An Environmental Assessment of Households in the Eastern Coachella Valley

From the 2014-2016 Environmental Justice Data Project

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Introduction

This report is a summary of data from physical samples and observations made in homes located in the Eastern Coachella Valley of Riverside County, California. The goal of this study was to determine the existence of health impacting contaminants inside homes of varying ages and construction types.

The work completed was designed to address topics of environmental justice and health disparities that often go unreported among people who live in disadvantaged communities. The Eastern Coachella Valley's primarily Latino community lives in close proximity to agricultural fields, waste processing facilities, the Salton Sea and a major trade corridor from California to the rest of the US. This report seeks to describe the contaminants and infrastructure issues that individuals are exposed to within some of the homes of this area.

The Coachella Valley is in Riverside County, California, and runs southeast of the San Bernardino Mountains to the northern shore of the Salton Sea. The Coachella Valley is part of the Colorado Desert with the Mojave Desert meeting its northwestern border. The Eastern Coachella Valley (ECV) is the southeast portion of the Coachella Valley, and includes the communities of Mecca, Thermal, North Shore, Oasis and the city of Coachella.

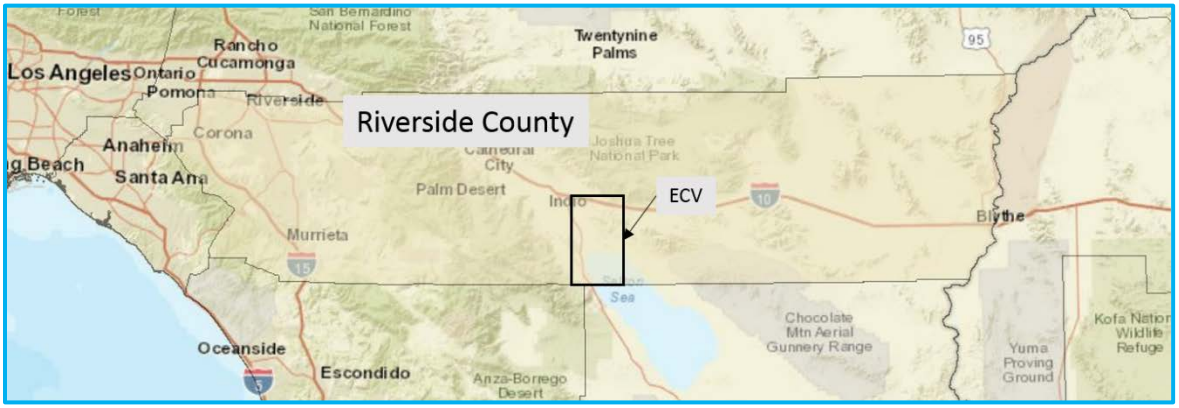

FIGURE 1 THE LOCATION OF THE EASTERN COACHELLA VALLEY IN SOUTHERN CALIFORNIA.

Our approach in this study was to attempt to identify potential contaminants or failing infrastructure that could contribute to a negative health outcome in residents. This report discusses a similar potential negative health response to microbes, allergens and other contaminants in homes as the microbial definition of home hygiene (Bloomfield S. , 2018). The role of the home environment and its relationship to transmitted diseases has been studied and described for developing countries but less so in the USA. There has been an increasing focus on "home hygiene" in discussions around the use of anti-microbial cleaning products and the development of antibiotic resistance. But little has been done to link the home environment to the spread of infectious agents and non-infectious respiratory issues. (Larson, et al., 2001)

The popular hygiene hypothesis was first described in 1989 and proposes that some autoimmune and other atopic diseases such as asthma are a result of reduced microbial exposure in early childhood (Bloomfield, et al., 2016). In popular media this concept has led to the conclusion that we have become "too clean" and that children need healthy exposure to bacteria to build their immune system. The hygiene hypothesis fails to consider the possibility that children from lower income households have higher exposures to environmental microbes and histamine irritants that originate from faulty wastewater infrastructure, poor indoor air quality, solid waste issues, poor drinking water quality and other environmental contaminants.

This report assesses these environmental exposures as potential environmental justice externalities; where households cannot improve their home hygiene conditions because of where they live. The working hypothesis is that contaminants exist in the home that can increase the public health risk for diseases and conditions such as asthma, infectious disease, and other negative conditions.

We investigated a series of environmental contaminants and household conditions that are listed in Table 1.

Table 1 Categories of Contaminants and Variables

Category	Variables
Drinking Water	ATP of drinking water
Indoor Air Quality	PM1, UV light for dust, cooling system, ERMI, Cooling system filter
Surface hygiene	Year home built, House material, Type of flooring material, Type of Window, Presence of pests and/or pets, Cleaning materials

Background

Population:

The estimated population of the ECV by the American Community Survey update to the US Census (U.S. Census Bureau, 2018) in 2016 was 67,658 with 875.26 people per square mile. The American Community survey (ACS) is a phone survey update to the US census. The ACS update is based on a smaller sample so it has a larger margin of error. The ACS 1-year estimate is not representative of the many rural residents who are not listed in telephone records (U.S. Census Bureau, 2016). This study instead used a satellite image based household sampling scheme to randomize and select homes for inclusion in the study. All locations were confirmed on the ground once the samples were selected to insure the locations were, in fact, inhabited residences.

TABLE 2 CENSUS DATA ON STUDY AREA

Community	Population	Median Household Yearly Income	Prevalence Living Below Poverty Level	% Hispanic or Latino
Coachella	43,826	$36,124	30.1%	97.6%
Mecca	8,863	$26,680	41.8%	99.9%
North Shore	3,199	$27,981	33%	95.3% [1]
Oasis	4,374	$22,210	48.4%	95.2%
Thermal	2,396	$28,443	32.3%	95.3% [1]
Source: (U.S. Census Bureau, 2018)				

Income: The percentage of people living below poverty line in Coachella was 30.1% by the Census 2016, which is 1.5 times the rate in the Riverside County, and the median household income was $36,124. Coachella had the highest median income of all the 5 communities chosen for the survey (U.S. Census Bureau, 2018). The other four communities are CDPs.[2]

Health: A systematic review (Sommer, et al., 2015) concluded that there is an association between socioeconomic inequalities and non-communicable diseases such as asthma. Asthma is now more prevalent among families with median incomes below poverty thresholds in the United States (Akinbami, Simon, & Rossen, 2015). There are many potential factors that could account for the occurrence of asthma in children (Jerschow, et al., 2017). This report summarizes some of the most important environmental exposures in the home that could contribute to asthma and other respiratory irritants.

Exposures: Types and Measurements

This home hygiene assessment used a series of structured observations and measurements of the indoor home environment. The home structured observation tool modified from a USEPA home asthma inspection checklist used by several California county departments of public health (USEPA, 2018). The USEPA checklist details he housing condition, water damage, evidence of pest infestation, presence of pets and the overall level of crowding. This study added observations on water and waste disposal while also using testing instruments that provided readings in real-time so that residents could see and learn from what the readings provided (Table 4).

[1] 2010 Census
[2] Unincorporated Census Designated Place.

Mold: Damp indoor spaces are associated with upper respiratory tract symptoms, coughing, and asthma symptoms in sensitized persons (Institute of Medicine (US), 2004). In order to provide a simple numeric estimate of mold concentration, the US EPA and the US Department of Housing and Urban Development, developed the Environmental Relative Moldiness Index (ERMI) scale (Vesper, et al., 2007) that compares the concentrations of potentially dangerous mold spores (found in conditions typical of moisture damage) to other strains of mold typically found in an outdoor environment without the presence of water damage. That research group concluded that a high ERMI could contribute to the initiation of asthma in children less than 5 years old (Vesper & Wymer, 2016).

Dust samples were obtained by surveyors in all homes by wiping the tops of doorways, bookshelves, and other surfaces using a Swiffer™ Sweeper cloth (P&G, Cincinnati, OH) (Vesper & Wymer, 2016). The dust sample was collected using a disposable glove to avoid contaminating the sample. The sampling cloth was placed in a zippered plastic bag and labeled with a unique study number. Samples were kept at room temperature until reaching the analytical lab, where the samples were frozen at -20°C until analyzed. Each dust sample was processed at the a commercial analytical lab (Mycometrics, Monmouth junction, NJ, USA) for 36 ERMI molds using mold specific quantitative polymerase chain reaction (QPCR) (Vesper, et al., 2007).

The ERMI metric classifies 36 indicator mold species into two groups. Group 1 includes the 26 species indicating water damage, and Group 2 consists of ten species commonly found in homes across the US, that primarily come from outside the home (Vesper, et al., 2007). The ERMI calculation takes the results from the concentrations (cell equivalents/mg dust) of each of all the molds collected and mathematically converts these into a single number where the larger the ERMI value, the greater the mold contamination. The Figure 2 below is the result from a nationwide study of mold in homes using the ERMI**.** When the overall ERMI is above 5, the presence of mold is shown through epidemiological studies (Vesper & Wymer, 2016) to either exacerbate asthma and allergic symptoms in sensitive individuals, or contribute to an initiation of an asthma condition in children less than 5 years old.

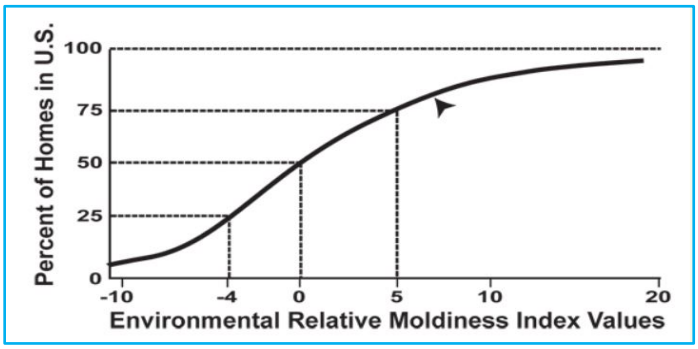

FIGURE 2 THE ENVIRONMENTAL RELATIVE MOLDINESS INDEX

Mold enters the indoor home environment through open doors, windows, vents, heating, and air conditioning systems. It can attach to shoes, clothes, pets, and can grow on paper products, ceiling tiles, wood products, drywall, carpet, and fabrics (USCDC, 2017). Several studies show higher ERMI values were more likely to be found in older dwellings (Méheust, et al., 2012) and houses with dogs, presented four times more bacterial species than houses without dogs (Vesper S, 2017). Houses with central air-conditioning also had lower ERMI values (Reponen, et al., 2013).

Mold related: The surveyors made structured observations about the indoor home environment that could have contributed to mold contamination or other moisture issues. The observations were of the indoor cooling system and presence of a recently changed filter on the HVAC system if one was present. They also noted if a window based air conditioner or an evaporative cooler (i.e. swamp cooler) was present. Other observations detailed the presence of domestic indoor or outdoor pets and pest infestation. For pest infestation, the surveyors trained to look under sinks, behind appliances and behind furniture to note the presence of pests and/or their indicators such as feces, wall stains or gnawing marks on building material. Potential pests could have included cockroaches, bedbugs, rats, or mice.

In addition to the above observations, the trained surveyors completed the following assessments:

- The surveyors observed and noted the type of cleaning materials under the sinks and categorized them as chemical disinfectants (i.e. bleach and ammonia compounds) and natural cleaning products such as borax and vinegar for cleaning.
- The surveyors noted the type of house construction and the year of construction was obtained from parcel data.
- The floor material was recorded as carpet, mixed surface, vinyl, linoleum, wood or other.
- Surveyors also made note of the types of windows and wall materials in the home. This assessment followed the checklist of the USEPA Asthma checklist (USEPA, 2018).
- The proximity of the home to a nearby agricultural field was determined using a GIS distance analysis in the ArcGIS software (ESRI, Redlands, California, USA).

Agricultural Products: Residents in the ECV live adjacent to agricultural fields. One study in Brazil found that households who live adjacent to farming activity are more likely to have poor respiratory outcomes. The study showed an association between short and long-term pesticide exposure, respiratory symptoms, and pulmonary function impairment (Buralli, et al., 2018). Another study found that rural agricultural household members have a higher exposure to endotoxins in indoor dust than households that are not near agricultural fields (Barnig, et al., 2013). The CHAMACOS[3] study at UC Berkeley

[3] Center for the Health Assessment of Mothers and Children of Salinas

linked the levels of organophosphate pesticide metabolites in the urine of 279 children living in California's Salinas Valley with decreased lung function (The Center for the Health Assessment of Mothers and Children of Salinas, 2019). Each tenfold increase in concentrations of organophosphate metabolites was associated with a 159-milliliter decrease in lung function, or about 8 percent less air, on average, when blowing out a candle. The magnitude of this decrease is similar to a child's secondhand smoke exposure when the parent smokes (Raanan R, 2015)[4].

Particulates: Particle pollution is one of the 6 National Ambient Air Quality Standards (USEPA, 2012) that is assessed by measuring the concentration of atmospheric particulate matter (PM). All air has some particulate matter and the USEPA has set outdoor standards for PM pollution that are based on risk assessments and health studies. Major health effects associated are respiratory disease, cardiovascular diseases, and reductions in lung function (WHO, 2005), all contributing to premature mortality. Particles that can reach lower parts of the airways are classified in fractions PM_{10} (diameter ≤ 10 μm), $PM_{2.5}$ (diameter ≤ 2.5 μm), and PM_1 (diameter ≤ 1μ m). Particles that are larger than 8 μm mainly remain at the pharynx, larynx, and trachea. Smaller particles measuring less than 4 μm are suggested to reach the lower respiratory tract in children (Brown, Gordon, Price, & Asgharian, 2013). In general, the smaller particle sizes can travel to lower portions of the respiratory tract and possibly cross to the blood.

The $PM_{2.5}$ and PM_{10} classifications are what the USEPA uses for regulatory concentrations in the NAAQS. The PM_1 metric has been proposed to be a better indicator, than $PM_{2.5}$ or PM_{10}, because those small particles can reach the alveoli and produce inflammation, and consequently, release mediators that promote acute episodes of respiratory diseases (Li, Wen, & Zhang, 2017). The PM_1 is the particle size that has the most negative health effect on lung function parameters (Zwozdziak, et al., 2016). It is possible to measure indoor PM_1 using a laser particle counter with calibrated air pump such as the HAZDUST EPAM5000 used in this study (SKCwest, Fullerton, CA).

Sources of indoor particles less than 2.5μm (and 1 μm) include smoking, cooking, fuel combustion for heating, burning incense, and animal dander (Li, Wen, & Zhang, 2017). The outdoor sources of PM2.5 include dust from certain soil types, wood burning, motor vehicle exhaust, fossil fuel combustion, and agricultural activities such as applications of fertilizer and insecticides (USEPA, 2012).

The presence or evidence of pests and pets has been established as an indoor air quality hazard for sensitive receptors with allergies. The dander and waste products from cockroaches, pet dander and rodent feces are biological pollutants that can cause allergic reactions, including asthma (USEPA, 2014).

Surface Contaminants: This home environmental assessment measured the degree to which residents are exposed to contaminants in their homes and in which

types of housing these exposures are most common. This study uses a sterile swab with the Hygiena luminometer (Hygiena LLC, Camarillo, California, USA) sampling system to measure food surface cleanliness. The swab system is able to give an immediate concentration of microorganisms on surfaces. The system gives an estimate of the amount of ATP on a surface which is a component in microbial cells. The ATP reacts with an enzyme called luciferase and produces a light that can be detected by the Luminometer, which is interpreted into the total microbial population in a sample (Pineau, 2016). A higher number from the swab system would indicate a lower efficiency for cleaning in the home. This home hygiene assessment measured 100cm^2 surfaces in the middle of each home that was visited. That surface was typically a dining room table or other central location.

The use of cleaning agents and disinfectants is considered in this assessment as a potential factor that could mitigate some of the organic debris on surfaces of the household. These chemicals are also considered an irritant and may trigger an asthma attack in some children and adults (USCDC, USDHUD, 2006).

Floor Hygiene: To measure floor surface contamination and cleaning methods, the home hygiene assessment used a handheld UV 395 LED lamp. The lamp was used to count the number of organic or otherwise fluorescing particles that glow under the UV395 lamp. This method allows quantification of dust particles seen per 100cm^2 of a floor area. The assessment team would typically sample the area underneath the central dining room table on the floor material or carpet in a dark place so the fluorescent dust particles could be counted without any type of visual assistance. The technique operates because tryptophan, similar carbon-based amino-acids and some minerals, will show fluoresce when exposed to a "black light" (Okache, Haggett, & Ajmal, 2015). The technique assumes that fluorescing specs seen on the floor are waste products from food, dander or other items that would normally be cleaned.

Cleaning Products, Pests and Pets: The indoor air quality of a home is influenced by particulates that originate from biological contaminants. These biological indoor air quality contaminants can trigger allergic reactions. The USEPA has the following summary about biological pollutants:

"Children, elderly people and people with breathing problems, allergies, and lung diseases are particularly susceptible to disease-causing biological agents in the indoor air. Mold, dust mites, pet dander and pest droppings or body parts can trigger asthma." (USEPA, 2014)

The use of certain cleaning products may also result in potential harmful impacts to the respiratory system in individuals with allergies. An increased risk of asthma triggers and respiratory symptoms is shown among professional cleaners who regularly use chemical agents (Svanes, et al., 2018). The cleaning products mainly associated with increased risk of asthma and rhinitis include cleaning sprays, bleach, ammonia, disinfectants and mixing products (Folletti, Siracusa, & Paolocci, 2017).

Drinking Water: The Hygiena Luminometer (Hygiena LLC, USA) was used to measure total ATP in drinking water as an indicator of total bacteria contamination in the water. This method is useful for drinking water because clean water from a laboratory filter or a municipal system with a normal chlorine content (from 0.2mg/L to 1mg/L free chlorine) will have a reading of zero on the Hygiena Luminometer.

TABLE 3 INDOOR PHYSICAL CONTAMINANTS MEASURED IN THIS ASSESSMENT.

Topic	Method Used	Housing Infrastructure challenge
Mold and biological indoor air quality	Environmental Relative Moldiness Index (ERMI)	Moisture damage and improperly sealed surfaces
Agricultural Contaminants	Indoor Dust (PM_1) and GIS distance to agricultural field	Age of in-house surfaces, indoor climate infrastructure and improperly sealed windows & doors
Non-biological indoor air quality	Indoor Dust (PM_1), observation of dirt road, and ERMI	Improperly sealed windows & doors, type of flooring, moisture damage, ease-of-maintenance of in-house surfaces, and paved road.
Surface Contaminants	Hygiena Luminometer	Moisture damage and ease-of-maintenance of in-house surfaces
Floor Hygiene	Black Light and observation	Type of flooring and ease-of-maintenance of in-house surfaces
Drinking Water	Hygiena Luminometer and Arsenic test.	Availability of clean drinking water, use of water vending machines for drinking water

TABLE 4 OBSERVATIONS MADE BY SURVEYORS IN THIS ASSESSMENT.

Topic	Observation	Housing Infrastructure challenge
Mold and biological indoor air quality	Window seals, window type, heating and cooling system technology, presence of pets, presence of pests, presence of solid waste.	Moisture damage and improperly sealed surfaces
Agricultural Contaminants	Proximity to agricultural field, window seals, window type, heating and cooling system technology, surface materials inside house and floor material.	Age of in-house surfaces, indoor climate infrastructure and improperly sealed windows & doors
Non-biological indoor air quality	Window seals, window type, heating and cooling system technology, wall surfaces, floor surfaces, paved road, type of cleaning materials used.	Improperly sealed windows & doors, type of flooring, moisture damage, ease-of-maintenance of in-house surfaces, and paved road.
Surface Contaminants	Type of cleaning materials, wall surfaces, floor surfaces,	Moisture damage and ease-of-maintenance of in-house surfaces
Floor Hygiene	Floor surfaces	Type of flooring and ease-of-maintenance of in-house surfaces
Drinking Water	Type of water sources in house.	Availability of clean drinking water, use of water vending machines for drinking water

Survey Design

A household survey was designed by stakeholders, promotoras and other community members to respond to concerns expressed about housing conditions in the ECV. The LLU team worked with CIRS, community stakeholders, promotoras, and the Building Healthy Communities team to build a health-based questionnaire that covered topics identified as important to community members.

The environmental assessment was designed to be administered at the same time as the health-based survey questionnaire by a second team member and did not require any additional questions or verbal feedback. An objective of the assessment was to use testing instruments that provided readings in real-time so that residents could see and learn from what the readings provided. The tool was also designed to collect observational data from the surveyor while the survey questionnaire was being administered. The surveyors provided the residents with a fact sheet and a summary of

the readings that were obtained at the conclusion of the interaction. The tool is included in appendix 1 and was estimated to take about 30 minutes to administer.

Sampling and Study Design

A large proportion of residents in the ECV are agricultural workers and their families. This population may not be responsive to phone or internet based health assessments. This could be due to several reasons including: the remote nature of their household; the informal or unconventional dwelling they reside in; and they may not be included in publically available phone or address lists. This study attempted to compensate for those factors by using extensive on-the-ground observation and household enumeration prior to creating a sampling frame for the in-person surveys.

Before sampling, the study team reviewed satellite images to define groups or "strata" of dwellings and the geographic limits of these strata. A "ground-truthing" walk occurred after sample areas were chosen. At this point, the field research team walked the limits of each sample area in each stratum to validate the locations of the households and enumerate each one within the sampling frame. The result was a complete community map that allowed for systematic, random sampling. This allowed the team to consider non-traditional dwellings in the sample frame for an improved community survey that ensured that everyone had a chance to be included.

The survey administrators then gave teams of Loma Linda University students and local community health "promotoras" lists of pre-selected addresses that were chosen using a randomized cluster sampling method. No substitutions were allowed and surveyors validated the house location through visits from the survey supervisor and a GIS device used during the time of the survey. The result of this sampling process was randomized selection of households in the communities of Mecca, Coachella, North Shore, Oasis and Thermal. This environmental health study (with 195 households) was a subset of the larger environmental health study with an enrollment of 645 households. The survey and sampling methods were approved by the Loma Linda University Institutional Review Board.

Data Collection

The survey team requested permission to conduct the home hygiene assessment after the residents gave informed consent for the health questionnaire. The surveyors would often travel in teams where some interviewers would conduct the survey questionnaire while others would conduct the home hygiene assessment. In the case where a respondent was not home, the health surveyor would visit the location several times at different times of the day and/or ask neighbors when that respondent was home.

Many of the selected households gave consent for the survey questionnaire, but did not give consent for the environmental assessment. The rate of refusal for the home

hygiene study was higher in North Shore neighborhoods where many respondents preferred to have the interview done outside of their home and not allow the surveyors to enter. The sample is comprised of 195 houses with a primary respondent facilitating the home environmental assessment. The majority of interviewees are female (51.1%), living with their spouse, with a mean age of 40.7 years old, and educational attainment to high school. Almost 98% of the respondents are Hispanic/Latino, with 72.7% immigrants born in Mexico. The main two cities that compose this sample are Coachella (36.8%) and Mecca (34.8%). 96% of participants speak fluent Spanish, but only 46.8% of them speak fluent English.

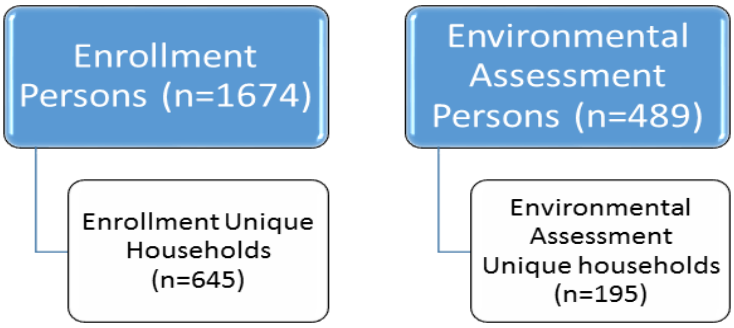

FIGURE 3 ENROLLMENT OF HOUSEHOLDS IN THE STUDY.

Response and Cooperation Rates

The number of households that responded to the health survey and participated in the home hygiene assessment is the cooperation rate (CR). Those were the number of households that were invited to participate (eligible) and those that agreed to participate or refused or otherwise unable to participate in the home hygiene study. The cooperation rate is the proportion of cases that participated of all eligible or invited to participate. The CR = 195/645 = 30.2%. In comparing the characteristics of environmental assessment participants and non-participants we found the population to be very similar and our sub-sample representative of the larger group.

Environmental Indicators

The environmental indicators measured during the home environmental assessment included several visual observations about the home and some real-time assessments of the air, water and surfaces using specific instruments. Table 3 lists these instruments and their operating parameters. Appendix 1 contains the assessment protocol that was administered in each household.

TABLE 5 METHODS USED IN THE HOME HYGIENE ENVIRONMENTAL ASSESSMENT FOR REAL-TIME DATA.

Parameter	Instrument	Detail	Units of measure
PM1	HazDust EPAM-5000	Run for 30minutes in each house with the cyclone attachment for PM1	Average of PM1 mg/M^3
ATP water	Hygiena Luminometer	Used 1 total ATP sampler for water on primary drinking water source	Total ATP as Relative Light Units (RLU).
ATP surface	Hygiena Luminometer	Used 1 total ATP swab on $100cm^2$ of center dining table.	Total ATP as Relative Light Units (RLU).
Black Light dust	UV 395nm black light	Counted dust particles visible to black light on $100cm^2$ surface below center dining table.	Dust per $100cm^2$
ERMI	qPCR of house dust	Collected total house dust on electropositive swab and sent to a USEPA laboratory.	Concentrations calculated for the ERMI.
Temperature	Non-contact Infrared Thermometer	Collected the temperature on the wall and temperature on the window in the living room.	Celsius (C^o)

Results:

Observations and environmental sensor tests were conducted in homes to assess the indoor environment and to provide real-time feedback to the residents. The Table 6 below shows results from the real-time assessments and the mold assessment that took place during the household study.

TABLE 6 ALL INDOOR TESTS FOR HOUSEHOLDS.

Variables	Number of Households	Min - Max	Average (*SD)
Mold: ERMI (Group I - Group II)	135	(-)2.99 - 38.6	8.02 (6.44)
Indoor Air Quality: PM1 dust (mg/m^3)	135	0 - 0.33	0.03 (0.05)
Surface Contaminants: Luminometer ATP from $100cm^2$ of food prep surface	143	0 - 9068	1584 (2017)
Floor Hygiene: UV 295 floor test (Number of specs / $100cm^2$)	143	0 - 576	46.9 (86.2)
Drinking Water: Luminometer ATP of drinking water source	108	0 - 565	24.9 (77.0)

* Standard Deviation

Home Characteristics

Observational assessments of the physical home are presented in Figures 4, 5 and 6. Homes were built before 1979 (30.8%), between 1980 and 1999 (21.5%), and built after 2000 (47.7%). There were 44% of the homes considered single family homes, 22.3% are apartments and 33.7% are mobile homes (Figure 5). The largest group (34.8%) of participants have lived at their residence for over 10 years (Figure 6).

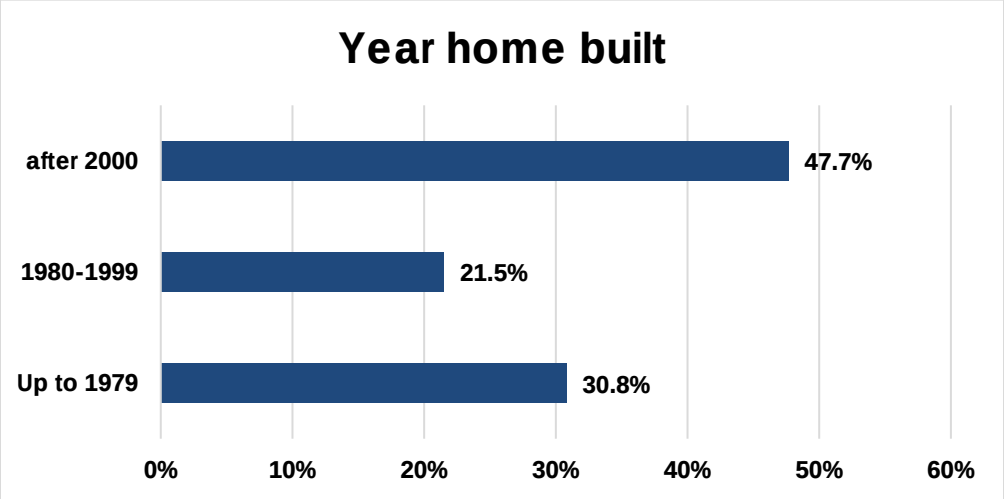

FIGURE 4 YEAR HOME BUILT

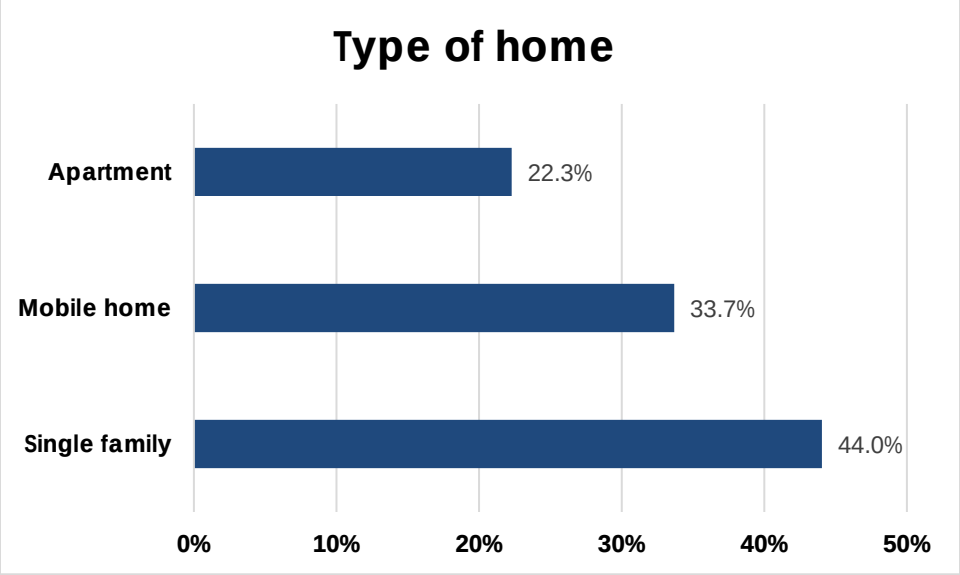

FIGURE 5 TYPE OF HOME

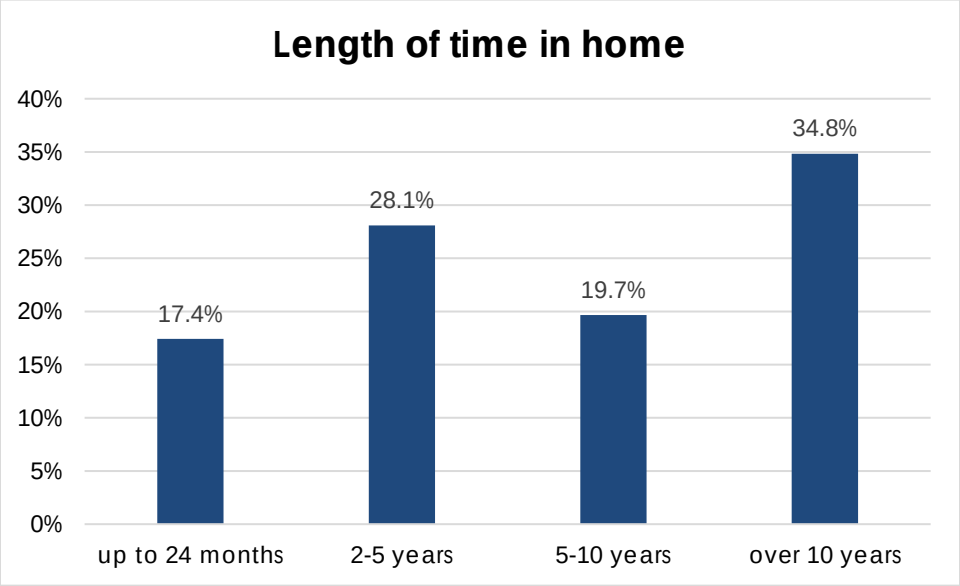

FIGURE 6 YEARS LIVED IN HOME

Surface Hygiene

The majority of residences are stick-built homes with a wooden frame, with 33.3% as stucco, 19.5% wood, 25.2% aluminum siding, and 0.6% adobe. Over 74% of the dwellings have at least[5] central air conditioning system, 40% utilize at least windows ac or electric fans, and 5.7% have an evaporative cooling systems (Table 7 and Figure 7). The evaporative cooling system is hypothesized as a possible contributor to the high mold concentrations reported in Table 7. The data was validated from google satellite images with visits to select homes where uncertainty about the cooling system existed. Some adjustments were made to the initial report of cooling systems, and an additional 38 homes were included with information on cooling system, which on the original data were missing.

The assessment team found that 17% of the air filters on heating/cooling systems were not changed as recommended, based on answers to the question: "Do you ever replace your air filter?" The USCDC recommends changing the air filter frequently, according to manufacturer, which usually ranges from every 6-12 months for homes with no pets and occupants with no allergies (USCDC, USDHUD, 2006).

The team found that 46.8% of the windows were not adequately sealed and only 19% had double pane glass (Table 7). Less than half of the residences had some carpet with 60% having some linoleum or vinyl or tile. Only 4% had some wood flooring.

[5] Households have "at least" a central air conditioning system with the possibility of other types of climate control systems.

TABLE 7 SURFACE HYGIENE VARIABLES AMONG HOUSEHOLDS

Variable	N (%)
House material	
Aluminum	40 (25.2%)
stucco/wood	32 (20.1%)
Stucco	53 (33.3%)
Adobe	1 (0.6%)
Wood	31 (19.5%)
Brick	2 (1.3%)
Total	159
Cooling system	
At least central air	146/192 (76%)
At least swamp/evaporator	11/192 (5.7%)
At least window ac/fans	78/192 (41%)
Change air filter	
Yes	83 / 100 (83%)
No	17 / 100 (17%)
Insulation system	
Window seals	52 / 111 (47%)
Double pane windows	21 / 111 (19%)
Type of flooring	
At least carpet	81/195 (42%)
At least vinyl/tile	117/195 (60%)
Wood	9/195 (4.6%)

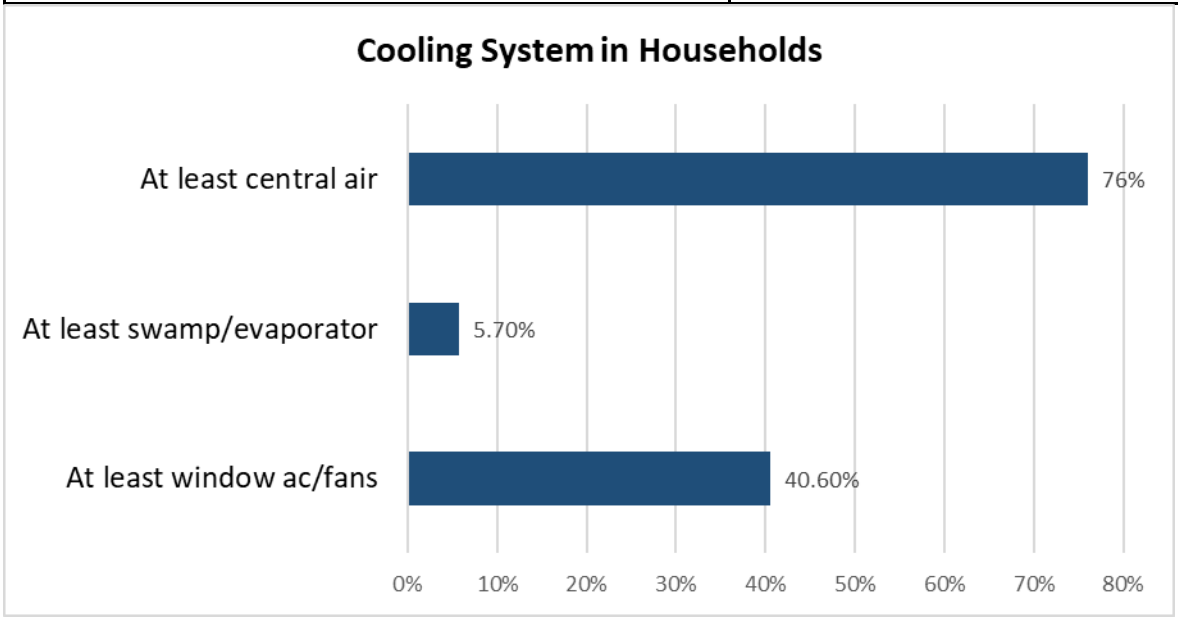

FIGURE 7 COOLING SYSTEM IN HOUSEHOLDS

Cleaning Products, Pests and Pets

The majority of households use at least bleach (47.2%) or Ammonia (24.6%) products for cleaning purposes. Evidence or presence of pests were observed or confirmed by the respondent in 49 of the homes (25.1%). The presence or evidence of pets, mainly dogs and cats, were reported or observed in 87 homes (55.1%).

TABLE 8 OBSERVATIONS OF CLEANING PRODUCTS, PESTS AND PETS

Variables	N (%)
Type of cleaning supplies	
At least bleach	92/195 (47.2%)
At least Ammonia	48/195 (24.6%)
At least borax	19/195 (9.7%)
At least natural	9/195 (4.6%)
Presence or evidence of pests (mice, rats, bedbugs, cockroaches)	
Yes	49 (25.1%)
No	146 (74.9%)
Total	195
Presence or evidence of pets (dogs, cats, other)	
Yes	87 (55.1%)
No	71 (44.9%)
Total	158

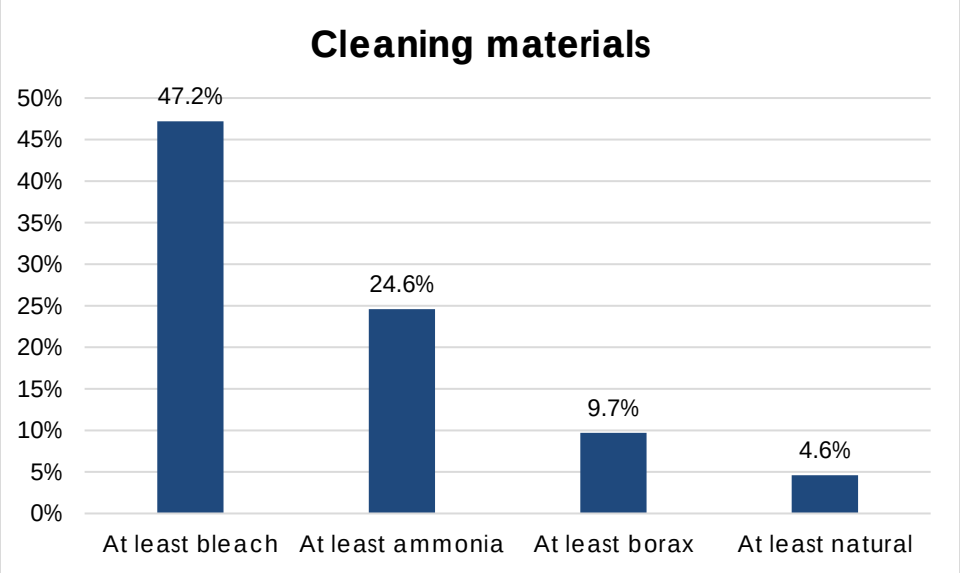

FIGURE 8 CLEANING MATERIALS USED IN HOUSEHOLDS

TABLE 9 MEDIAN AND MEAN ATP RESULTS ON FOOD PREPARATION SURFACE.

Variable	Median (*IQR)	Mean (SD)	p-value
Type of House (N=143)			
Single family	846 (2210)	1775.89 (2137.7)	0.27
Mobile home	547 (1451)	1474.6 (2065.30)	
Apartment	740 (1591)	1413.35 (1741.85)	
Type of cooling system (N=143)			
Central air	819 (1514)	1486.2 (1775.4)	0.40
Evaporator	2243 (6868)	3003.5 (3380.6)	
Window ac	443 (1243)	1436.9 (2234.3)	
Type of flooring (N=128)			
carpet	771 (1313)	1375.14 (1759.9)	0.60
vinyl/tile	785 (3181)	2036.5 (2442.8)	
wood	516	756 (448.1)	
Type of cleaning (N=116)			
bleach/ammonia/ajax	708 (1295)	1496.8 (2082.9)	0.94
natural/borax/vinegar	700 (1165)	1311 (1597.3)	
Type of cleaning: at least bleach (N=143)			
Yes	703 (1457)	1485.1 (1998.9)	0.51
no	786 (2056)	1902.5 (2073.4)	
Presence or evidence of pests (N=143)			
Yes	1007 (2356)	1671.7 (2025.2)	0.86
No	728 (1308)	1544.2 (2023)	
Presence of pets (N=142)			
Yes	785 (1214)	1402.9 (1797.7)	0.80
No	692 (2444)	1811.8 (2264.5)	

*Interquartile range *SD – Standard Deviation

Drinking Water

There were 70.4% of the houses with microbial contamination in their drinking water sample (Figure 8). This method used the Hygenia Luminometer total ATP test[6] for total bacteria in water. Surveyors obtained this water sample from the household's primary drinking water source, as identified by the household members. This was a refillable jug of water on a cooler spigot or a filtered water source from the refrigerator (Figure 8).

[6] https://www.hygiena.com/food-and-beverage-products/aquasnap-food-and-beverage.html

The surveyors used the HACH low range arsenic test kit (HACH, Loveland, Colorado, USA)[7] for tap water tests. The team found arsenic above the 10ppb USEPA maximum contamination[8] level in 7 homes out of the total of 195. All seven of these homes were mobile homes where the residents were already aware about arsenic in their tap water.

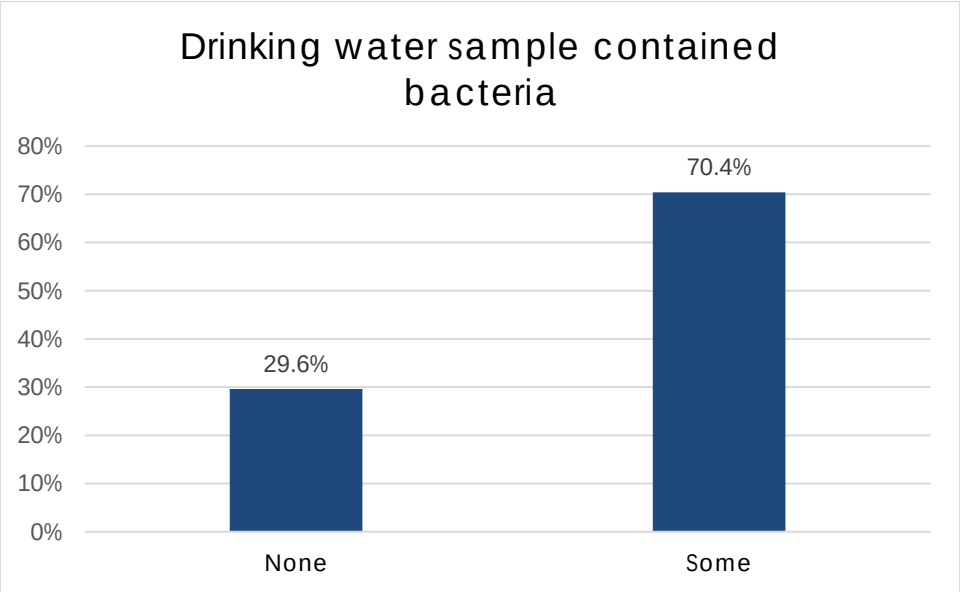

FIGURE 9 PRESENCE AND ABSENCE OF DRINKING WATER SAMPLES THAT CONTAINED BACTERIA.

[7] https://www.hach.com/arsenic-low-range-test-kit/product-details?id=7640217303
[8] https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

TABLE 10 MEDIAN ATP RESULTS ON WATER SAMPLE PER SOURCE OF WATER COLLECTED

Variable	Median (IQR)	Mean (SD)	p-value
Source of water tested (N=100)			
Tap water	1 (5)	19.64 (82.46)	**<0.001**
Filter	12.5 (21)	13.62 (10.78)	
Refrigerator	60.5 (156)	84.25 (85.47)	
Bottle water	7.5	7.5 (2.12)	
Gallon/jugs	20 (73)	52.75 (67.63)	
Pairwise comparison	**Test Statistic (SE)**		**P-value (Adj. p-value)[a]**
Tap vs gallons/jugs	-39.926 (10.61)		**0.001 (0.002)**
Tap vs refrigerator	-47.301 (14.65)		**0.001 (0.012)**
Source of water tested (N=107)			
Tap water	1 (5)	19.64 (82.46)	**<0.001[b]**
Other	12 (30)	33.28 (52.85)	
Source of water tested (N=86)			
Tap water	1 (5)	19.64 (82.46)	**<0.001[b]**
Gallons/Jugs	20 (73)	52.75 (67.63)	

[a] Significance values adjusted by the Bonferroni correction for multiple tests.

[b] Mann Whitney U test

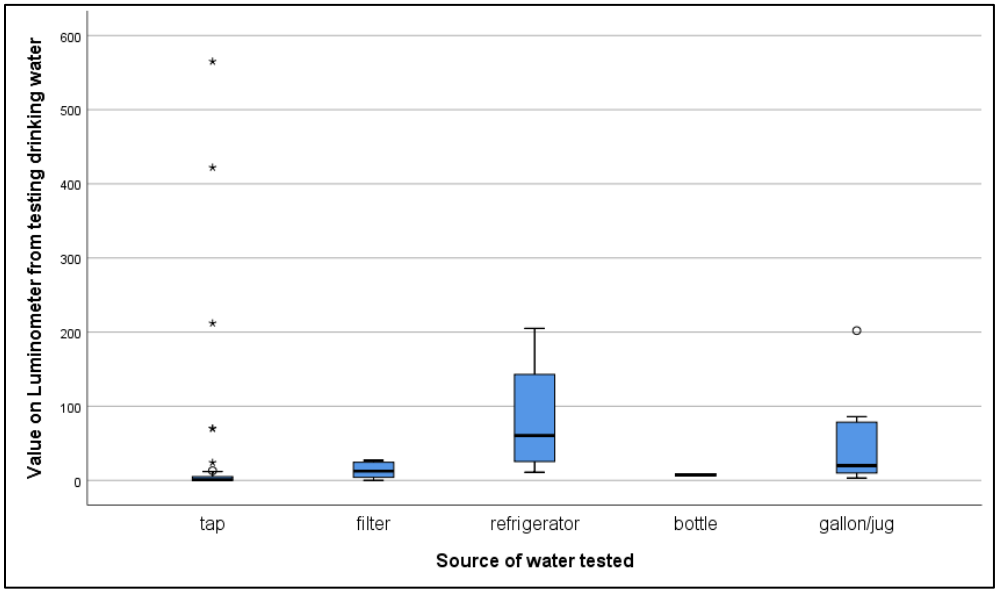

FIGURE 10 BOX PLOT OF VALUES ON WATER LUMINOMETER PER DRINKING WATER SAMPLE

Indoor Air Quality

The surveyors measured PM1 indoor air quality by placing the Hazdust EPAM 5000 in a central location of the house for 30 minutes. The Hazdust sensor collects a time-weighted-average of the indoor dust concentration of dust sizes that are smaller than 1-micron particle size. The sensor gives results in milligrams per cubic meter of air (mg/M^3)[9].

Surveyors collected a dust sample for mold that was processed by a USEPA approved lab[10] . The mold assessment used the Environmental Relative Moldiness index (ERMI) method. The ERMI metric classifies 36 indicator mold species and mathematically converts these into a single number where the larger the ERMI value, the greater the mold contamination. This method is in the section titled "Exposures: Types and Measurements".

Apartment homes with central air conditioner systems had lower PM1 than older homes with evaporative coolers, window air conditioners, or in homes without their filter changed frequently. Newer homes that built after 2000 presented a lower PM1 value than all other homes (Figure 10 & Table 11)[11]. The ERMI was significantly lower in newer homes built after 2000.

The surveyors assessed surface hygiene using a UV 395 portable light and followed the method in the above section called "Exposures: Types and Measurements". Table 12 shows counts of fluorescing specs per $100cm^2$ were significantly higher medians in apartments, in houses with carpet, in homes with no pets, and in households who use natural cleaning products versus bleach/ammonia products[12]. Wood floors had significantly less fluorescing organics detected than carpet.

[9] https://www.skcinc.com/catalog/index.php?cPath=300000000_303000000_303000400
[10] https://www.mycometrics.com/
[11] Statistically significant by the Kruskal-Wallis test (p=0.028) adjusted by the Bonferroni correction.
[12] Statistically significant results by the Kruskal-Wallis test and adjusted by the Bonferroni correction.

TABLE 11 ERMI RESULTS PER VARIABLE

Variable	Mean (SD)	p-value
Type of House (N=135)		
Single family	8.96 (7.34)	0.168
Mobile home	8.19 (6.78)	
Apartment	6.28 (3.58)	
Type of cooling system (N=132)		
Central air	7.68 (6.56)	0.393
Evaporator	10.94 (10.97)	
Window ac	8.84 (4.61)	
Type of flooring (N=95)		
Carpet	7. 22 (5.98)	0.466
vinyl/tile	8.21 (6.45)	
Wood	11.93 (1.72)	
Type of cleaning (N=80)		
bleach/ammonia/ajax	7.33 (5.86)	0.563
natural/borax/vinegar	8.18 (6.88)	
Year built		
Up to 1979	9.39 (6.60)	**0.006**
1980 to 1999	10.02 (7.71)	
After 2000	6.09 (4.61)	
Year built post-hoc Tukey HSD	**Mean diff (SE)**	
After 2000 vs Up to 1979	-3.30 (1.28)	**0.03**[a]
After 2000 vs 1980 to 1999	-3.94 (1.42)	**0.018**[a]
Up to 1979 vs 1980 to 1999	-0.63 (1.53)	0.91
Presence or evidence of pests		
Yes	8.73 (5.67)	0.47
No	7.79 (6.69)	
Presence of Pets		
Yes	6.73 (4.98)	0.177
No	8.36 (6.87)	
Change air filter		
Yes	7.49 (6.12)	0.214
No	10.01 (7.77)	

Note: all analysis comparing groups were parametric tests, with t test or ANOVA where appropriate. [a] p-value indicate post-hoc Tukey's HSD test between groups.

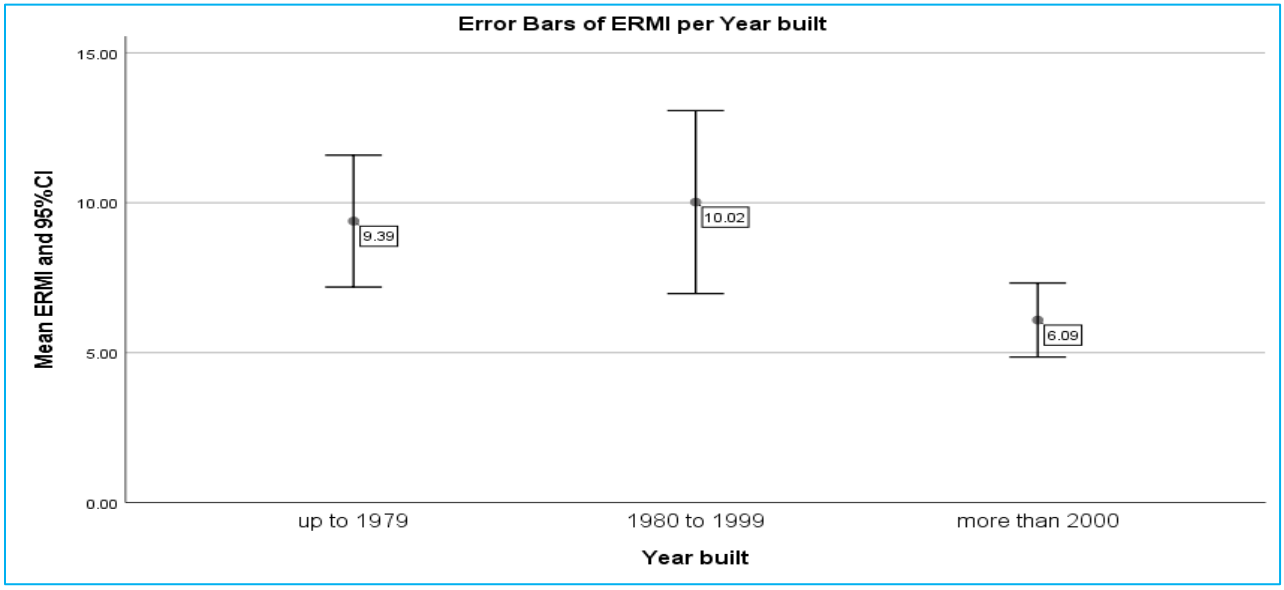

FIGURE 11 ERROR BARS SHOWING MEAN AND 95% C.I. OF ERMI PER YEAR OF HOME BUILT.

TABLE 12 HAZDUST RESULTS OF PM[1] PER VARIABLE.

Variable	Median (IQR)	Mean (SD)	Geometric Mean	p-value
Type of House (N=134)				
Single family	0.02 (0.035)	0.028 (0.025)	0.00	0.058
Mobile home	0.03 (0.028)	0.044 (0.049)	0.029	
Apartment	0.018 (0.024)	0.045 (0.082)	0.019	
Type of cooling system (N=135)				
Central air	0.02 (0.035)	0.037 (0.055)	0.00	0.244
Evaporator	0.03 (0.075)	0.056 (0.057)	0.036	
Window ac	0.03 (0.023)	0.034 (0.025)	0.026	
Type of flooring (N=123)				
Carpet	0.028 (0.032)	0.036 (0.044)	0.00	0.616
vinyl/tile	0.02 (0.030)	0.039 (0.06)	0.00	
Wood	0.018	0.029 (0.029)	0.019	
Type of cleaning (N=113)				
bleach/ammonia/ajax	0.029 (0.034)	0.042 (0.054)	0.00	0.424
natural/borax/vinegar	0.024 (0.028)	0.028 (0.021)	0.021	
Year Built (N=119)				
Up to 1979	0.036 (0.044)	0.048 (0.051)	0.032	**0.028**
1980 to 1999	0.022 (0.032)	0.028 (0.027)	0.00	
After 2000	0.018 (0.030)	0.037 (0.063)	0.00	
Year built Pairwise comparison	**Test Statistic (SE)**			**P-value (Adj. p-value)[a]**
After 2000 vs Up to 1979	17.87 (7.25)			**0.014 (0.041)**
1980 to 1999 vs up to 1979	19.05 (9.04)			0.035 (0.105)
1980 to 1999 vs after 2000	-1.181 (8.37)			0.888 (1.00)
Presence or evidence of pests (N=135)				
Yes	0.023 (0.031)	0.029 (0.025)	0.00	0.427
No	0.026 (0.032)	0.041 (0.058)	0.00	
Presence of pets (134)				
Yes	0.023 (0.030)	0.031 (0.031)	0.00	0.332
No	0.028 (0.035)	0.046 (0.068)	0.00	
Change air filter (N=83)				
Yes	0.018 (0.028)	0.028 (0.038)	0.00	0.152
No	0.028 (0.041)	0.04 (0.038)	0.028	
Note: all tests were non-parametric, with Kruskal-Wallis or Mann-Whitney U when appropriate.				
[a] Significance values adjusted by the Bonferroni correction for multiple tests.				

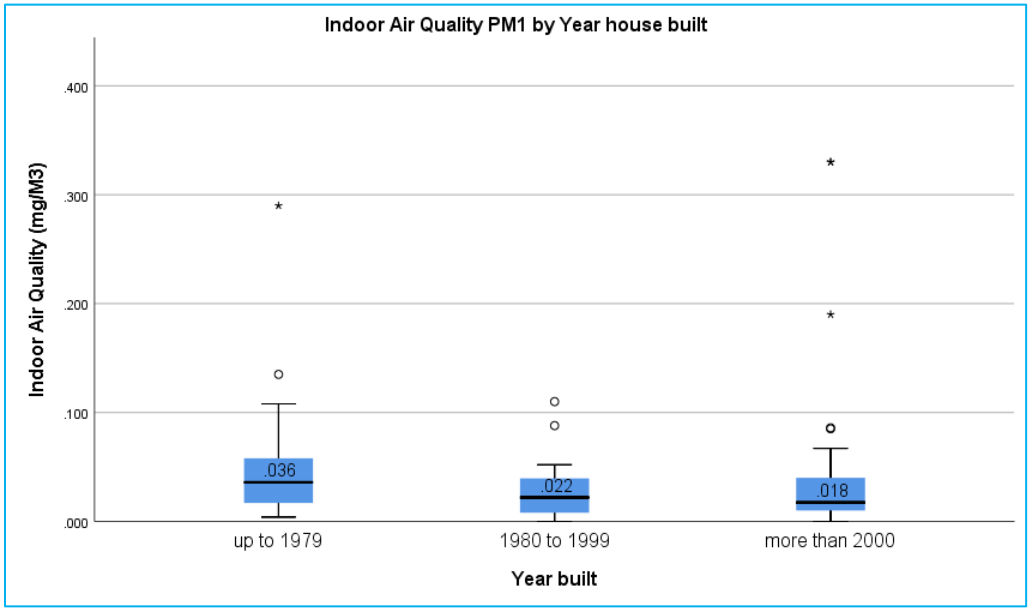

FIGURE 12 INDOOR AQ PM1 BY YEAR BUILT

TABLE 13 UV 395 FLUORESCING PARTICLE TESTS PER VARIABLES

Variable	Median (IQR)	Mean (SD)	p-value
Type of House (N=142)			
Single family	14.5 (30)	41.17 (94.07)	**0.006**
Mobile home	10 (27)	31.62 (55.7)	
Apartment	30 (66)	77.86 (100.7)	
Type of house comparison	**Test Statistic (SE)**		**P-value (Adj. p-value)[a]**
Mobile home vs apartment	-27.47 (9.17)		**0.003 (0.008)**
Single family vs apartment	-23.82 (8.74)		**0.006 (0.019)**
Type of flooring (N=127)			
carpet	20 (60)	62.7 (102.9)	**0.007**
vinyl/tile	15 (28)	27.65 (49.56)	
wood	0	1.67 (2.89)	
Flooring comparison	**Test Statistic (SE)**		**P-value (Adj. p-value)[a]**
Wood vs vinyl/tile	39.55 (21.82)		0.07 (0.210)
Wood vs carpet	54.43 (21.64)		**0.012 (0.036)**
vinyl/tile vs carpet	14.88 (6.7)		0.026 (0.079)
Type of flooring: at least carpet (N=143)			
Yes	20 (60)	62.7 (102.9)	**0.006[b]**
No	13 (25)	30.4 (61.1)	
Type of cleaning (N=115)			
bleach/ammonia/ajax	15 (31)	40.65 (71.12)	0.117
natural/borax/vinegar	21 (40)	66.97 (121.63)	
Presence or evidence of pests (N=143)			
Yes	15.5 (57)	62.89 (118.3)	0.59
No	15 (34)	39.79 (66.9)	
Presence of pets (N=143)			
Yes	10.5 (32)	45.68 (98.01)	**0.031[b]**
No	17 (44)	48.27 (71.31)	

[a] Significance values adjusted by the Bonferroni correction for multiple tests.

[b] Mann Whitney U test

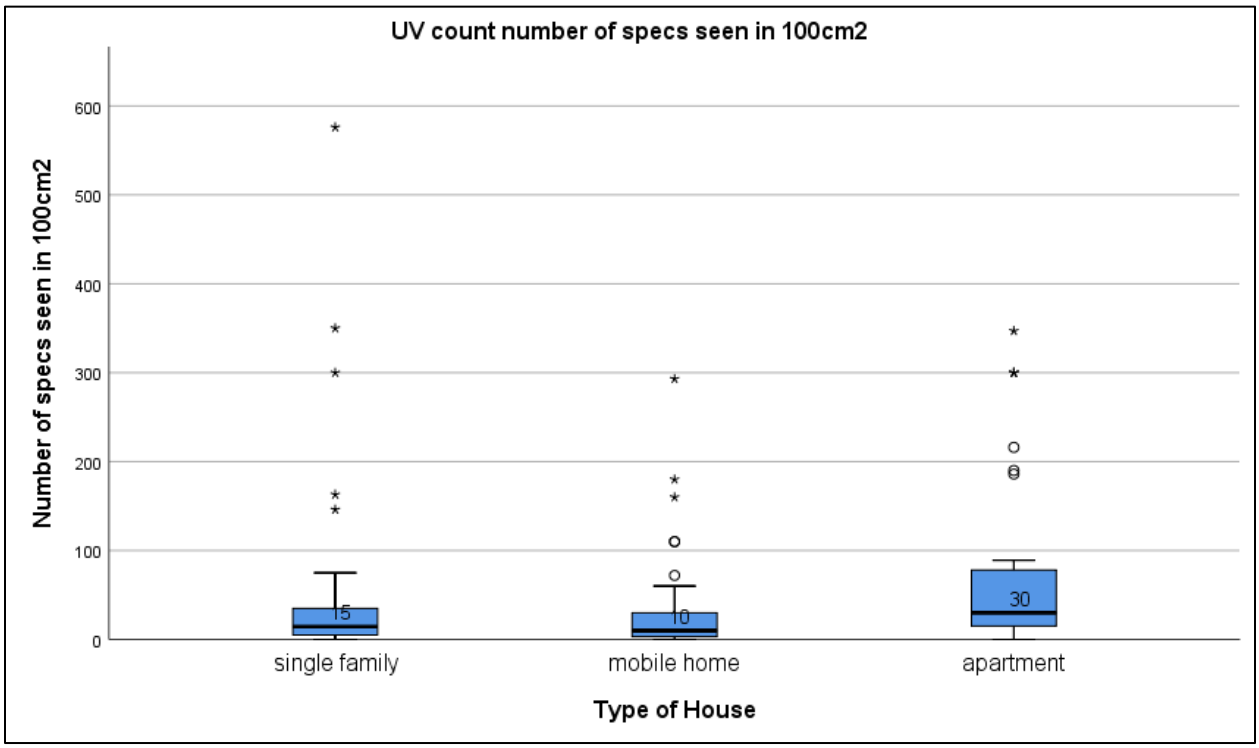

FIGURE 13 COUNT OF UV FLUORESCING PARTICLES SEEN IN 100 CM^2 SHOWN BY HOUSING TYPE.

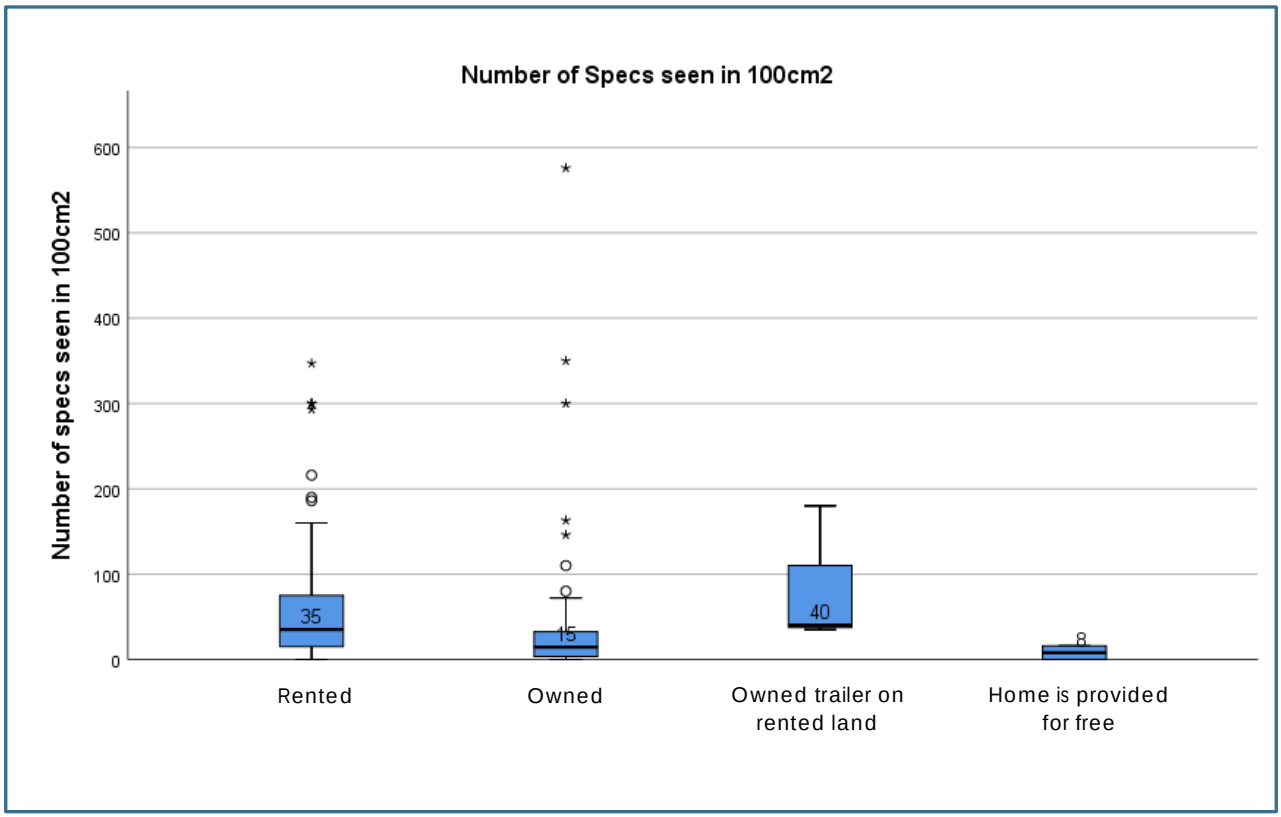

FIGURE 14 NUMBER OF UV FLUORESCING PARTICLES SEEN IN 100 CM^2.

Discussion and Recommendations

This study evaluates contaminants within ECV homes due to environmental injustices and regional disparities. The working hypothesis is that contaminants exist in the home that can increase the public health risk for diseases and conditions such as asthma, infectious disease, and other negative conditions. This report summarizes the environmental contaminants and individual exposures to those contaminants. The environmental household assessment builds on health disparity themes developed in a population-based report on health status of residents of the ECV (Villarejo, Kresge, & Wadsworth, 2012).

Drinking Water

Many households in this study are outside the limits of water district services and rely on well water sources contaminated with arsenic or other chemicals (London, Greenfield, & Zagofsky, 2013). The residents are aware of the contamination and purchase drinking water from water stores, water vending machines, or have drinking water delivered to them. In all of these scenarios, residents will use a water cooler or other secondary spigot to deliver the water. Surveyors in this study sampled the drinking water source in each home and tested it with an ATP sensor that provides a number to estimate the concentration of bacteria within one minute of collecting the sample. This was a useful method to collect data, but also to inform residents of the bacterial contamination in drinking water.

Over 70% of the samples in the study detected the presence of microbial contamination in the drinking water source. The results were higher among samples collected from the 5-gallon jugs that families use to store the water they purchased from a vending machine or water store. If the household was on a tap water source with chlorine, the ATP luminometer reported zero bacteria in all but five samples (Table 9). The USEPA National Primary Drinking Water Regulations (NPDWR) state that the Maximum Contaminant Level Goal for public water systems should contain zero microorganisms, in order to pose no health risk (USEPA, 2015). The water stored in the 5-gallon jugs and refrigerator filter were positive for ATP with a mean count of 52 and 84 respectively (Table 9).

Indoor Air Quality

The proximity of homes to agricultural areas can increase exposure to dust, pesticides and herbicides that can lead to poor respiratory health outcomes (Ward, et al., 2006). Many of the homes and communities in the ECV are directly adjacent to agricultural fields and often located on dirt roads resulting in airborne dust. To protect the indoor environment from contaminants unique to the ECV, the ideal home should have dual

pane windows, updated weather seals and an updated climate control system that effectively filters contaminants out of the indoor air. Most mobile homes and older single family homes in the area lack this type of infrastructure.

Central Air Conditioning: Figure 7 describes the cooling systems with 76% of all households observed as having a central cooling system and 5.7% having an evaporative cooler. The high percentage of homes with a central AC system suggests good indoor air quality management. Those systems should adequately filter the indoor air quality if they are maintained. Of the houses with a central AC, 83% were found to have changed their filter recently. Table 12 shows indoor air particulates for the different types of air conditioning systems and other indoor air quality considerations.

The PM_1 concentrations were higher among older dwellings, with a median of 36 µg/m^3 for houses built before 1979, median of 22 µg/m^3 for houses built between the years 1980 and 1999, and median of 17µg/m^3 for newer houses, built after 2000. Median PM_1 was higher on houses that do not change air filter (28µg/m^3) compared to those that change their air filter (18µg/m^3). Those houses with central air conditioning present with lower median PM_1 (20µg/m^3 versus 30µg/m^3). Although not statistically significant, a central air conditioning system could reduce the indoor air PM1 particles by 33% in some ECV homes. The age of the home was the only measure that showed significance on Table 12.

Windows: Since older houses may not have proper insulation and upgraded windows, they are likely to have more dust penetration from the outdoors and less efficient indoor filtering of new dust created. The Table 7 shows that only 19% of 111 houses had double pane windows and almost half (47% of 111) had functional weather seals on the windows. A weatherization program could help decrease indoor air contaminants by upgrading windows and insulation.

Carpet: The UV 395 fluorescing dust check showed that there was a higher median particle count in apartments than in single-family homes or mobile homes (30 versus 14.5 and 10). This may be because apartments usually have carpeted floors, and households with carpet had higher counts than those with wood flooring, tile, or vinyl (23 versus 15). Those households that reported as using bleach or ammonia cleaning products had a lower median UV dust count than houses using natural products (15 and 21 respectively).

PM1: The PM_1 metric is a better indicator, than $PM_{2.5}$ or PM_{10}, because the smaller particles can reach the alveoli and produce inflammation, and consequently, release mediators that promote acute episodes of respiratory diseases (Li, Wen, & Zhang, 2017) such as asthma. The PM_1 is the particle size that has the most negative health effect on lung function parameters (Zwozdziak, et al., 2016). There are no standards for PM_1 set by the USEPA or other agencies, but recent studies from Asian cities suggest that 24-hour averages of outdoor air above 30µg/M^3 were associated with increased emergency

department visits (Li, Wen, & Zhang, 2017). The median PM_1 of houses that did not change their air filter was 28 µg/M^3.

The measure of PM_1 within the households had a median TWA (Time Weighted Average) of 0.025 mg/m^3 or 25 µg/m^3 and a mean TWA of 0.038 mg/m^3 or 38 µg/m^3. There is no current established guideline for PM_1 concentrations, the outdoor ambient air quality standard for $PM_{2.5}$ is 25 µg/M^3 as a 24-hour mean and annual mean of 12 µg/m^3 for $PM_{2.5}$ (USEPA, 2012) (Heal, Kumar, & Harrison, 2012). These weight-based standards for $PM_{2.5}$ are less than the PM_1 values observed in the homes of this study. This is concerning because a PM1 sized particles are more potent than PM2.5 and should have a standard much lower than the PM2.5.

Mold and ERMI: The year of house construction is associated with increased mold and ERMI values (Méheust, et al., 2012) (Sinclair, Russell, Kray, & Vesper, 2018). In this report, the mean ERMI values were higher for houses built before 1979 and between 1980 and 1999 (9.39 and 10.02 respectively) when compared to newer homes built after year 2000 (6.09). the type of cooling system also presents differences in the mean ERMI, with a lower mean (7.68) for houses with central air conditioning and higher means for houses with evaporative coolers or window air conditioners (10.94 and 8.84 respectively). The lack of air conditioning was linked to higher ERMI values in other studies and associated with a low socioeconomic status (Reponen, et al., 2013).

Damp indoor spaces are associated with upper respiratory tract symptoms, coughing, and asthma symptoms in sensitized persons (Institute of Medicine (US), 2004). Exposure to mold inside homes increases within homes that are not well- insulated, older dwellings, with pets, with leaks, and lack of air conditioning. Higher ERMI values occur especially among older dwellings. Some materials of older mobile homes and older stick-built homes, and uneven surfaces make it difficult to remove microbes, limiting surface cleaning as a control measure to prevent transmission of pathogens or other indoor contaminants (Rutala, Barbee, Aguiar, Sobsey, & Weber, 2000).

Recommendations:

Education about Drinking Water Vending Machines: The 5-gallon water jugs used to store drinking water were positive for bacteria (Table 9). This finding lead to a related study and report that investigates the drinking water vending machines in the ECV. The finding and the separate vending machine investigation require that residents should be aware of the water that they are purchasing and the standards for commercial vending machines. Many of the households with contaminated 5-gallon water jugs were also on the district tap water. Many of these residents may not realize that their tap water is disinfected with a chlorine residual and is tested for bacteria daily. The drinking water vending machines require monthly testing and maintenance, but offer no publicly visible indication that they are monitored. An education program about the

drinking water vending machines should occur in tandem with improved publicly visible maintenance of the vending machines.

Point Of Use Water Filters: Pueblo Unido CDC provided several reverse osmosis under-sink water filters to Polanco parks in the ECV. This is an improved interim option for residents who are reliant on drinking water from contaminated wells. The Pueblo Unido organization is working with the ECV infrastructure task force to advocate for public funded drinking water pipe infrastructure into the area.

New Filters in AC Units: The first recommendation is to maintain indoor AC systems by updating the filter to protect the health of those inside the home. This is a feasible recommendation because over 76% of observed houses, apartments and trailers have a central AC system (Figure 7). Continually running and maintaining the central AC system may seem expensive or not necessary, but the potential improvements in respiratory health outweighs the added expense. In many cases, installing new filter media in existing AC systems will filter and trap fine particulates.

Use AC to Prevent Moisture: Maintaining the central AC system will regulate the humidity, reduce the likelihood of moisture, and control mold problems in the home. Excess heat and moisture facilitates mold growth and pest infestation. Mold spores and pest irritants in a home are known to trigger and sometimes initiate Asthma in children (USEPA, 2014) (USCDC, 2017).

Weatherization: A weatherization assistance program could also help improve indoor air quality because it would replace old windows, window seals and some insulation in a home. These programs exist to update a home so that the home's infrastructure can sufficiently filter out the fine particulates and keep the indoor air quality stable and often better than the outdoor air quality. This is important for the Eastern Coachella Valley due to the agricultural particulate pollution, ozone pollution, occasional odor, and modulate hot summer temperatures.

Surfaces: Many older homes in the Eastern Coachella Valley are mobile homes or modified mobile homes that have uneven surfaces that are difficult to clean. This report found that older houses (trailers and mixed-use homes) had a higher amount of mold contamination (Figure 10). This is due to many infrastructure factors, but one being that older houses have surfaces that are more porous and difficult to clean. Most solutions are prohibitively expensive and recommendations require policies to promote construction of housing that is appropriate for the current population.

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Appendix 1: The home environmental assessment

Initial Entry to House: ☐Explain visit / Consent ☐Validated *promotora* name_____ ☐Setup Hazdust ☐Start Sample for Arsenic ☐Musty/Moldy ☐no odor, air freshener ☐cat/dog waste smell ☐dusty ☐evidence of smoker ☐incense/candle/potpourri ☐chemical cleaning smell ☐ no smell Note:_____

Kitchen: ☐ Ask to look in kitchen for chemicals/cleaning supplies under sink and other locations. Ask to take samples of water and surfaces

Brand	Product	Liquid/Gel/ Powder/ Bar Solid		Brand	Product	Liquid/Gel/ Powder/ Bar Solid

☐ Gas stove ☐ electric stove. ☐ Stove vent/fan ☐Fire ext. present&working. ☐ oily/dirty walls near food prep. ☐ Easy to clean wall surfaces (tile/plastic/stone or glossy paint or wood). ☐ old uneven wall surfaces difficult to clean (fake/old wood, old trailer style). ☐ sponge in/around sink. ☐ dish rag/cloth for hand dishwashing. ☐Steel wool. ☐functioning refrigerator ☐Hot water flows ☐Cold water flows ☐Stove for cooking

☐Floor type_____☐Visible mold: site of mold:_____ size:_____cm x _____cm.
☐Mice/rat feces/gnawing under sink or behind appliances. ☐roaches/silverfish/moths under sink or behind appliances

Kitchen Samples – let water run from tap for **2 minutes**, then collect sample. ☐Verify kitchen tap water is unfiltered.

Luminometer Water- let run 2 minutes prior: use clean cup they drink from: Use black stick.
☐ from unfiltered kitchen tap:
Value:_____ RLU
☐ From other source:
Value: _____ RLU
circle other source: Fridge w/filter | water cooler filled from vending machine or store | water cooler water fresh from company| undersink or house water filter | other:
_____

Chlorine Water – Let water run 2 min. use sample container: & follow instr For total Cl.
☐ Total Cl value _____ppm

Water Lab Sample- Use sample bottle. Collect from tap: let run 2 minutes prior. Fill to 100ml line.
☐ Collect from unfiltered kitchen tap:
☐ From other source:
circle other source: Fridge w/filter | water cooler filled from vending machine or store | water cooler water fresh from company| undersink or house water filter | other:
_____

Arsenic Water- Use kit bottle: let run 2 minutes prior. Fill to line.
☐ Collect from unfiltered kitchen tap: If not available obtain from another tap.
Value: ppm

Luminometer surface- swab 100cm^2 of food prep area /cutting board. Use red swab.
☐ Food prep surface
Value:_____ RLU

Luminometer hand- swab 10 fingertips of person attending you in the house. Use red swab.
☐Value:_____ RLU

Surface Lab sample- Use supplied rayon tipped swab and label with HID and swab 100cm^2
Write site name on swab tube.
☐Food prep surface: site name_____
☐Second food surface: site name_____

Living Room ☐ Ask to look behind & under furniture. Be unobtrusive and don't move furniture.

Black light- select a dark, but well-traveled location on the living room floor, shine the black light 10cm up at an area of 10x10cm.Use template Count the number of fluorescing specs visible with human eye.
☐ # of particles_____/100cm^2
Site location: _____
☐Floor type in living room: ☐short carpet ☐Medium or long carpet☐Linoleum or vinyl ☐wood or wood analogue ☐mixed ☐Tile☐Other_____

Indoor Dust- select a well-traveled location in the where most people pass through. Set the Hazdust on that table and begin the measurement. Choose "overwrite" The Hazdust should be drawing air from the center of the room/area at the height of a child's breathing zone. Check flow at 4L/min. Leave unit for entire visit. Record before leaving.
☐ Sample taken for _____min
☐ TWA average _____mgPM$_1$/M^3 air
☐ smoker in house☐cooking while sampling

Temperature- select a wall with sunlight shining on it and a nearby window. Aim the IR thermometer at the wall and record an average temperature °F at your head height. Aim the IR thermometer at the center of the window and record the temperature.
☐ temperature of wall _____°F
☐ temperature of window_____°F
☐ has double pane windows
☐ single pane windows

☐ Ask to see the AC system to check the filter. ☐The filter has dust you can push off with your finger | ☐ The HVAC functions | ☐Central AC and heat ☐ ceiling fan in living room ☐ other electric fans around☐Evaporative "swamp" cooler ☐Window AC units ☐ Other cooling units:_____ | ☐ Well insulated from solar thermal heating (has weather stripping/seals) | ☐ Kitchen/bathroom ventilation fans☐Bedroom ceiling fans☐Oven ventilation fan☐has open windows(with or without screen). |

☐ Smoke alarms working and well placed ☐ Carbon monoxide alarm working ☐ Alarms present, BUT not functioning☐No alarms | Heat fuel: ☐Natural gas☐Electric☐Oil☐Propane☐Wood | ☐Space Heaters ☐Oven as heater ☐HVAC with furnace ☐Other:____

Noise: ☐TV is on constantly☐Radio is always on☐Loud outdoor noise☐Loud vehicle noise☐Other_____
Entertainment: ☐TV>10" ☐DVD/video game☐large music stereo☐Other electronics_____
☐>10 books/book shelf☐Separate living room from house
Appearance: ☐Crowded with too much stuff☐Spacious clean and organized☐Cluttered and unorganized☐Neglected and needs cleaning☐Vacant seems out of use☐Other

Cleaning equipment: ☐Vacuum☐Vacuum with HEPA☐Damp mop/dusting mop☐ dry Sweep broom
Number of people sleeping in ☐living room_____☐ in bedrooms_____per bedroom for _____bedrooms in house
Pests: ☐Mice/rat feces/gnawing in HVAC or around furniture ☐roaches/silverfish/moth or their waste seen.
Plumbed Amenities: ☐Hot/Cold water☐flushing toilet☐shower for bathing☐windows that open/close☐Has laundry washer☐Dryer

Pet Management on next page….

Bedroom: ☐Ask to go into child's bedroom otherwise adults bedroom for asthma assessment. If no access take mold sample from living room and kitchen.
☐Able to access bedroom. ☐No child's bedroom and only adult bedroom ☐Not given access to child's bedroom☐No access to any |
☐Took mold sample (use antistatic wipe with a gloved hand to wipe all door jams, fan tops, tops of picture frames for dust. Keep wiping until the wipe is very dirty. Place in ziplock bag with gloved hand. Discard glove, and label bag with HID using a black sharpie marker. Store in cooler or refrigerator)
☐Checked bed for bedbugs: ☐Has bedbugs in bed. ☐Mice/rat feces/gnawing around furniture ☐roaches/silverfish/moth or pest waste seen. ☐Total number of bedrooms visited in home _____

Yard:☐Ask to go into backyard to see pet management. Look for dog waste, pets, animals, living structures, solid waste. ☐Not given access to backyard

Pet management –

Dogs -.☐ How many dogs _____	***Cats*** - ☐ How many cats _____	***Other Animals*** -☐ How many _____
☐Kept strictly outdoors ☐Inside home but not allowed in bedrooms ☐full access in home ☐sleeping location_____ ☐Not sure&do not see dogs around the home ☐Not given access to house/yard for pet observe. Odor: ☐slight in house ☐heavy in house ☐slight in yard ☐heavy in yard Waste: ☐Not in yard ☐present in yard ☐smelled it but could not find it	☐Kept strictly outdoors ☐Inside home but not allowed in bedrooms ☐full access in home ☐sleeping location_____ ☐Not sure&do not see cats around the home ☐Not given access to house/yard for pet observe. Odor: ☐slight in house ☐heavy in house ☐slight in yard ☐heavy in yard Waste: ☐With indoor litterbox☐With outdoor litterbox ☐No waste seen in yard ☐present in yard ☐smelled it but could not find it	☐Type of animal_____ ☐Inside home but not allowed in bedrooms ☐full access in home ☐sleeping location ☐Not sure&do not see any around the home ☐Not given access to house/yard for pet observe. Odor: ☐slight in house ☐heavy in house ☐slight in yard ☐heavy in yard Waste: ☐With indoor litterbox☐With outdoor litterbox ☐No waste seen in yard ☐present in yard ☐smelled it but could not find it Note:

Pests: Look for evidence behind stacked wood and other yard clutter. Look around trashcans and recycling bins.

Trash cans: ☐tidy with lids☐Trash cans uncovered and accessible to rodents☐recycling bins tidy and closed☐recycling bins unorganize with piles of recyclable items in yard☐not sure/cannot determine

☐Mice/rat with feces/burrows seen ☐roaches seen

Standing water seen: ☐in Tires☐In recycled plastics☐In open trash cans☐ puddles on ground ☐In Old stuff like pots/pans/buckets☐N standing water ☐Unable to determine☐ Note_____

☐Water pressure _____psi Obtain water pressure from an outdoor spigot. Remove hose and place dial guage on spigot. Completely open spigot and record number

The House is/has: ☐A home garden☐adjacent to an agricultural field☐children toys in yard☐grass lawn☐xeriscaped☐appears not maintained at all☐does have some shade structures☐does have some shade trees☐is fenced and secure☐has swimming pool☐Other_____

Front Yard: Complete this during your backyard visit or on your way out of the house

Type of building materials: ☐wood frame☐ stucco☐brick or block☐Adobe☐Trailer (vinyl or aluminum)

Floors lived in: ☐Basement ☐1st floor ☐2nd floor ☐3rd floor or higher

Other dwellings in yard used for sleeping: ☐lean-to, storage shed, ☐barracks, ☐other trailers/RVs, ☐A garage, ☐Other_____. ☐None.

Cooling: ☐Shade trees on house ☐External windows have outdoor shade against sun ☐Internal windows are covered with thermal blocking curtains ☐internal windows have blinds☐%of roof covered by shade_____

Vehicles on property: ☐# cars/trucks___☐#RVs/Buses___☐#Bicycles____☐motorcycles____☐tractors or other_____

Odors in yard: ☐fertilizer odor ☐chemical odor ☐trash odor ☐sewage odor ☐pleasant odor or natural odor

Home needs: ☐structural maintenance ☐Repairs on home or yard in progress ☐Needs no maintenance☐ Other_____

The foundation is: ☐with a basement☐ a slab on soil ☐has a crawlspace ☐is a multi-story home

Overall experience ☐Respondent was accommodating, pleasant and interested in assessment, ☐seemed busy and rushed my assessment, ☐didn't seem to mind my assessment and let me conduct the walk-around.

Common cleaners

Brands	Product	Liquid/Gel/ Powder/ Bar Solid
Clorox/Tuxedo/Cardenas/Rosa	Bleach	Liquid
Pine sol/tea tree/home sense/Baking soda/ Borax/Vinegar	Plant based or other Natural cleaner	Liquid/powder
AJAX cleanser	Bleach based powder	powder
Dawn/Palmolive/Gain	Antibacterial Dishwashing soap	Liquid
409/Windex/Window	All purpose ammonia cleaner "QUAT"	Spray liquid