefits of nature and modeling the health benefits of different greenspace scenarios. I will also provide support on quantifying the ecosystem services of nature, as well as the economic benefits of nature for health and ecosystem services.

1. **James P**, Hart JE, Banay RF, Laden F. Exposure to Greenness and Mortality in a Nationwide Prospective Cohort Study of Women. Environmental Health Perspectives. 2016 124(9):1344-52. PMID: 27074702; PMCID: PMC5010419.
2. Casey JA, **James P**, Cushing L, Jesdale BM, Morello-Frosch R. Race, Ethnicity, Income Concentration and 10-Year Change in Urban Greenness in the United States. Int J Environ Res Public Health. 2017 Dec 10;14(12). PMID: 29232867; PMCID: PMC5750964.

3. Brochu P, Jimenez MP, **James P**, Kinney PL, Lane K. Benefits of Increasing Greenness on All-Cause Mortality in the Largest Metropolitan Areas of the United States Within the Past Two Decades. Front

Public Health. 2022 May 10;10:841936. doi: 10.3389/fpubh.2022.841936. PMID: 35619828; PMCID: PMC9127575.

4. Jimenez MP, Suel E, Rifas-Shiman SL, Hystad P, Larkin A, Hankey S, Just AC, Redline S, Oken E, **James P**. Street-view greenspace exposure and objective sleep characteristics among children. Environ Res. 2022 Nov;214(Pt 1):113744. doi: 10.1016/j.envres.2022.113744. Epub 2022 Jun 25. PMID: 35760115; PMCID: PMC9930007.
5. Klompmaker JO, Laden F, Browning MHEM, Dominici F, Ogletree SS, Rigolon A, Hart JE*, **James P***. Associations of parks, greenness, and blue space with cardiovascular and respiratory disease hospitalization in the US Medicare cohort. Environ Pollut. 2022 Nov 1;312:120046. doi: 10.1016/j.envpol.2022.120046. Epub 2022 Aug 29. PMID: 36049575; PMCID: PMC10236532.
6. Browning MHEM, Rigolon A, Ogletree S, Wang R, Klompmaker JO, Bailey C, Gagnon R, **James P**. The PAD-US-AR dataset: Measuring accessible and recreational parks in the contiguous United States. Sci Data. 2022 Dec 16;9(1):773. doi: 10.1038/s41597-022-01857-7. PMID: 36526628; PMCID: PMC9758140.
7. Klompmaker JO, Hart JE, Bailey CR, Browning MHEM, Casey JA, Hanley JR, Minson CT, Ogletree SS, Rigolon A, Laden F, **James P**. Racial, Ethnic, and Socioeconomic Disparities in Multiple Measures of Blue and Green Spaces in the United States. Environ Health Perspect. 2023 Jan;131(1):17007. doi: 10.1289/EHP11164. Epub 2023 Jan 25. PMID: 36696102; PMCID: PMC9875842.
8. Stowell JD, Ngo C, Jimenez MP, Kinney PL, **James P**. Development of a global urban greenness indicator dataset for 1,000+ cities. Data Brief. 2023 Jun;48:109140. doi: 10.1016/j.dib.2023.109140. Epub 2023 Apr 11. PMID: 37069950; PMCID: PMC10088350.
9. Klompmaker JO, Mork D, Zanobetti A, Braun D, Hankey S, Hart JE, Hystad P, Jimenez MP, Laden F, Larkin A, Lin PD, Suel E, Yi L, Zhang W, Delaney SW, **James P**. Associations of street-view greenspace with Parkinson's disease hospitalizations in an open cohort of elderly US Medicare beneficiaries. Environ Int. 2024 May 11;188:108739. doi: 10.1016/j.envint.2024.108739. Epub ahead of print. PMID: 38754245.
10. Jimenez MP, Wagner M, Laden F, Hart JE, Grodstein F, **James P**. Midlife Residential Greenness and Late-Life Cognitive Decline among Nurses' Health Study Participants. Environ Health Perspect. 2024 Jul;132(7):77003. doi: 10.1289/EHP13588. Epub 2024 Jul 17. PMID: 39016600; PMCID: PMC11253812.

B. Positions, Scientific Appointments, and Honors

Positions and Employment

2024 -	Associate Professor, Department of Public Health Sciences, University of California, Davis School of Medicine, Davis, CA
2024 -	Director, Center for Occupational and Environmental Health, Department of Public Health Sciences, University of California, Davis School of Medicine, Davis, CA
2024 -	Adjunct Associate Professor, Department of Environmental Health, HSPH, Boston, MA
2024 -	Visiting Associate Professor, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston, MA
2021 - 2024	Associate Professor, Department of Environmental Health, HSPH, Boston, MA
2021 - 2024	Associate Professor, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston, MA
2019 - 2021	Assistant Professor, Department of Environmental Health, HSPH, Boston, MA
2017 - 2021	Assistant Professor, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston, MA
2012 - 2014	Postdoctoral Fellow, NIH National Research Service Award: Cardiovascular Disease Epidemiology Training Program in Behavior, the Environment, and Global Health (T32 HL 098048), HSPH, Department of Epidemiology, Boston, MA

Scientific Appointments and Professional Memberships

2024 -	Chapter Author, First National Nature Assessment, U.S. Global Change Research Program
2007 -	Member, International Society for Environmental Epidemiology

Honors

2021	Harvard Chan Student Mentoring Award, Graduation 2021
2019	ISPOR Award for Excellence in Methodology in Health Economics and Outcomes Research

C. Contributions to Science

1. *Establishing relationships between contextual factors and health behaviors and chronic disease risk.* Health behaviors are largely a consequence of the dynamic social, physical, and ecological context with which individuals interact. Spatial factors, such as well-connected streets, light at night, noise, and air pollution, as well as access to green, natural environments, may affect mental health, cognitive function, diet, routine physical activity, and sleep quality, as well as directly impact chronic disease. Modifying contextual exposures has the potential to significantly alter patterns of mental health, physical activity, sleep, and diet, and ultimately chronic disease. I have contributed multiple manuscripts that quantify the relationships between contextual factors and health behaviors and chronic disease risk, which are essential to identifying potential contextual interventions.
   a. Fong K, Hart JE, **James P**. A Review of Epidemiologic Studies on Greenness and Health: Updated Literature Through 2017. Current Environmental Health Reports. 2018 Mar;5(1):77-87. PMID: 29392643; PMCID: PMC5878143.
   b. Jimenez MP,* DeVille NV,* Elliott EG, Schiff JE, Wilt GE, Hart JE, **James P**. Associations of Nature Exposure and Health: A Review of the Evidence. Int J Environ Res Public Health. 2021 Apr 30;18(9):4790. PMID: 33946197; PMCID: PMC8125471.
   c. Iyer HS, Hart JE, **James P**, Elliott EG, DeVille NV, Holmes MD, De Vivo I, Mucci LA, Laden F, Rebbeck TR. Impact of neighborhood socioeconomic status, income segregation, and greenness on blood biomarkers of inflammation. Environ Int. 2022 Apr;162:107164. doi: 10.1016/j.envint.2022.107164. Epub 2022 Mar 5. PMID: 35255255; PMCID: PMC8985077.
   d. Towe-Goodman N, McArthur KL, Willoughby M, Swingler MM, Wychgram C, Just AC, Kloog I, Bennett DH, Berry D, Hazlehurst MF, **James P**, Jimenez MP, Lai JS, Leve LD, Gatzke-Kopp L, Schweitzer JB, Bekelman TA, Calub C, Carnell S, Deoni S, D'Sa V, Kelly C, Koinis-Mitchell D, Petriello M, Thapaliya G, Wright RJ, Zhang X, Kress AM; Environmental Influences on Child Health Outcomes program collaborators. Green Space and Internalizing or Externalizing Symptoms Among Children. JAMA Netw Open. 2024 Apr 1;7(4):e245742. doi: 10.1001/jamanetworkopen.2024.5742. PMID: 38598238; PMCID: PMC11007572.

2. *Developing methodology to estimate causal relationships between contextual factors and health behaviors.* Research on context and health contains numerous methodological shortcomings. I am establishing methods to improve contextual exposure assessment through empirical analysis; to estimate the magnitude of residential self-selection; to validate questionnaires on perceptions of neighborhoods; to calculate neighborhood-health relationships in quasi-randomized study designs; and to establish new metrics of access to healthy and unhealthy foods.
   a. **James P**, Berrigan D, Hart JE, Hipp JA, Hoehner CM, Kerr J, Major JM, Oka M, Laden F. Effects of buffer size and shape on associations between the built environment and energy balance. *Health Place*. 2014 May;27:162-70. doi: 10.1016/j.healthplace.2014.02.003. PMID: 24607875; PMCID: PMC4028172.
   b. **James P**, Hart JE, Arcaya MC, Feskanich D, Laden F, Subramanian SV. Neighborhood Self-Selection: The Role of Pre-Move Health Factors on the Built and Socioeconomic Environment. *Int J Environ Res Public Health*. 2015 Oct 8;12(10):12489-504. doi: 10.3390/ijerph121012489. PMID: 26457712; PMCID: PMC4626981.
   c. Hirsch JA, Michael YL, Moore KA, Melly S, Hughes TM, Hayden K, Luchsinger JA, Jimenez MP, **James P**, Besser LM, Sánchez B, Diez Roux AV. Longitudinal neighbourhood determinants with cognitive health and dementia disparities: protocol of the Multi-Ethnic Study of Atherosclerosis Neighborhoods and Aging prospective cohort study. *BMJ Open*. 2022 Nov 11;12(11):e066971. doi: 10.1136/bmjopen-2022-066971. PMID: 36368762; PMCID: PMC9660618.
   d. **James P**, Wilt GE, Jimenez MP. Invited Perspective: Can My Smartphone Assess My Exposure? The Potential to Retroactively Estimate Personalized Exposures using Smartphone Location Data. *Environ Health Perspect*. 2022 Nov;130(11):111304. doi: 10.1289/EHP12237. PMID: 36356209; PMCID: PMC9648903.

A complete list of my peer-reviewed publications can be found at: http://www.ncbi.nlm.nih.gov/myncbi/peter.james.1/bibliography/40047305/public/?sort=date&direction=ascending

CURRICULUM VITAE

ALESSANDRO OSSOLA, PhD
387 N Quad, 95616, CA, USA Assistant Professor

University of California Davis

EDUCATION

University of Melbourne, School of Ecosystem and Forest Sciences Melbourne, Australia PhD, Urban Ecology
Jun 2012-Aug 2016

Title: "Habitat complexity impacts soil biodiversity and ecological processes in urban ecosystems"

University of Insubria Varese, Italy
MSc, Natural Resource Management, *magna cum laude* 2006-2008
Title: "Prealpine semi-natural grasslands: contribution as carbon sink and bioenergy source"

University of Insubria Varese, Italy
BSc, Natural Resource Management, *magna cum laude* 2002-2005
Title: "Evaluation of the role of Lombardy Parks (Italy) for carbon sequestration"

SELECTED AWARDS

- Graduate Program Advising and Mentoring Award – UC Davis Graduate Studies 2023
- New Innovator Award – Foundation for Food and Agriculture Research (FFAR) 2023
- US National Academy of Sciences, Engineering and Medicine, NRC Fellow 2016

RESEARCH EXPERIENCE

University of California, Department of Plant Sciences Davis, USA Assistant Professor and Assistant Agronomist Nov 2021-current

Centre for Smart Green CitiesSydney, Australia

Macquarie University, Department of Biological Sciences Sept 2017-Sept 2021 Research Coordinator and Research Fellow

National Risk Management Research Laboratory – US EPA Cincinnati, OH, USA US National Academy of Sciences, Engineering and Medicine Jul 2016-Aug 2017 (relinquished) National Research Council (NRC) Postdoctoral Associate

University of Melbourne, School of Ecosystem and Forest Sciences Melbourne, Australia Postgraduate Researcher
May 2012-Mar 2016

Since my PhD award, I secured 15 grants/awards as (co)-PI in AU and the US (~$3.67M), with 27 grants not awarded (success rate of 37%). Since the last merit, I am the sole PI on a contract with USDA-FS ($420k), the sole PI on a New Innovator Award by FFAR ($450k), and a co-Pi on 5 new smaller grants and awards (>$696k).

TEACHING EXPERIENCE

University of California, Department of Plant Science Davis, USA Assistant Professor in urban plants (ENH06) and urban forestry (ENH100) Nov 2021-current

Macquarie University, Department of Biological Sciences Sydney, Australia Guest lecturer for the subjects "Conservation and Biodiversity" (BIOL349), "Climate Impacts and Adaptation" (CLIM803), "Climate Change Impacts" (BIOL876), "Biological Conservation" (BIOL875), and "Design Thinking" (MGSM819).

University of Melbourne, School of Ecosystem and Forest Sciences Melbourne, Australia

Guest lecturer for the subject "Urban Soils, Substrates and Water" (ERTH90028), and "Horticulture for Sustainable Communities" (HORT20013), Associate Degree in Environmental Horticulture and Associate Degree in Urban Horticulture.

LEADERSHIP AND SERVICE

University service. I am an active member of the Academic and Strategic Planning, Marketing and Communication Strategy, Curriculum, DEI, IT committees for UCD Plant Science Dept (30-40h/y). I serve on the UCD campus tree committee (5h/y), the Sacramento Data Hub Initiative (7h/y), and Admissions for GGHA (20h/y) and GGE graduate groups (15h/y). I am a lead Faculty Advisor for GGG (30h/y). In 2023/4 I served on 2 Recruitment Advisory committees (160h) and 4 PhD Qualifying exams (32h).

Contribution to committees for scientific societies, and/or public service committees. I serve on the Executive Oversight Team of the Los Angeles Center for Urban Natural Resources Sustainability. In Sept 2023 I testified in a Hearing of the AB 1757 NWL Expert Advisory Committee of the California Natural Resources Agency. I further advise the City of Davis, Cal-IPC, Plant Right and other NGOs and local governments on a per-need basis. Since last merit I contributed to 13 media appearances, comprising the L.A. Times and Washington Post (n. 49 TV, newspaper, radio, magazine contributions since PhD conferral).

Non-university services. I reviewed ~80 manuscripts for 34 international journals. Since 2023 I am an Associate Editor for Landscape and Urban Planning (IF 9.1). Since last merit I reviewed 6 grants for the US National Academy of Science, Medicine and Engineering (NASEM), and one for each the Natural Sciences and Engineering Research Council of Canada (NSERC), The Hebrew University Center for Sustainability, and the Austrian Science Fund (FWF). Since my PhD I reviewed 22 national and international grants for NASEM, NOAA, NERC (UK), BMBF-DLR (Germany), NWO-NWA (The Netherland), NSERC (Canada), IRC (Ireland).

PUBLICATIONS

Overall I have published 71 peer-reviewed publications, 23 of which are first-authored and 9 last-authored. My H-index is 33, i-10-index is 51. The average impact factor of journals I published is 7.5 ± 0.6 (SEM). Some key publications relevant to this grant application are listed below:

1. Locke, D., **Ossola**, A., Schmit, J.P., Grove, M., 2024. Sub-parcel scale analysis is needed to capture socially-driven canopy cover change in Baltimore, MD. Landscape and Urban Planning (in press).
2. McPhearson, T., Frantzeskaki, **Ossola**, A., Diep, L., Anderson, P., Blatch, T., Colliers, M., Cook, E., Culwick Fatti, C., Grimm, N., Haase, D., Herreros-Cantiz, P., Kavonic, J., Lin, BB., Lopes Meneses, D., Matsler, M., Moglia, M., Morató, J., O'Farrell, P., Grabowski, Z.J., Roy, P., Singh, C., Wang, J., Zhou, W., 2024. Global synthesis and regional insights for mainstreaming urban nature-based solutions (PNAS, in press).
3. Stevens, H., Graham, P., Beggs, P., **Ossola**, A., 2024. Associations between violent crime inside and outside, air temperature, urban heat island magnitude, and urban green space. International Journal of Biometeorology, 68: 661–673. https://doi.org/10.1007/s00484-023-02613-1 IF 3.7.
4. Browning, M.H.E.M., Locke, D. Konijnendijk, C., Labib, S.M., Rigolon, A., Yeager, R., Bardhan, M., Berland, A., Dadvand, P., Helbich, M., Li, F., Li, H., James, P., Klompmaker, J., Reuben, A., Roman, L. Patwary, M., O'Neil-

Dunne, J., **Ossola**, A., Wang, R., Yang, B., Yi, L. Zhang, J., Nieuwenhuijsen, M., 2023. Measuring the 3-30-300 Rule to Help Cities Meet Nature Access Thresholds. Science of the Total Environment, 167739. https://doi.org/10.1016/j.scitotenv.2023.167739, IF 10.8.

5. **Ossola**, A., Yu, M., Bustamante, H., Uthayakumaran, L., Le Roux, J., Leishman, M.R., 2023. Research note: Integrating big data to predict tree root blockages across sewer networks. Landscape and Urban Planning, 240, 104892. https://doi.org/10.1016/j.landurbplan.2023.104892, IF 9.1.
6. Yeager, R., Browning, M.H.E.M., Breyer, E., **Ossola**, A., Larson, L., Riggs, D.W., Chandler, C., Rigolon, A., Fleischer, D., Keith, R., Hart, J., Walker, K., Smith, T., Bhatnagar, A., 2023. Greenness and socioeconomic status: complexity of intra-neighborhood context and equity of residential planting implementation. Environment International, 176:107955. https://doi.org/10.1016/j.envint.2023.107955, IF=13.3
7. Kingsley, J., O Diekmann, L., Egerer, M., Lin, B., **Ossola**, A., Marsh, P., 2022. "My garden has become our garden": Experiences of gardening during COVID-19. Health and Place, 76: 102854 https://doi.org/10.1016/j.healthplace.2022.102854, IF=4.1.
8. Egerer, M., Lin, B., Kingsley, J., Marsh, P., Diekmann, L., **Ossola**, A., 2022. Gardening can relieve human stress and boost nature connection during the COVID-19 pandemic. Urban Forestry and Urban Greening, 68, 127483, https://doi.org/10.1016/j.ufug.2022.127483, IF=6.4.
9. Locke, D., **Ossola**, A., Minor, E., Lin, B., 2022. Spatial contagion structures urban vegetation from parcel to landscape. People and Nature, 4(1): 88-102, https://doi.org/10.1002/pan3.10254, IF=6.1.
10. Croeser, T., Garrard, G., Sharma, R., **Ossola**, A., Bekessy, S., 2021. Choosing the right nature-based solutions to meet diverse urban challenges. Urban Forestry and Urban Greening, 65: 127337, https://doi.org/10.1016/j.ufug.2021.127337, IF=6.4.
11. Lin, B., Egerer, M., Kingsley, J., Marsh, P., Diekmann, L., **Ossola**, A., 2021. COVID-19 gardening may plant the seeds for a greener, healthier future. Frontiers in Ecology and the Environment, 19: 491–493. https://doi.org/10.1002/fee.2416, IF=10.3.
12. **Ossola**, A., Jenerette, D., McGrawth, A., Chow, W., Hughes, L., Leishman, M.L., 2021. Small vegetated patches greatly reduce urban surface temperature during a summer heatwave in Adelaide, Australia. Landscape and Urban Planning, 209, 104046, https://doi.org/10.1016/j.landurbplan.2021.104046, IF=9.1.
13. Marsh, P., O Diekmann, L., Egerer, M., Lin, B., **Ossola**, A., Kingsley, J., 2021. Where Birds Felt Louder: gardens as refuges during COVID-19. Wellbeing, Space & Society, 2: 100055, https://doi.org/10.1016/j.wss.2021.100055
14. **Ossola**, A., Lin, B., 2021. Making Nature-Based Solutions "climate-ready" for the 50°C world. Environmental Science and Policy, 123: 151-159, https://doi.org/10.1016/j.envsci.2021.05.026, IF=6.0.
15. Lin, B., **Ossola**, A., Ripple, W., Alberti, M., Andersson, E., Bai, X., Dobbs, C., Elmqvist, T., Evans, K.L., Frantzeskaki, N., Fuller, R., Gaston. K.J., Haase, D., Jim, C.Y., Konijnendijk, C., Nagendra, H., Niemelä, J., McPhearson, T., Moomaw, W.R., Parnell, S., Pataki, D., Tan, P.Y., 2021. Integrating solutions to adapt cities for climate change. The Lancet Planetary Health, 5(7): e479–e486, https://doi.org/10.1016/S2542-5196(21)00135-2, IF=25.7.
16. **Ossola**, A., Hoeppner, J.M., Burley, H., Gallagher, R.V., Beaumont, L.J., Leishman, M.R., 2020. The Global Urban Tree Inventory: A database of the diverse tree flora that inhabits the world's cities. Global Ecology and Biogeography, 29:1907-1914. https://doi.org/10.1111/geb.13169, IF=6.9.
17. **Ossola**, A., Locke, D., Lin, B., Minor, E., 2019. Yards increase forest connectivity in urban landscapes. Landscape Ecology. 34, 2935–2948. https://doi.org/10.1007/s10980-019-00923-7, IF=5.2.
18. **Ossola**, A., Locke, D., Lin, B., Minor, E., 2019. Greening in style: Urban form, architecture and the structure of front and backyard vegetation. Landscape and Urban Planning, 185: 141-157. https://doi.org/10.1016/j.landurbplan.2019.02.014, IF=9.1.
19. **Ossola**, A., Egerer, M., Lin, B., Rook, G., Setälä, H., 2018. Lost food narratives can grow human health in cities. Frontiers in Ecology and the Environment, 16(10): 560-562. https://doi.org/10.1002/fee.1977, IF=10.3.
20. Lin, B., Egerer, M., **Ossola**, A., 2018. Urban gardens as a space to engender biophilia: Evidence and ways forward. Frontiers in the Build Environment, vol.4, art.79. https://doi.org/10.3389/fbuil.2018.00079.
21. **Ossola**, A., Niemelä, J., 2018. Urban Biodiversity: from Research to Practice. Routledge, London and New York. ISBN: 9781138224391.

MICHAEL R. SPRINGBORN

Professor – Department of Environmental Science & Policy
University of California, Davis

APPOINTMENTS

2022- **Full Professor**, University of California, Davis
2015-2022 **Associate Professor**, University of California, Davis
2008-2015 **Assistant Professor**, University of California, Davis

EDUCATION

Ph.D. **Environmental Science and Management** (2008)
Economics and Environmental Science Training Program
Donald Bren School of Environmental Science and Management University of California, Santa Barbara

M.A. **Economics**, University of California, Santa Barbara (2004)
B.A. **Psychology**, University of Colorado, Boulder (1999)

AREAS OF SPECIAL INTEREST

Environmental and resource economics, biodiversity and human health.

SYNERGISTIC ACTIVITIES: I have worked on several research projects on economics and human health, including the impacts of disease and feedbacks from shocks to local biodiversity. Since 2021 I have worked as a co-PI on an NSF-funded project on management strategy for kelp restoration under climate uncertainty. More generally, I've worked on numerous interdisciplinary marine management research projects (resulting in publications listed below) and participated as a member of seven interdisciplinary research groups at various NSF-funded centers (NCEAS, NIMBioS, and SESYNC).

SELECTED JOURNAL PUBLICATIONS

Highlighted:

- Joakim A. Weill, Matthieu Stigler, Olivier Deschenes and Michael R. Springborn. Researchers' degrees of flexibility: Revisiting COVID-19 policy evaluations. **Economic Inquiry**. *Provisionally accepted*.
- [36] Michael R. Springborn, Joakim A. Weill, Karen R. Lips, Roberto Ibáñez, and Aniruddha Ghosh. Amphibian Collapses Increased Malaria Incidence in Central America. ***Environmental Research Letters***, 2022, 17(10).
- Jack H. Buckner, Gerardo Chowell and Michael R. Springborn. Dynamic Prioritization of COVID-19 Vaccines When Social Distancing is Limited for Essential Workers. ***Proceedings of the National Academy of Sciences***, 118(16), 2021.
- Joakim A. Weill, Matthieu Stigler, Olivier Deschenes, and Michael R. Springborn. Social Distancing Responses to COVID-19 Emergency Declarations Strongly Differentiated by Income. ***Proceedings of the National Academy of Sciences***, 117(33), 19658–19660, 2020.
- Matthew MacLachlan, Michael R. Springborn and Paul Fackler. Learning about a moving target in resource management: Optimal Bayesian disease control. ***American Journal of Agricultural Economics***, 99(1), 140–162, 2017.

Additional:

- Appilineni Kushal, Michael Springborn, and Fernanda Valdovinos. Assessing Impacts of Bycatch Policies and Fishers' Heterogeneous Information on Food Webs and Fishery Sustainability. **Philosophical Transactions of the Royal Society B**. 379(1909), 2024.
- Pierce Donovan and Michael R. Springborn. Balancing conservation and commerce: A shadow value viability approach for governing bycatch. ***Journal of Environmental Economics and Management***, 114, 2022.
- Matthew J. MacLachlan, Andrew M. Liebhold, Takehiko Yamanaka, and Michael R. Springborn. Hidden patterns of insect invasion risk revealed from two centuries of alien species discoveries. ***Science Advances***, 7(44), 2021.
- Michael R. Springborn, Amanda Faig, Allison Dedrick and Marissa Baskett. Beyond biomass: valuing genetic diversity in natural resource management. ***American Journal of Agricultural Economics***, 102(2), 607-624, 2020.
- Michael R. Springborn and Amanda Faig. Moving forward: a simulation-based approach for solving dynamic resource management problems. ***Marine Resource Economics***, 34(3), 199-224, 2019.
- Pierce Donovan, Lucas Bair, Charles B. Yackulic and Michael R. Springborn. Safety in numbers: cost-effective endangered species management for viable populations. ***Land Economics***, 95(3), 435-453, 2019.
- Jacob LaRiviere, David Kling, James Sanchirico, Charles Sims and Michael R. Springborn. Characterizing Uncertainty and Learning in the Economics of Resource and Environmental Management. ***Review of Economics and Environmental Policy***, 12(1), 92-112, 2018
- Michael R. Springborn. Risk aversion and adaptive management: insights from a multi-armed bandit model of invasive species risk. ***Journal of Environmental Economics and Management,*** 68(2), 226–242, 2014.

SELECTED EXTRAMURAL FUNDING

- *Accelerating Bull Kelp Ecosystem Recovery in a Recently Deforested Site in Northern California by Using a Strategic Sequence of Restoration Techniques & Community Participation.* California Sea Grant, 2024-2026 ($1,600,000), co-PI.
- *DISES: Between maintenance and transformation: a socio-environmental systems framework for restoration decision-making under climate change.* National Science Foundation, 2021-2026 ($1,599,937), co-PI.
- *Risks of Animal and Plant Infectious Diseases Through Trade (RAPID Trade).* National Science Foundation, 2014-2018 ($1,450,000), co-PI.
- *Modeling Anthropogenic Effects in the Spread of Infectious Disease*. National Institutes of Health, 2011-2014 ($1,600,000), co-PI.
- *Quantifying Demographic Differences in Social Distancing and Impacts of COVID-19 Across the U.S.* University of California—Emergency COVID-19 Research Seed Funding, 2020 ($24,889), PI.

BIOGRAPHICAL SKETCH

NAME: Hertz-Picciotto, Irva

POSITION TITLE: Distinguished Professor, Department of Public Health Sciences Director, Environmental Health Sciences Center

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE	Completion Date	FIELD OF STUDY
University of California, Berkeley			
College of Letters and Science	B.A.	6/1970	Mathematics
School of Public Health	M.P.H.	6/1984	Epidemiology
School of Public Health	M.A.	6/1985	Biostatistics
School of Public Health	Ph.D.	1/1989	Epidemiology

Personal Statement

Dr. Hertz-Picciotto, Director, Environmental Health Sciences Core Center (EHSC) *THREE*: ***T***owards ***H***ealth, ***R***esilience and ***E***nvironmental ***E***quity; Professor, Department of Public Health Sciences; and Chief, Division of Environmental and Occupational Health, UC Davis School of Medicine, is an internationally recognized environmental epidemiologist with continuous NIH funding for 30+ years. She has over 380 peer-reviewed publications on environmental exposures and their health effects in pregnancy, the newborn, children and adults. She has published on epidemiologic methods to improve validity of observational research. Since 2002, she has led a pioneering research program on environmental etiology of autism and other neurodevelopmental disorders, identified myriad risk and protective factors—findings now well replicated; and jumpstarted the field of non-genetic causes for autism. In 2015, she initiated the EHSC Center *THREE*, which now brings together dozens of faculty from six Schools and Colleges. Its mission is to advance understanding of environmental impacts on health & development, and, through community collaborations, to translate research into policies and practices that improve public health. The Center has two focus regions in the State: Northern California, the epicenter of mega-fires that have encroached into the Wildland-Urban-Interface (WUI), and the California Central Valley, home to a large Latinx population, the highest particulate air pollution in the country, extreme temperatures in summer, and high rates of asthma and respiratory conditions.

Climate change: More than 30 years ago, Dr. Hertz-Picciotto co-authored the first report on climate change and health, "Human health: Analysis of Climate Related to Health." (see Ten top publications #1). When wildfires in 2017 devastated several communities in northern California, she returned to this topic and received a Time-Sensitive R21 grant to launch ***"What-Now, CA?"*** (***W***ildfires and ***H***ealth: ***A***ssessing the ***T***oll in ***No***rthern ***Ca***lifornia), a longitudinal cohort study of wildfires, to understand acute and long-term impacts on health and well-being. Under her leadership, the EHSC has funded over a dozen pilot projects on wildfires and health.

Professional accomplishments: Dr. Hertz-Picciotto chaired five National Academy of Sciences, and Institute of Medicine panels, including "Breast Cancer and the Environment" (2010-2011) and "Vietnam Veterans and Agent Orange" (2017-2018). She served as president for two of the largest professional epidemiology societies (SER and ISEE) and on numerous scientific advisory boards including for U.S. EPA (Environmental Protection Agency), NIEHS National Toxicology Program, California Air Resources Board (CARB) Research Screening Committee (2007-2014) and California's Prop 65 Carcinogen Identification Committee, and currently serves on the Prop 65 DARTIC: Developmental and Reproductive Toxicant Identification Committee. She has sat on editorial boards for the *American Journal of Epidemiology*, *Epidemiology, Environmental Health Perspectives*, and *Autism Research.* In 2011, she received the International Society of Environmental Epidemiology's Goldsmith Award for Sustained and Outstanding Contributions to Environmental Epidemiology.

Community Partnerships and Policy: Since 1992, she has partnered with numerous community organizations on research projects driven by community needs, such as the COVID19 testing program designed to overcome barriers in Latinx communities in four counties of California: we brought together ten community organizations and four UC Davis Centers. She has actively collaborated with community leaders in translating

scientific evidence for policy-makers, for example, on pesticides and child development to California legislative hearings, gubernatorial briefings, and Congressional hearings, which resulted in withdrawal of chlorpyrifos from uses in California. She co-founded Project TENDR (Targeting Environment and Neuro- Developmental Risks), which includes members from advocacy organizations such as Earthjustice and Natural Resources Defense Council, and presents, in plain language for governmental representatives and staff, results of research that supports evidence-based policy changes at the national and state levels.

Contribution and Role on this Project: Dr. Hertz-Picciotto will serve as co-investigator, will attend regular meetings, and will advise Dr. James, the PI, throughout the project, as needed and appropriate. Dr. Hertz- Picciotto brings 30+ years of environmental health research experience, expertise in epidemiologic methods for study design and analysis, a strong track record in developing collaborative research teams, broad understanding of California's agencies, the scope of the State's climate change policies particularly the California landscape (figuratively and literally) with regard to adaptations, and a lengthy history of research partnering with Environmental Justice communities (See "Community Partnerships and Policy" above). As a senior scientist and Center Director, she can also serve as a liaison to the UC Davis School of Medicine Dean, the Clinical and Translational Sciences Center Director, and other senior leadership across several Colleges and Schools, including the Vice Chancellor for Human Health Sciences and the Vice Chancellor for Research.

Employment:

2020-2024	National Advisory Environmental Health Sciences Council
2019-	California Governor's Developmental and Reproductive Toxicant Identification Committee (DARTIC) for Proposition 65
2017-2018	NASEM (National Academy of Sciences, Engineering & Medicine), Chair, Panel on Vietnam Veterans and Agent Orange
2016-	MPI, UC Davis ECHO (Environmental Influences on Child Health Outcomes)-ReCHARGE Cohort study
2015-	Director, NIEHS Environmental Health Sciences Core Center at University of California Davis
2014-2019	Director, Biostatistics, Bioinformatics and Research Design Core, UC Davis MIND Intellectual and Developmental Disabilities Research Center (IDDRC)
2011-	Director, Program in Environmental Epidemiology of Autism and Neurodevelopment, MIND Institute
2011-2023	Vice Chair for Research, Department of Public Health Sciences
2007-2012	Director, Northern California Collaborative Center for the National Children's Study
2006-	Chief, Division of Environmental and Occupational Health, Dept Pub Health Sciences, UC Davis
2006-2011	Deputy Director, Center for Children's Environmental Health, UC Davis
2002-	Professor, Department of Public Health Sciences, UC Davis;
1999-04	Professor, Department of Epidemiology, School of Public Health, UNC, Chapel Hill, NC
1995-98	Associate Professor, Department of Epidemiology, School of Public Health, UNC, Chapel Hill
1990-95	Assistant Professor, Department of Epidemiology, School of Public Health, UNC, Chapel Hill
1989-90	Asst. Research Epidemiologist, Dept Biomedical & Environmental Health Sciences, UC Berkeley
1988-89	Epidemiologist, California Dept. Health Services (now: Dept Public Health), Berkeley, CA
1985-88	Environmental Health Statistician, Calif. Public Health Foundation, Berkeley, CA
1985-87	Staff Research Associate, Occupational Health Unit, Dept. Internal Medicine, Univ Calif, Davis, CA
1983-84	Research Associate, Lawrence Berkeley Laboratory, Division of Biology & Medicine, Berkeley, CA
1974-82	Mathematics Instructor: Berkeley Unified School District and Urban School of San Francisco, CA

Honors, Awards, Professional Service & Honorary Lectures

RESEARCH Impact: Hertz-Picciotto ranked in the top 6 faculty for NIH funding in Public Health Sciences, according to the **Blue Ridge Rankings,** for *eight consecutive years (2015-2022)*.

Listed in World's Top 1000 Female Scientists by Research.com: Hertz-Picciotto, I. *November 2022*
https://research.com/scientists-rankings/best-female-scientists
Invited speaker: The American Association for Child and Adolescent Psychiatry, October 2020

Keynote speaker: The International Association for the Scientific Study of Intellectual and Developmental Disabilities (IASSIDD), Melbourne, Australia, August 2016

Keynote speaker: International Meeting for Autism Research (IMFAR), Baltimore, MD, May 2016 Keynote speaker: The Gatlinburg Conference on Intellectual and Developmental Disabilities, March 2016

Goldsmith Lifetime Achievement Award by the International Society for Environmental Epidemiology 2011 Chair, Institute of Medicine Committee on Breast Cancer and the Environment, 2010-2011

Chair, Expert Panel on CDC's Vaccine Safety Database for Studies of Autism and Thimerosal, 2006 Keynote speaker: 2nd Annual National Environmental Public Health Tracking Conference, 2005, Atlanta NCI Distinguished Lecturer in Occupational and Environmental Cancer, National Cancer Institute 2004 Chair, National Academy of Sciences/Institute of Medicine Panels on Agent Orange and Vietnam Veterans,

2002, 2004, and 2017-18

Boards of Editors (past & present): *Epidemiology*, *American Journal of Epidemiology*, *Environmental Health Perspectives*, *Autism Research, Environment International*

President, Society for Epidemiologic Research, 2004-2005

President, International Society for Environmental Epidemiology, 2001-2002 NAS/NRC Lifetime Appointment as National Associate of the National Academies

Abraham Lilienfeld Student Prize Paper, best dissertation, Society for Epidemiologic Research, June 1988

Citations – Spotlight Publications on Climate and the Impact on Human Health:

a. White, MR and **Hertz-Picciotto, I**. Human health: analysis of climate related to health. In: MR White (ed), *Characterization of Information Requirements for Studies of CO_2 Effects: Water Resources, Agriculture, Fisheries, Forests and Human Health*. DOE/ER-0236, U.S. Department of Energy, Washington, D.C., 1985.
b. Towe-Goodman N, McArthur KL, Willoughby M, et al. and Environmental Influences on Child Health Outcomes program collaborators. Green Space and Internalizing or Externalizing Symptoms Among Children. *JAMA Netw Open*. 2024 Apr 1;7(4):e245742. doi: 10.1001/jamanetworkopen.2024.5742. PMID: 38598238; PMCID: PMC11007572.
c. **Hertz-Picciotto I,** California Wildfires: Mental and Physical Health, Unmet Needs, and Future Directions. *ISEE (International Soc Environmental Epidemiology)* Symposium 2023, Athens Greece
d. Rubino F, Raffuse S, O'Neill SM, Reid S, Jia Y, Zou Y, Schmidt RJ, Kenyon NJ, **Hertz-Picciotto I**. Northern California 2017 Wildfires, respiratory health and racial disparities. (In review)
e. Snyder M, Miles M, **Hertz-Picciotto I**, et al. Household Needs Among Wildfire Survivors in the 2017 Northern California Wildfires. *Environmental Research: Health* doi: 10.1088/issn.2752-5309. *Under Review*

Other Contributions to Science

Studies of air pollution have primarily addressed asthma in children and adults, or bronchitis and cancer in adults. A few papers examined infant deaths or birthweight. My pioneering work into immune biomarkers and non-asthmatic respiratory conditions (b,c) in the Czech Childhood Health and Air Pollution Study contributed to emergence of immunotoxicity in environmental epidemiologic studies (a). Our equally novel findings that prenatal *air pollutant exposures were linked with autism (d)*, have been widely replicated, although null findings have also been reported, and confounding from social factors cannot be precluded.

a. **Hertz-Picciotto I**, Herr CEW, Yap P-S, et al. Air pollution and lymphocyte phenotype proportions in cord blood. *Environmental Health Perspectives*. 2005. 113(10): 1391-1398. PMID: 16203253.PMCID: PMC1281286

b. **Hertz-Picciotto I**, Baker RJ, Yap P-S, et al. Early childhood lower respiratory illness and air pollution. *Env Health Perspect* 2007 Oct;115(10):1510-8. PMID:17938744. PMCID: PMC2022654

Complete Publication List in MyBibliography: http://www.ncbi.nlm.nih.gov/pubmed/?term=irva+hertz-picciotto

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Noli Brazil

eRA COMMONS USER NAME (credential, e.g., agency login): nbrazil POSITION TITLE: Associate Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of California, Berkeley, Berkeley, CA	BS	05/2003	Business Administration
Stanford University, Palo Alto, CA	MS	06/2007	Statistics
University of California, Berkeley, Berkeley, CA	Ph.D.	05/2013	Demography

A. Personal Statement

I earned my PhD in Demography in 2013 from the University of California, Berkeley. I was a Postdoctoral Associate at the Center for Research on Inequalities in the Life Course at Yale University from 2013 to 2015 and a Postdoctoral Fellow at the Spatial Sciences Institute at the University of Southern California from 2015 to 2017. Between 2017 and 2023, I was an Assistant Professor in the Department of Human Ecology at the University of California, Davis, and am currently an Associate Professor. My research focuses on revealing understudied patterns, causes, and consequences of neighborhood inequality in cities. I examine spatial inequality across multiple ecological dimensions, including transportation, health, environmental, education, and crime. The rationale driving this comprehensive and transdisciplinary approach is the perspective that environmental sustainability is shaped by multiple ecological factors and, in turn, shape multiple outcomes, such as health and well-being. Furthermore, I examine how pathways linking place to well-being are stratified by neighborhood racial composition, and are shaped by broader structural factors such as residential segregation. Such a comprehensive approach requires collaboration across multiple fields, the use of a wide set of tools and methods, and the melding of theoretical perspectives from various disciplines. I have collaborated with scholars from a wide range of disciplines, including Geography, Public Health, Sociology, Economics, Planning, Criminology and Demography. I employ a quantitative approach to studying social inequality, relying on datasets from traditional (e.g. U.S. Census) and nontraditional (e.g. cell phone pings) sources and employing a toolkit of statistical methods drawn from a variety of disciplines, including formal demography, econometrics, spatial data science, and social network analysis. I have been the PI or Co-PI for seven grants from a variety of institutions, including Russell Sage Foundation, Spencer Foundation, the State of California, and the National Science Foundation. In short, I have both scientific and technical expertise as well as leadership skills necessary to carry out the proposed work.

Bastomski, S., Brazil, N., & Papachristos, A. V. (2017). Neighborhood co-offending networks, structural embeddedness, and violent crime in Chicago. *Social Networks*, *51*, 23-39.

Brazil, N. (2022). Environmental inequality in the neighborhood networks of urban mobility in US cities. *Proceedings of the National Academy of Sciences*, *119*(17), e2117776119.

Brazil, N. (2022). The multidimensional clustering of health and its ecological risk factors. *Social science & medicine*, *295*, 113772.

Brazil, N., Chakalov, B. T., & Ko, M. (2024). The health implications of neighborhood networks based on daily mobility in US cities. *Social Science & Medicine*, *354*, 117058.

B. Positions, Scientific Appointments, and Honors

Positions and Employment

2023- Associate Professor, Department of Human Ecology, University of California, Davis 2017-2023 Assistant Professor, Department of Human Ecology, University of California, Davis 2015-2017 Postdoctoral Scholar, Spatial Sciences Institute, University of Southern California 2013-2017 Postdoctoral Associate, Center for Research on Inequalities and the Life Course, Yale

University

Honors

2022 National Institutes of Health OBSSR Matilda White Riley Early Stage Investigator 2011 Outstanding Graduate Student Instructor Award, University of California, Berkeley

C. Contributions to Science

1. I have conducted several interrelated studies examining how public schools influence neighborhood processes and outcomes. Using data on a nationally representative sample of adolescents, I found that ignoring either school or neighborhood context biases estimates of neighborhood and school effects on key adolescent outcomes. Despite these interdependencies, I found that of the over 200 school and neighborhood effects studies I reviewed, only 21% accounted for both neighborhoods and schools in their analyses (Brazil, 2016). In a study examining the neighborhood characteristics of school closures, I found closures are typically located in neighborhoods with lower percent White and Hispanic, and higher percent Black and socioeconomic disadvantage (Brazil and Candipan, 2022). Given these associations, school closures have the potential for widening racial and socioeconomic gaps if they negatively impact neighborhoods. In an analysis of public school closures occurring between 2000 and 2010 in metropolitan areas, I found that closures decreased local property values, with larger decreases occurring in neighborhoods with a greater presence of Black residents (Brazil, 2019). In a study exploiting a natural experiment in Chicago, which experienced the largest public school closure in U.S. history in 2013, I found that school closures are associated with increased crime rates in the neighborhood (Brazil, 2020).

Brazil, N., & Candipan, J. (2022). The neighborhood ethnoracial and socioeconomic context of public elementary school closures in US metropolitan areas. *Social Science Research*, *103*, 102655.

Candipan, J., & Brazil, N. (2022). The neighborhood context of school openings: Charter school expansion and socioeconomic ascent in the United States. *Journal of Urban Affairs*, *44*(9), 1244- 1269.

Brazil, N. (2020). Effects of public school closures on crime: The case of the 2013 Chicago mass school closure. *Sociological Science*, *7*, 128-151.

Brazil, N. (2016). The effects of social context on youth outcomes: Studying neighborhoods and schools simultaneously. *Teachers College Record*, *118*(7), 1-30.

2. I wanted to expand on my Ph.D. work by examining other processes that contribute to neighborhood inequality, and in turn, the impacts of neighborhood inequality on other outcomes. As such during my postdoctoral fellowship at Yale University, I set out to extend the literature linking neighborhood conditions to local crime and enforcement through a number of interrelated studies. First, despite the significant decrease in crime rates in the United States since their peak in the mid-1990s, violent crime remains disturbingly higher in economically disadvantaged areas of cities, many of which have violent crime rates that are significantly higher than the national average (Papachristos, Brazil and Cheng, 2018). Second, we found that criminal social networks connect neighborhoods across long distances and neighborhoods socially embedded within a community of high-crime neighborhoods experience higher rates of violence (Bastomski, Brazil and Papachristos, 2017). Third, in a solo-authored project conducted after my time at Yale, I found that potential bias in law enforcement is not relegated to police violence and arrests, but also applies to more innocuous, everyday governance such as forfeitures and parking tickets (Brazil, 2020).

Brazil, N., & Portier, A. (2022). Investing in gentrification: The eligibility of gentrifying neighborhoods for federal place-based economic investment in US cities. Urban Affairs Review, 58(5), 1234- 1276.

Brazil, N. (2020). The unequal spatial distribution of city government fines: The case of parking tickets in Los Angeles. Urban Affairs Review, 56(3), 823-856.

Papachristos, A. V., Brazil, N., & Cheng, T. (2018). Understanding the crime gap: Violence and inequality in an American city. City and Community, 17(4), 1051-1074

Bastomski, S., Brazil, N., & Papachristos, A. V. (2017). Neighborhood co-offending networks, structural embeddedness, and violent crime in Chicago. Social Networks, 51, 23-39.

3. In working towards the broader goal of characterizing the multidimensional nature of neighborhood inequality that drives my research trajectory, I began examining the relationship between neighborhood conditions and transportation access during my postdoctoral fellowship at the Spatial Sciences Institute in the University of Southern California.

Morrison, C. N., Kirk, D. S., Brazil, N. B., & Humphreys, D. K. (2022). Ride-Hailing and Road Traffic Crashes: A Critical Review. American journal of epidemiology, 191(5), 751-758.

Brazil, N., & Kirk, D. (2020). Ridehailing and alcohol-involved traffic fatalities in the United States: The average and heterogeneous association of uber. PLoS one, 15(9), e0238744.

Kirk, D. S., Cavalli, N., & Brazil, N. (2020). The implications of ridehailing for risky driving and road accident injuries and fatalities. Social Science & Medicine, 250, 112793.

Brazil, N., & Kirk, D. S. (2016). Uber and metropolitan traffic fatalities in the United States. American journal of epidemiology, 184(3), 192-198.

4. The next phase in my research trajectory aims to expand current conceptualizations of neighborhood inequality by looking beyond the neighborhoods that individuals live in. Neighborhood effects studies have made clear that residential neighborhoods impact the health and well-being of its residents. This research restricts processes of neighborhood influence to operate only within and between geographically contiguous neighbors. However, we are underestimating the role of neighborhood conditions in explaining inequality if disadvantage extends beyond the residential environment into a network of neighborhoods spanning the urban landscape based on where residents move within a city. My current work uses cell phone location data for over 40 million devices in the United States to track the neighborhoods that residents visit over the course of the year for work, errands and leisure, the neighborhood conditions that residents are exposed to as they travel across these networks, and variation in these outcomes across neighborhood race/ethnicity and socioeconomic status. As a pre-cursor to this project, I published a paper showing that counties both near and far that are connected via migration flows share similar health factors and well-being outcomes (Brazil, 2022). This paper received the National Institutes of Health OBSSR Matilda White Riley Early Stage Investigator award. In a paper published in the *Proceedings of the National Academy of Sciences*, I next examined network exposure to neighborhood air pollution levels for the 88 most populous cities in the US. Findings indicate that racial and socioeconomic inequality in air pollution exposure extends beyond the residential neighborhood to the neighborhoods that residents visit (Brazil, 2022). A recently published paper found that socioeconomic advantage levels in neighborhood networks differ from the levels at the residential and adjacent scales across all ethnoracial neighborhoods.

Bastomski, S., Brazil, N., & Papachristos, A. V. (2017). Neighborhood co-offending networks, structural embeddedness, and violent crime in Chicago. Social Networks, 51, 23-39.

Brazil, N. (2022). Environmental inequality in the neighborhood networks of urban mobility in US cities. Proceedings of the National Academy of Sciences, 119(17), e2117776119.

Brazil, N. (2022). The multidimensional clustering of health and its ecological risk factors. Social science & medicine, 295, 113772.

Brazil, N., Chakalov, B. T., & Ko, M. (2024). The health implications of neighborhood networks based on daily mobility in US cities. Social Science & Medicine, 354, 117058.

BIOGRAPHICAL SKETCH

NAME: London, Jonathan K

eRA COMMONS USER NAME (credential, e.g., agency login): JKLONDON POSITION TITLE: Professor

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Brown University	B.A.	06/1991	Environmental Studies
University of California, Berkeley	M.C.P.	06/1995	City and Regional Planning
University of California, Berkeley	Ph.D.	12/2001	Rural Sociology and Geography

A. Personal Statement

As a social scientist, I study the complex dynamics of conflict and collaboration between leaders in advocacy, policy, and research sectors, with a particular focus on rural regions. In particular, I study environmental justice and the racialized distribution of environmental health hazards in disadvantaged places and populations and the ways in which EJ social movements organize grassroots, legal, and scientific resources to contest these injustices. My recent work has focused on air quality, pesticides, and drinking water problems in rural farmworker communities, controversies over soil lead and urban gardens, and the development of interactive on-line mapping platforms for analyzing and communicating EJ issues. I pursue this research through an engaged-scholarship approach based on mutual learning and benefit between university and community partners. I also work extensively with scholars from a wide range of disciplines including ecology, public health, engineering, environmental design, law, education, and the humanities. I was the founding director for the Center for Regional Change at UC Davis, an applied policy-oriented research institute dedicated to building healthy, prosperous, sustainable, and equitable regions in California and beyond. I am now lead for the Community Engagement Core for the UC Davis Environmental Health Science Center linking environmental health scientists with community organizations and public agencies to inform solutions for pressing environmental justice and health equity issues. I have over 30 years of experience in community-based participatory action research throughout California, as well as in Nepal, South Africa, and Russia.

B. Major Projects

I have led two major policy evaluation studies of an innovative California law (AB 617) intended to improve air quality in disadvantaged and over-burdened communities. This role includes extensive collaboration with community-based environmental justice and health equity organizations, state and regional public agencies and interdisciplinary research teams.

The California Wellness Foundation London (PI) 09/01/22-08/31/24 Assessing the Impacts of Community-based Air Quality Monitoring and Management

Robert Wood Johnson Foundation London (PI) 09/01/20-08/31/23 Assessing the Impacts of Community-based Air Quality Monitoring and Management

California Resources Agency, Co-PI (7/1/2018-9/1/2024)

I have played leadership roles in a multi-year applied research project focused on socio-ecological revitalization of a low-income and over-burdened rural region of California. I have led the production of socio- economic studies of community-wellbeing as well as extensive collaboration and engagement with Tribes in the region.

As Faculty Director of the Community Engagement Core of the UC Davis Environmental Health Sciences Core Center I facilitate multi-directional learning between center researchers and community leaders. This involves inter-disciplinary collaboration, facilitating productive engagement with community and policy leaders and training and capacity building for both community and academic partners in Community-Based Participatory Action Research.

NIH/NIEHS P30 ES023513 Hertz-Picciotto (PI/Director) 06/15/20-03/31/25 UC Davis Environmental Health Sciences Core Center

C. Positions, Scientific Appointments, and Honors

Positions and Scientific Appointments

2023-present Program Director, Community and Regional Development

2022-2023 Vice Chair, Scholarship and Space, Department of Human Ecology 2022-present Professor, Department of Human Ecology

2018-2019 Vice Chair: Department of Human Ecology

2016-present Director, Community Engagement Core, Environmental Health Science Core Center 2015-2022 Associate Professor, Department of Human Ecology

2015-2019 Chair, Community Development Graduate Group 2008-2014 Assistant Professor, Department of Human Ecology

2007-2021 Founding Faculty Director, Center for Regional Change

Honors

2024UC Davis Teaching for Global Learning Faculty Award 2020-2024 Robert Wood Johnson Interdisciplinary Research Leaders

2023Community Development Graduate Group Faculty of the Year 2020 UC Davis Senate Award for Scholarly Public Service

D. Contributions to Science

1. **New methods to measure cumulative environmental and social vulnerability:** I have made substantial contributions to the development of new socio-spatial methodologies utilized to analyze and map the distribution of environmental hazards and social vulnerability through my team's creation of an approach called Cumulative Environmental Vulnerability Assessment (CEVA). In contrast to reductionist chemical-by-chemical risk analyses, CEVA measures the clustering and layering of multiple environmental hazards (e.g., pesticides, toxic waste, air and water pollution) in and around communities with high degrees of social vulnerability (e.g., those highly segregated by race, ethnicity and class). By providing a method to visualize socio-spatial patterns of environmental injustice, CEVA provides a potent way for EJ movement organizations, public agencies, foundations and others to identify the people and places in greatest need for protections and to build collaborative approaches to achieve these ends. This methodology has influenced the development of California's own cumulative environmental impacts methodology and has been incorporated into numerous local and regional plans for sustainable and healthy communities.
   a. Huang G, **London J**. Cumulative Environmental Vulnerability and Environmental Justice in California's San Joaquin Valley. *International Journal of Environmental Research and Public Health* 2012 May;9(5):1593-1608. PMCID: PMC3386574
   b. Huang G, **London J**. Mapping in and out of "messes": An adaptive, participatory, and transdisciplinary approach to assessing cumulative environmental justice impacts. *Landscape and Urban Planning* 2016 Oct;154:57-67. doi: 10.1016/j.landurbplan.2016.02.014

2. **Critical environmental justice studies:** My research intervenes in a growing body of work based on theoretical and empirical engagements with environmental justice (EJ) social movements and their institutional and scientific contexts. In particular, my work seeks to fill a crucial gap in social movement studies in the fields of sociology and human geography. Much of the existing scholarship presents social movements, state, and scientific institutions as largely autonomous entities that contend with and accommodate each other, but do not shape each other in discursive and material ways. In contrast, I argue that what is most compelling about EJ movements is the way in which they are provoking major transformations in the ways in which environmental and social policies are developed and implemented at

local, state, national and international levels. In particular, my research demonstrates that EJ movements are 1) producing new forms of environmental citizenship in which historically marginalized populations are achieving unprecedented political agency and impact, 2) provoking distinct dynamics of conflict and collaboration between these populations and public agencies, and 3) encouraging new scientific methodologies to measure and map environmental injustices.

   b. **London J**, Sze J, Cadenasso M. Transdisciplinary Conversations in Environmental Justice Studies. In: Holifield R, Walker G, Chakraborty J (Eds.) Environmental Justice Handbook. New York: Routledge Press, 2017.
   c. **London J**, Cutts BB, Schwarz K, Schmidt L, Cadenasso ML. Unearthing the entangled roots of urban agriculture. *Agriculture and Human Values* 2020 Nov;38:205-220. doi: 10.1007/s10460-020-10158-x

3. **States, social movements, and scientists in environmental justice conflicts:** My research on the dynamics of conflict and collaboration in environmental governance has made important contributions to the EJ literature by examining the factors that shape the contentious relationships between state, social movement and scientific actors. The puzzle I seek to solve is why policy and planning processes intended to resolve conflicts over environmental and natural resources tend to produce, reproduce, and even exacerbate these conflicts. I place particular emphasis on the scale of the policy forum and the resource in question, the public participation models, and the broader political economic and social contexts of the policy processes. I argue that, without these, using analytical frameworks the patterns of conflict and collaboration will seem irrational and idiosyncratic with little to offer to theorizing about race, space, and the production of environmental injustice.
   a. **London JK**, Fencl AL, Watterson S, Choueiri Y, Seaton P, Jarin J, Dawson M, Aranda A, King A, Nguyen P, Pannu C, Firestone L, Bailey C. Disadvantaged Unincorporated Communities and the Struggle for Water Justice in California. *Water Alternatives* 2021; 14(2):520-545. https://scholarship.law.columbia.edu/faculty_scholarship/3598
   b. **London JK**, Harrison JL. From environmental justice activist to agency staff: Implications for agencies, movement organizations, and these insider allies. *Environmental Justice* 2021 Oct;14(5):338-344. doi: 10.1089/env.2021.0011
   c. MacIver L, **London JK**, Sampson N, Gordon M, Grow R, Eady V. Owning Our Air: Lessons from West Oakland's Engagement with AB 617 for Addressing Structural Environmental Racism. *American Journal of Public Health* 2022;112:262-270.

4. **Community-based participatory action research:** I have both practiced and studied the processes of engaging grassroots communities and organizations around collaborative research to address pressing community concerns.
   a. **London J**, Zagofsky T, Huang G, Saklar J. Collaboration, Participation and Technology: The San Joaquin Valley Cumulative Health Impacts Project. *Gateways: International Journal of Community Research and Engagement. Special Edition: Sustaining Community - University Partnerships* 2011;4: 12-30. doi: 10.5130/ijcre.v4i0.1780
   c. **London JK**, Haapanen KA, Backus A, Mack SM, Lindsey M, Andrade K. Aligning Community-Engaged Research to Context. *International Journal of Environmental Research and Public Health* 2020 Feb;17(4): 1187. PMCID: PMC7068394
   d. Haapanen KA, **London JK**, Andrade K. Creating the Current and Riding the Wave: Persistence and Change in Community-Engaged Health Sciences Research. *Social Sciences* 2023 May;12(5):312. doi: 10.3390/socsci12050312

5. **International development:** I have applied my expertise in rural community development in a range of international contexts over the past 30 years. My major region of work has been Nepal, drawing on collaborative projects with Nepalese students and colleagues. My most recent work stems from my co-developing an award-winning bi-national learning exchange in Nepal called Community, Technology and Sustainability in Nepal.
   a. Erbstein N, **London JK**, Poudel B, Katwal S. Authentic Collaboration and Active Commitment to Equity: An Evolving Case of Centering Marginalized Voices in Education Abroad. *Frontiers: The Interdisciplinary Journal of Study Abroad* 2022;34(2). doi: 10.36366/frontiers.v34i3.676

NAME: Capps, Shosha

eRA COMMONS USER NAME (credential, e.g., agency login): SACAPPS POSITION TITLE: Academic Coordinator; Community Engagement Core Co-Lead

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
College of Charleston, Charleston, SC	BS	05/2003	Political Science
University of California, Davis, CA	MS	06/2011	International Agricultural Development
University of California, Davis, CA	MS	06/2011	Community and Regional Development

A. Personal Statement

In my role as the Co-Lead of the UC Davis Environmental Health Sciences Center (EHSC)'s Community Engagement Core, I support a wide range of community stakeholders and academic researchers to design, conduct, and communicate community-driven and/or community-engaged research in the fields of Environmental Health, with a focus on environmental justice and collaborating with those communities across California experiencing the greatest exposure and health disparities. Dr. London and I share responsibility for the overall management and oversight of the Core, representing the Core on the Center Leadership Group, integrating the Core into the center as a whole, and ensuring the administrative and programmatic success of the core. My efforts are focused on (i) developing and maintaining networks of community-based organizations, academic researchers, and relevant public agencies to support university-community research collaboration; (ii) developing and conducting Community-Engaged Research, Translational Research, and Science Communications trainings; and (iii) integrating community research priorities across all Center activities.

I bring more than a decade of experience facilitating transdisciplinary community-university research partnerships with California communities experiencing health and environmental exposure disparities. Prior to joining the EHSCC in 2021, I served for 7 years as the research analyst at the University of California's Sustainable Agriculture Research and Education Program, a special program of UC Cooperative Extension. In that role I engaged small scale farmers and rural agricultural communities in the Sacramento and San Joaquin Valleys in policy-relevant research and educational convenings. I also bring expertise and commitment to facilitating organizational antiracism work in a university/research setting, including facilitating the Social Equity Committee at the UCD Agricultural Sustainability Institute for 5 years, co-founding the UC Division of Agriculture and Natural Resource's statewide Diversity, Equity, and Inclusion Alliance, and taking a leading role in facilitating the EHSCC's Anti-Racism Committee.

I am highly successful in facilitating collaborations focused on action-oriented, policy-relevant research addressing disparities experienced by low-income communities and communities of color. Throughout my career, I worked collaboratively with community organizations, academic researchers, and policymakers to help identify shared priorities, ask meaningful questions, and craft creative solutions. I am skilled in finding common ground across lines of difference, translating specialized and challenging content to diverse audiences, and applying an equity lens to all aspects of the research process.

Ongoing research support highlights:

Community-Engaged Research Training: I design and conduct an 8-hour Community Engaged Research training for the academic and community recipients of the UC Davis Environmental Health Sciences Center's Pilot Program each year, making significant revisions to content and materials for each cohort in response to feedback from previous participants. This includes creating new materials addressing research design, roles,

and data handling for community-university research teams, fiscal management of non-university partner payments, navigating the IRB process with a community partner, and recommendations on various forms of accessibility. I am also currently developing curriculum and programming for an upcoming year-long iteration of EHSC's Community Environmental Health Sciences Academy, in collaboration with community stakeholders and faculty. This program will focus on empowering mid-career nonprofit staff and community advocates to serve as equal partners on university research projects through education, mentorship, and relationship building with both established and early career academic researchers.

Another key role I play at UC Davis Environmental Health Sciences is developing and maintaining both formal and informal networks of community-based organizations, academic researchers, and relevant public agencies to support our efforts to connect faculty with stakeholders to build relationships and collaborations. One of the ways I do this is through developing and managing the EHSC **Community Advisory Committee** (CAC), which is the largest and most active of the Center's three formal advisory groups. In addition to planning and facilitating EHSC-CAC meetings twice a year in which CAC members help set Center strategic priorities, I have also made significant improvements to the management of CAC through an asset and needs assessment process that clarified member roles, revised committee structure to better align with member preferences, streamlined payments, and identified gaps in representation for new member recruitment. As a result, we have added new representatives in a number of key issues and geographic areas and increased overall engagement.

Another significant and ongoing undertaking during my tenure has been the expansion (2021) and revision (2022, 2023) of the UC Davis Environmental Health Sciences **Community Research Priorities**, which describe high priority, policy-relevant environmental health issues in San Joaquin Valley. I lead the process of collaborating with close to a dozen community stakeholders to ensure that the document includes key context for researchers, including current policy context, knowledge gaps, and stakeholder-generated research questions. I also worked with the academic researchers in in EHSC's Leadership Group to more closely align our stakeholders' priorities with NIEHS strategic plan and funding priorities. In 2022, our method for crafting Community Research Priorities was featured in the Partnerships for Environmental Public Health Research Center and presented at the National Institute for Environmental Health Sciences Annual Meeting.

Active research projects:

Toxic Metals Monitoring Regional Network (ToMMoRW): High time resolution community-based air monitoring in California's Salton Sea air basin. Funder: US Environmental Protection Agency, Enhanced Air Quality Monitoring for Communities Program. Award: $500,000, 7/1/23 – 6/30/26. PIs: Luis Olmedo & Christian Torres (Comite Civico del Valle), Tony Wexler and Hanyang Li (UC Davis). Role: Facilitate community-university partnership.

Wildfire Exposures through Air and Water and Their Impact on Cancer. Funder: UC Davis Comprehensive Cancer Center. Award: $149,998, 7/1/22 – 6/30/24. PIs: Shehnaz Hussain and Irva Hertz-Picciotto. Role: Facilitate community partnership with Environmental Justice Coalition for Water.

Assessing Toxic VOC Exposures with GC-CF-IMS. Funder: US Environmental Protection Agency. Award:

$799,660, 5/1/22 – 4/30/25. PI: Anthony Wexler. Role: Recruit and facilitate stakeholder advisory committee.

B. Positions, Scientific Appointments, and Honors

2021 – present ***Co-Director, Community Engagement Core,*** **University of California, Davis Environmental Health Science Center. Departments of Human Ecology and Public Health Sciences.**
2014-2021 ***Community Food Systems Analyst*****, University of California Sustainable Agriculture Research and Education Program, UC Division of Agriculture and Natural Resources**
2011-2014 ***Regional Farmer Trainings Program Coordinator, Agricultural Grants Manager*****, Inter-Faith Food Shuttle, Raleigh, NC**

C. Contributions to Science

Silva, M., Capps, S., London, J. Community-Engaged Research and the Use of Open Access ToxVal/ToxRef In Vivo Databases and New Approach Methodologies (NAM) to Address Human Health Risks from

Environmental Contaminants. *Birth Defects Research Journal*. 2024; (Special Issue: Addressing Health Disparities through Environmental Justice and Community Engagement). Status: Accepted, in revision.

Capps, S., London, J., Martinez, N., Silva, M., Sellen, J., Hamilton, K., Jensen, R., Seaton, P., Vielma, E., Woo, D., Alatorre, M., Mares-Alatorre, M., Johnson, T., Firestone, L. 2023. *Community Research Priorities***.** UC Davis Environmental Health Sciences Center, Community Engagement Core. https://environmentalhealth.ucdavis.edu/scientists/our-community-research-priorities

Capps, S., Rodriguez, S., London, J., Taiwo, T., Thompson, A., Martinez, N., Silva, M., Sellen, J., Hamilton, K., Jensen, R., Seaton, P., Vielma, E., Woo, D., Alatorre, M., Mares-Alatorre, M., Johnson, T., Jahanzad, E. 2022. *Community Research Priorities***.** UC Davis Environmental Health Sciences Center, Community Engagement Core. https://arcg.is/1Wea9y0

Capps, S., Rodriguez, S., Taiwo, T., London, J., Martinez, N., Silva, M., Sellen, J., Hamilton, K., Jensen, R., Seaton, P., Vielma, E., Woo, D., Alatorre, M., Mares-Alatorre, M., Johnson, T., and Jahanzad, E. July 13-17, 2022. *Prioritizing Community Stakeholders in Environmental Health Research: Integrating Community Research Priorities at the UC Davis Environmental Health Sciences Center*. Poster presentation, National Institute for Environmental Health Sciences Annual Meeting, NYC, New York.

Silva, M., Biddle, J., Taiwo, T., Capps, S., Rodriguez, S., and London, J. March 27-31, 2022. *Community Outreach and Engagement: Building Partnerships to Promote Health. Community Engagement Core, Environmental Health Sciences Center, University of California, Davis, CA*. Poster presentation, Society of Toxicology Annual Meeting, San Diego, CA.

Community Engagement Strategies: Integrating Community Research Priorities into EHSC's Pilot Program. Presentation to the National Institute of Environmental Health Science Core Center's Partnerships for Environmental Public Health (PEPH) Leadership Group, including the Directors of all NIEHS P30 Center's Community Engagement Cores. November 15, 2022

Capps, S., Rodriguez, S., London, J., Taiwo, T., Thompson, A., Martinez, N., Silva, M., Sellen, J., Hamilton, K., Jensen, R., Seaton, P., Vielma, E., Woo, D., Alatorre, M., Mares-Alatorre, M., Johnson, T., Jahanzad, E. 2021. *Community Research Priorities*. UC Davis Environmental Health Sciences Center, Community Engagement Core. https://environmentalhealth.ucdavis.edu/scientists/pilot-projects-program/2022-2023- community-research-priorities

Capps, S. *Community Partnerships and IRB Factsheet*. UC Davis Environmental Health Sciences Center, Community Engagement Core. https://ucdavis.box.com/s/zco8oavh4k2qp2iaoz3bn02gxzuqi4gr

London, J., Capps, S., Taiwo, T. 2022. *Research Partnerships on a Continuum: Community Involvement and the Role of the Academic Researcher.* UC Davis Environmental Health Sciences Center, Community Engagement Core. https://ucdavis.box.com/s/zq1qv6z6rmniayzqb7hs90f37ua6uyhk. Original version published as part of the Building Equitable Partnerships for Environmental Justice curriculum (London et al. 2018)

Gupta, C., Campbell, D., Munden-Dixon, K., Sowerwine, J., Capps, S., Feenstra, G., and Van Soelen Kim, J. (2018). *Food policy councils and local governments: Creating effective collaboration for food systems change*. Journal of Agriculture, Food Systems and Community Development

Gupta, C., Van Soelen Kim, J., Sowerwine, J., Feenstra, G., Campbell, D., Capps, S. and Munden-Dixon, K. 2017*. UC Cooperative Extension Study of California Food Policy Councils*. UC Davis, UC SAREP. https://sarep.ucdavis.edu/sites/g/files/dgvnsk5751/files/inline-files/CA_FPC_Final_Report.pdf

EXHIBIT A6

CURRENT & PENDING SUPPORT

PI: James, Peter					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	24RD010	CARB	Quantifying Greenspace Impacts on Human Health in California	1/1/2025	12/31/2026
Pending	Not Assigned	UC Office of the President	University of California Center of Excellence in Nature and Health	1/1/2025	12/31/2026
Pending	Not Assigned	Icahn School of Medicine at Mount Sinai/NIH	Indoor air pollution reduction and maternal respiratory morbidity among urban pregnant women with asthma: The AIR-MAMA study	4/1/2025	3/31/2030
Pending	Not Assigned	University of Louisville/NIH	The Health Impacts of Investments for Climate Adaptation	10/1/2024	9/30/2029
Pending	Not Assigned	Harvard University/NIH	Community, Workplace, Cultural Assets and Healthy Aging	7/1/2025	6/30/2030
Active	R01AG087199	NIH	Environmental Resources for Individual Cognitive Health/Resilience (EnRICH)	5/15/2024	2/28/2029
Active	R01HL150119	NIH	Built Environment Assessment through Computer visiON (BEACON): Applying Deep Learning to Street-Level and Satellite Images to Estimate Built Environment Effects on Cardiovascular Health	7/1/2024	6/30/2025
Active	R01CA249982	Boston University/NIH	Socio-environmental context in monoclonal gammopathy of undetermined significance (MGUS) disparities	6/1/2024	5/31/2025
Active	A24-3528	REI Cooperative Action Fund	Establishing a Nationwide Repository of Spatial Metrics of Nature	5/31/2024	5/31/2026
Active	U01HL145386	Harvard/NIH	Integrating lifecourse approaches, biologic and digital phenotypes in support of heart and lung disease epidemiologic research	2/1/2024	1/31/2025

PI: Brazil, Noli					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	24RD010	CARB	Quantifying Greenspace Impacts on Human Health in California	1/1/2025	12/31/2026
Active	2207-39618	Russell Sage Foundation	Disparities in Exposure Risk to Environmental Disadvantage in Neighborhood Networks Formed by Urban Mobility Flows	7/1/2023	6/30/2025
Active	N/A	American Institutes for Research in the Behavioral Sciences	Transitional Kindergarten Expansion as an Opportunity to Reduce School Segregation	7/1/2024	7/1/2027

PI: Capps, Shosha					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	24RD010	CARB	Quantifying Greenspace Impacts on Human Health in California	1/1/2025	12/31/2026
Active	P30ES023513	NIH	UC Davis Environmental Health Sciences Core Center	1/1/2019	3/31/2025
Active	N/A	US Environmental Protection Agency (EPA)	Toxic Metals Monitoring Regional Network (ToMMoRW): High time resolution community-based air monitoring in California's Salton Sea air basin.	7/1/2023	6/30/2026
Active	N/A	US Environmental Protection Agency (EPA)	Assessing Toxic VOC Exposures with GC-CFIMS	5/1/2022	4/30/2025

PI: Hertz-Picciotto, Irva					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	24RD010	CARB	Quantifying Greenspace Impacts on Human Health in California	1/1/2025	12/31/2026
Pending	P30ES023513	NIH	Renewal - UC Davis Environmental Health Sciences Core Center	4/1/2025	3/31/2030

Funded	CE1HS54376-01-00	PHS Health Resources and Services Administration (HRSA)	Facilities and Equipment for UC Davis Health Institute on Wildfires, Health, Equity, and Resilience.	9/30/2024	9/30/2027
Funded	UG3OD023365	NIH	Revisiting ReCHARGE: ECHO Follow up on Middle Childhood and Adolescence	9/1/2016	5/31/2025
Funded	R01ES031701	NIH	The CHARGE Study Phase II: A Multifactorial Approach to Autism Etiology	5/1/2020	1/31/2026
Funded	R01ES031117	Icahn School of Medicine at mount Sinai/NIH	Environmental chemical mixtures and metabolomics in autism spectrum disorder	5/1/2020	1/31/2025
Funded	P30ES023513	NIH	UC Davis Environmental Health Sciences Core Center	4/1/2020	3/31/2025
Funded	U24ES928533	NIH	BUILDS MARBLES: Biorepository Upkeep and Infrastructure for Longitudinal Data Sharing for MARBLES	12/1/2022	11/30/2027
Funded	R01ES034554	Johns Hopkins University/NIH	GEARS: Combining advances in Genomics and Environmental Science to accelerate Actionable Research and Practice in ASD	9/1/2022	8/31/2027
Funded	UG3OD035550	NIH	Prenatal Environment and Child Health (PEACH) in ECHO	9/1/2023	8/31/2030
Funded	UG3OD023342	Drexel University/NIH	Trajectories and Environments in Autism: a Multi-cohort Study (TEAMS)	9/1/2023	8/31/2030

PI: London, Jonathan					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	24RD010	CARB	Quantifying Greenspace Impacts on Human Health in California	1/1/2025	12/31/2026
Active	N/A	The California Wellness Foundation	Assessment of AB 617 Implementation in the San Joaquin Valley	9/1/2022	8/31/2024
Active	N/A	US Environmental Protection Agency (EPA)	Toxic Metals Monitoring Regional Network (ToMMoRW): High time resolution community-based air	7/1/2023	6/30/2026

			monitoring in California's Salton Sea air basin.		
Active	N/A	The California Resources Agency	Environmental Education in Clear Lake, CA	9/1/2022	8/31/2024
Active	P30ES023513	NIH / National Institute of Environmental Health Sciences (NIEHS)	UC Davis Environmental Health Sciences Core Center	1/1/2019	3/31/2025
Active	N/A	US Environmental Protection Agency (EPA)	Assessing Toxic VOC Exposures with GC-CFIMS	5/1/2022	4/30/2025

PI: Ossola, Alessandro					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	24RD010	CARB	Quantifying Greenspace Impacts on Human Health in California	1/1/2025	12/31/2026
Pending	Not Assigned	Qatar National Research Fund	Unveiling Climate Vulnerability, Safeguarding Qatari Vulnerable Plants with Correlative and Joint Species Distribution Models under Climate Change	1/1/2025	12/31/2027
Pending	Not Assigned	CDFA Specialty Crop Mulit State Program	Are native landscape plants ready for climate change?	1/1/2025	12/31/2027
Pending	Not Assigned	CDFA Specialty Crop Mulit State Program	A new green carpet for California: Water-saving groundcovers for urban landscapes	11/1/2025	6/30/2028
Current	N/A	California Department of Food and Agriculture	Climate ready vines for the Western United States Crop Multi-State Program	3/31/2022	3/30/2025
Current	N/A	USDA-NIFA	Urban heat islands as windows into climate change and ecosystem service provisioning by street trees	9/1/2022	8/31/2025
Current	22-000107	Foundation for Food and Agriculture	A Big Data Tool for Urban Crop Selection Under Climate Change	7/1/2023	6/30/2026

Current	N/A	California Department of Food and Agriculture	Can polyploidy increase drought tolerance in landscape plants?	11/1/2022	4/30/2025
Current	22-CS-11272131-041	USDA – Forest Service	Post-fire Tree Risk Assessment Protocol for Western Urban Forests	9/26/2022	9/26/2027
Current	N/A	UC Davis	UC Davis-Israel Collaborations in Research 2023-25 Mobility Grant	1/1/2024	7/31/2025
Current	23-CS-11272123-031	USDA – Forest Service	Evaluating tree cooling performance in California schoolyards	9/1/2023	8/13/2028
Current	A23-0822	University of Sydney – UC Davis Ignite Program	Fire over the Fence	11/1/2024	11/1/2025

PI: Springborn, Michael					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	24RD010	CARB	Quantifying Greenspace Impacts on Human Health in California	1/1/2025	12/31/2026
Current	N/A	National Science Foundation	DISES: Between maintenance and transformation: an SES framework for restoration decision-making under climate change	7/1/2021	6/30/2026
Current	N/A	Sea Grant	Accelerating Bull Kelp Ecosystem Recovery in a Recently Deforested Location in Northern California by Using a Strategic Sequence of Restoration Techniques & Community Participation	2/1/2024	1/31/2026

EXHIBIT A7

THIRD PARTY CONFIDENTIAL INFORMATION

CONFIDENTIAL NONDISCLOSURE AGREEMENT

Exhibit A7 is not applicable for this Agreement.

EXHIBIT B1

BUDGET JUSTIFICATION

Key Personnel:

Peter James, ScD, Associate Professor, Principal Investigator, 25% effort per year.

Dr. James is an environmental epidemiologist with considerable experience in the field of epidemiology of spatial and contextual factors. He has nearly a decade of experience studying how nature impacts human health in cohort studies and large administrative health datasets. As the Principal Investigator for this project, Dr. James will be responsible for the scientific direction and overall conduct of the project. He will contribute to all phases of the project but will specifically play the lead on Tasks 1-5. He will also coordinate across all investigators on this project to ensure the Contractor meets all deliverables on time.

Alessandro Ossola, PhD, Assistant Professor, Co-Investigator, 5% effort per year.

Dr. Ossola is an ecologist with expertise in measuring greenspace and ecosystem services. Dr. Ossola will contribute across all Tasks but will play a major role in Tasks 2-5.

Michael Springborn, PhD, Professor, Co-Investigator, 5% effort per year.

Dr. Springborn is an environmental economist, with expertise in quantifying the economic impacts of ecosystem services and health outcomes. Dr. Springborn will focus on quantifying the economic benefits of greenspace in terms of health and ecosystem service outcomes. This will be especially important in Tasks 3-5.

Irva Hertz-Picciotto, PhD, Professor, Co-Investigator, 1% effort per year.

Dr. Hertz-Picciotto is an environmental epidemiologist and the Director of the UC Davis NIEHS EHSC Center. Leaning on her decades of expertise in health datasets across California, Dr. Hertz-Picciotto will assist with identifying and linking greenspace datasets to relevant health datasets. This will specifically be important for Tasks 2-4. In her role as the Director of the EHSC, where she has supported extensive community engagement, Dr. Hertz-Picciotto will also contribute her expertise to Task 6.

Noli Brazil, PhD, Associate Professor, Co-Investigator, 5% effort per year.

Dr. Brazil is spatial scientist with expertise on applying spatial data to solve problems in human health and ecology. Dr. Brazil will contribute his expertise to Tasks 2-5.

Jonathan London, PhD, Professor, Co-Investigator, 5% effort per year.

Dr. London is a nationally recognized expert in Community-Based Participatory Action Research (CPBAR) in environmental health and justice. Dr. London will lead Task 6, the Community Focused Advisory Group work on this project.

Shosha Capps, MS, Academic Coordinator, Community Engagement Core Co-Lead, Co- Investigator, 15% effort per year.

Ms. Capps brings more than a decade of experience facilitating university-community collaborations, with a focus on action-oriented, policy relevant research addressing health, access, and exposure disparities experienced by low-income communities and communities of color in California's Central Valley. She has served as the Co-Director of EHSC THREE's

Community Engagement Core since 2021. Ms. Capps will play a major role in Task 6 and will call on her experience and relationships to support the Community Focused Advisory Group.

Other Personnel:

Mariela Alaniz, Research Data Analyst, 10% effort per year.

Ms. Alaniz is a Research Data Analyst within the EHSC. She will assist with analyzing data across all Tasks in the project.

To be appointed – Graduate Student Researcher (GSR), 25% effort per year.

The GSR will assist with literature reviews and analyzing data across all Tasks in the project.

To be appointed – Graduate Student Researcher (GSR), 25% effort per year.

The GSR will assist with literature reviews and analyzing data across all Tasks in the project.

To be appointed – Postdoc, 45% effort per year.

The Postdoctoral fellow will assist with literature reviews and analyzing data across all Tasks in the project. They will also provide support in the Community Focused Advisory Group.

A 3% increase in annual salary costs has been added in year 2 for all personnel.

Personnel	Mo. Salary	Est. Months	% of Effort	Total
Peter James	$250,000	12	25%	$62,500
Peter James	$257,500	12	25%	$64,375
Alessandro Ossola	$112,000	12	5%	$5,600
Alessandro Ossola	$115,360	12	5%	$5,768
Jonathan London	$177,600	12	5%	$8,880
Jonathan London	$182,928	12	5%	$9,146
Michael Springborn	$195,100	12	5%	$9,755
Michael Springborn	$200,953	12	5%	$10,048
Irva Hertz-Picciotto	$402,100	12	1%	$4,021
Irva Hertz-Picciotto	$414,163	12	1%	$4,142
Noli Brazil	$131,800	12	5%	$6,590
Noli Brazil	$135,754	12	5%	$6,788
Shosha Capps	$97,116	12	15%	$14,567
Shosha Capps	$100,029	12	15%	$15,004
Mariela Alaniz	$131,800	12	10%	$8,794
Mariela Alaniz	$135,754	12	10%	$9,057
TBN – GSR 1	$74,488	12	25%	$18,622
TBN – GSR 1	$76,723	12	25%	$19,181
TBN – GSR 2	$74,488	12	25%	$18,622
TBN – GSR 2	$76,723	12	25%	$19,181
TBN – Postdoc	$74,088	12	45%	$33,340
TBN – Postdoc	$76,311	12	45%	$34,340
Total				**$388,321**

Fringe Benefits:

Fringe benefits are calculated using the composite benefit rates developed by the UC Davis Costing and Policy office and approved by the Department of Health and Human Services on 11/28/2023. Rates are applied by title code and adjusted annually by fiscal year. Projected rates for this project period are:

Personnel	**Rate 1 (1/1/25-6/30/25)**	**Rate 2 (7/1/25-6/30/26)**	**Rate 3 (7/1/26-12/31/26)**	**Total**
Peter James	26.9%	27.7%	28.5%	$35,152
Alessandro Ossola	40.7%	41.9%	43.2%	$4,767
Jonathan London	40.7%	41.9%	43.2%	$7,559
Michael Springborn	40.7%	41.9%	43.2%	$8,304
Irva Hertz-Picciotto	26.9%	27.7%	28.5%	$2,262
Noli Brazil	40.7%	41.9%	43.2%	$5,610
Shosha Capps	40.7%	41.9%	43.2%	$12,400
Mariela Alaniz	51.4%	52.9%	54.5%	$9,450
TBN - GSR 1	1.9%	2%	2.1%	$756
TBN - GSR 2	1.9%	2%	2.1%	$756
TBN – Postdoc	25%	25.8%	26.6%	$17,465
Total				**$104,481**

Materials & Supplies:

Farm Computing Node Access - $4,000 per year is requested.

Farm Computing Node Access is required to process and analyze large spatial datasets on greenspace and ecosystem services, as well as for health analyses.

Community Partner Compensation - $10,000 per year is requested.

To ensure meaningful engagement and collaboration with our Community Advisory Group, the Contractor plans to recruit eight community partner members. Their participation is vital for the success of our project, as they provide invaluable insights and perspectives that reflect the needs and priorities of the community. The Contractor proposes compensating each community partner member at a rate of $125 per hour for a total of 10 hours per year. This brings the total compensation for each member to $1,250, resulting in an overall budget allocation of $10,000 per year.

Other Costs:

GSR Tuition/Fees:

Tuition and fee remission for graduate students is requested as part of the student's compensation package. Year 1: $17,505, Year 2: $18,569

Indirect Costs:

Indirect costs are calculated at the sponsor's approved rate of 27% MTDC. Equipment, tuition remissions, rental costs of off-campus facilities, and the portion of each subaward exceeding

$25,000 are not included in the modified total direct cost.

Base	Rate	Total
$520,802	27%	$140,616

EXHIBIT B2

SUBAWARDEE BUDGET(S)

2 is not applicable for this Agreement.

EXHIBIT B3

INVOICE ELEMENTS

In accordance with Section 14 of Exhibit C – Payment and Invoicing, the invoice, summary report and/or transaction/payroll ledger shall be certified by the University's Financial Contact and the PI (or their respective designees).

Invoicing frequency

☒ Quarterly ☐ Monthly

Invoicing signature format

☐ Ink ☒ Facsimile/Electronic Approval

Summary Invoice – includes either on the invoice or in a separate summary document – by approved budget category (Exhibit B) – expenditures for the invoice period, approved budget, cumulative expenditures and budget balance available[1]

- Personnel
- Equipment
- Travel
- Subawardee – Consultants
- Subawardee – Subcontract/Subrecipients
- Materials & Supplies
- Other Direct Costs
    - TOTAL DIRECT COSTS (if available from system)
- Indirect Costs
    - TOTAL

Detailed transaction ledger and/or payroll ledger for the invoice period [2]

- University Fund OR Agency Award # (to connect to invoice summary)
- Invoice/Report Period (matching invoice summary)
- GL Account/Object Code
- Doc Type (or subledger reference)
- Transaction Reference#
- Transaction Description, Vendor and/or Employee Name
- Transaction Posting Date
- Time Worked
- Transaction Amount

[1] If this information is not on the invoice or summary attachment, it may be included in a detailed transaction ledger.

[2] For salaries and wages, these elements are anticipated to be included in the detailed transaction ledger. If all elements are not contained in the transaction ledger, then a separate payroll ledger may be provided with the required elements.

EXHIBIT D

ADDITIONAL REQUIREMENTS ASSOCIATED WITH FUNDING SOURCES

Exhibit D is not applicable for this Agreement.

EXHIBIT E

SPECIAL CONDITIONS FOR SECURITY OF CONFIDENTIAL INFORMATION

Exhibit E is not applicable for this Agreement.

EXHIBIT F

ACCESS TO STATE FACILITIES OR COMPUTING RESOURCES

Exhibit F is not applicable for this Agreement.

EXHIBIT G

NEGOTIATED ALTERNATE UTC TERMS

Exhibit C, Section 14 – Payment & Invoicing is hereby amended to incorporate the following:

Add Item A – Section 6:

6) CARB shall withhold payment equal to 10 percent after the contractor has been compensated for 90 percent of the agreement per Exhibit B1, Budget Justification. The 10 percent shall be withheld until completion of all work and submission to CARB by the University of a final report approved by CARB in accordance with Exhibit A1, Schedule of Deliverables, Section 2. It is the University's responsibility to submit one (1) original and one (1) copy of the final invoice.

Modify Item C – Invoicing, 2 is hereby replaced in its entirety with the following:

2) Invoices shall be submitted in arrears not more frequently ~~than monthly and not less frequently~~ than quarterly to the State Financial Contact, identified in Exhibit A3. Invoices may be submitted electronically by email. If submitted electronically, invoice must include the following certification for State certification to the State Controller's Office, in compliance with SAM 8422.1

This bill has been checked against our records and found to be the original one presented for payment and has not been paid. We have recorded this payment so as to prevent later duplicate payment.

Signed: _____

State Agency Accounting Officer

Add Item E:

E. Advance Payment

1) Nothing herein contained shall preclude advance payments pursuant to Title 2, Division 3, Part 1, Chapter 3, Article 1 of the Government Code of the State of California.

2) Upon termination or completion of this Agreement, Contractor shall refund any excess funds to the CARB. Contractor will reconcile total Agreement costs to total payments received in advance and any remaining advance will be refunded to the CARB's Accounting Office. In the event the Agreement is terminated, total project costs incurred prior to the effective date of termination (including close-out costs) will be reconciled to total project payments received in advance and any remaining advance will be refunded to the CARB. In either event Contractor shall return any balance due to CARB within sixty (60) days, of expiration or earlier termination.

UC DAVIS
OFFICE OF RESEARCH

September 23, 2024

California Air Resource Board CARB

Proposal entitled..... **Quantifying Greenspace Impacts on Human Health and Ecosystem Services in California**
Principal Investigator..... **Dr. Peter James**

To Whom It May Concern:

On behalf of The Regents of the University of California, Davis campus, it is my pleasure to provide institutional support and approval in support of the proposal referenced above in response to CARB Fiscal Year 2024-2025 Research program.

We look forward to expediting new contracts with all State agencies by using the **Model Language for Contracts with the University of California and California State Universities** as directed by the California Department of General Services and available here: https://www.dgs.ca.gov/OLS/Resources/Page-Content/Office-of-Legal-Services-Resources-List-Folder/Model-Contract-Language.

Please note that we are submitting the proposal with the maximum allowable indirect costs, calculated at 27% of modified total direct costs (MTDC) per the State, UC's, and CSU's current agreement on allowable indirect costs. At 27% of MTDC, this rate is lower than both our applicable federally negotiated rate, https://research.ucdavis.edu/wp-content/uploads/FA-Rate-Agreement.pdf, and the UC negotiated state indirect cost rate of 35%. Indirect costs are real costs of conducting research, and it is the University of California's obligation to seek full reimbursement for project costs.

Please contact me with any administrative questions. We request correspondence pertaining to this proposal be sent via email to proposals@ucdavis.edu or mailed to the Office of Research Sponsored Programs Office, One Shields Ave, Davis, CA 95616-5270. Please refer to SPO Proposal 25-1282 on all future correspondence

We look forward to working with you on this important project.

Sincerely,

Samuel Boyes

Digitally signed by Samuel Boyes
Date: 2024.09.23 15:04:17 -07'00'

Samuel Boyes

Contracts and Grants Analyst

Plan ahead! The UC F&A Rate for State agency awards* will increase over time as follows:

Now – 6/30/2025	35%
7/1/2025 – 6/30/2026	40%

*The appropriate UC federally negotiated F&A Rate will apply to State agency awards made with federal funding. Please see 2 CFR § 200.414 and 2 CFR § 200.331.

Send Award Notice to:

Office of Research, Sponsored Programs
One Shields Ave
University of California
Davis, California 95616-5270
awards@ucdavis.edu

Send Checks (Payable to The Regents of the University of California) to:

UC Davis AR Lockbox
PO Box 741816
Los Angeles, CA 90074–1816
Phone: 530-752-0460
cashier@ucdavis.edu