Appendix 2:

Adapting to Rising Tide's Social Vulnerability and Contamination Burden Mapping

Summary

The San Francisco Bay Conservation and Development Commission (BCDC) Adapting to Rising Tides (ART) Program developed a dataset to better understand community vulnerability to current and future flooding due to sea level rise and storm surges. The community vulnerability shapefile contains 4 categories of information:

1. **Social Vulnerability Indicators**

Certain socioeconomic characteristics may reduce ability to prepare for, respond to, or recover from a hazard event. Census block groups with high concentrations (relative to the 9 county Bay Area) of these characteristics are flagged as socially vulnerable, with each block group assigned a rank of highest, high, moderate, and low. Data are from American Community Survey (ACS) 2016 5-year estimates.

2. **Contamination Vulnerability Indicators**

The presence of contaminated lands and water raises health and environmental justice concerns, which worsen with flooding and sea level rise. A rank of highest, high, moderate, and lower for the severity of contamination in each block group was calculated using data compiled by CalEPA Office of Environmental Health Hazard Assessment (OEHHA) for use in CalEnviroScreen 3.0.

3. **Residential Exposure to Sea Level Rise**

Calculated by intersecting Metropolitan Transportation Commission 2010 residential parcel data with 2017 ART Bay Area Sea Level Rise and Shoreline Analysis data, FEMA 100 and 500 year flood zone data, and San Francisco 100 year precipitation data to generate percent residential exposure at

each water level by block group. The number of residential units exposed in each block group was divided by total residential units per block group.

4. **Complementary Community Vulnerability Screening Tools**

Many screening approaches exist to characterize disadvantaged or vulnerable communities. Often in the Bay Area, different designations of disadvantaged/vulnerable communities are located in the same area. It is recommended to use the ART approach in combination with other complementary tools and designations. The following are included in this shapefile as fields for cross-referencing: CalEnviroScreen 3.0 total score, Metropolitan Transportation Commission Community of Concern designation, UC Berkeley Displacement and Gentrification Typologies.

Development Process

This dataset originated in the 2015 Stronger Housing, Safer Communities project. The project's advisory committee of recognized experts, including community advocates, selected social characteristics which contribute to vulnerability to hazards (flood and seismic), drawing on professional experience, local knowledge, and consultation of academic and federally-sponsored research. Additional attributes ranking the presence of contaminated sites were added to the dataset following input from the working group for the ART Bay Area project, Policies for a Rising Bay project, and BCDC Environmental Justice and Social Equity Bay Plan Amendment. Data and methods should be continually updated as thinking surrounding community and social vulnerability evolves.

Mapping Social Vulnerability and Contamination Burden

Definitions of social vulnerability vary across contexts and screening tools. In the context of hazard mitigation, resilience, and climate adaptation planning, 'social vulnerability' often refers to social and economic barriers that diminish the capacity to prepare for, respond to, and recover from a harmful event such as a flood. The goal of mapping social vulnerability with sea level rise is to identify areas where people will be impacted more heavily by flooding due to preexisting social and economic stressors. There is precedent for similar mapping tools that illuminate social vulnerability as a critical element to consider in planning, including

CalEnviroScreen 3.0. The ART program developed a dataset specific to social vulnerability to hazard (flood and seismic) risk. Creating a new mapping tool was particularly important, as CalEnviroScreen 3.0 uses Census tracts, and not blocks, which did not give high enough resolution to capture key communities in the Bay Area.[i] The dataset originated in the 2015 Stronger Housing Safer Communities project, a partner effort between BCDC and the Resilience Program at the Association of Bay Area Governments to better understand and characterize housing and community vulnerability to flooding and earthquakes, and to develop strategies to reduce these vulnerabilities.[ii]

An advisory committee of recognized experts, including community advocates, developed criteria for vulnerabilities and strategies based on professional experience, local knowledge, and consultation of academic and federally sponsored research. The methodology and mapping have been further refined through review from organizations such as the Bay Area Regional Health Inequities Initiative,[iii] Resilient Communities Initiative[iv], the Resilient by Design Bay Area Challenge,[v] and the ART Bay Area Regional Working Group. We hope to update these as understandings of social vulnerability mapping evolve.

ART Social Vulnerability Ranking

Social vulnerability was ranked using a triggering methodology. Block groups that have a concentration of individuals or households with a particular vulnerability characteristic that is either in the 70th percentile or 90th percentile are counted towards a "total". Each block group was given a total count of indicators that scored above the two triggering rates. Indicators in each category are counted the same, when in real life they do not contribute equally to vulnerability. For example, income may contribute more to community vulnerability than the presence of young children, but it is difficult to quantify how much more. The combination of both these characteristics results in higher vulnerability than either one on its own, which is why a total count method is used.

Rankings of social vulnerability were assigned by looking at the distributions of the data. Block groups labeled "**Highest social vulnerability"** have:

- 8 or more social vulnerability indicators with rates in the 70th percentile, relative to nine county Bay Area; *and/or*

- 6 or more social vulnerability indicators with rates in the 90th percentile, relative to nine county Bay Area

Block groups labeled "**High social vulnerability"** don't meet criteria in "Highest" category, and have:

- 6-7 indicators in the 70th percentile; *and/or*
- 4-5 indicators in the 90th percentile

Block groups labeled "**Moderate social vulnerability"** don't meet criteria in "Highest" and "High" categories, and have:

- 4-5 indicators in the 70th percentile; *and/or*
- 3 indicators in the 90th percentile

Block groups labeled "**Low social vulnerability**" don't meet any of the criteria above, and those labeled "**Not calculated**" contained characteristics that were not estimated in the American Community Survey, due to low population and other factors leading to low survey response.

ART Social Vulnerability Indicators

The indicators used by the ART Program do not represent all socioeconomic characteristics, but those which specifically contribute to increased vulnerability to hazards. These characteristics are not transposable with "disadvantaged communities," which have a specific definition in state law. Disadvantaged communities include environmental hazards and adverse health impacts, such as poor air quality and respiratory health issues. To incorporate these elements of disadvantage, tools such as CalEnviroScreen are cross-referenced in the ART Bay Area project. Other community vulnerability mapping that may be of use the project are those from the Metropolitan Transportation Commission and the Bay Area Air Quality Management District, which are partner agencies working at the regional scale. Displacement screening was added after the project working group made clear that it is necessary to consider displacement is early stages of the project—during researching community vulnerability, and not only considered when evaluating the impacts of potential adaptation strategies later in the project.

Renters

Renters have less control over the condition of housing than those who own their homes. Renters have a limited ability to make repairs or improvements, such as flood proofing, and less information about hazards. During disaster recovery periods, information about financial aid and resources from federal programs are focused on homeowners. Rental households are more likely to be low-income and endure greater health impairments due to housing unaffordability. Renters are vulnerable to eviction and face greater risk of displacement—an extensive problem in the Bay Area. A similar characteristic is used in the Stronger Housing, Safer Communities project, CalEnviroScreen 3.0, and MTC's Communities of Concern. [vi] [vii] [viii] [ix] [x] [xi] [xii] [xiii] [xiv]

Young Children Under 5

Young children are more physically impaired by floodwater covering walkways, more likely to come into contact with contaminated water, have more sensitive immune systems susceptible to disease and exhaustion, and are more vulnerable to the effects of climate change.[xv] An association between rain events and children's emergency department visits has been observed.[xvi] Young children have greater care needs which still need to be met during a hazard event. These include daycare or other childcare services, or specific material needs, such as formula and diapers. Sufficient information is often not available about the locations and specific needs of young children, and they can experience more difficulties in evacuation.

Older Adults

Older adults are also more physically impaired by floodwater covering walkways, more susceptible to disease and exhaustion, more likely to have a pre-existing health condition and disability, declining and more vulnerable to climate change health effects.[xvii] Older adults are more likely to need special food, medications, and medical equipment, making them more vulnerable to power outages and other impacts of hazards. Sufficient information is often not available about the locations and specific needs of older adults, and they can experience more difficulties in evacuation. Cognitive function declines as we age, making processing information and responding during a disaster more difficult for the elderly. Older adults can be on a limited fixed-income and have less financial ability to respond to or recover from a hazard. Older adults which live alone are particularly vulnerable. A similar characteristic is used in the Stronger Housing, Safer Communities project and MTC's Communities of Concern. [xviii] [xix] [xx] [xxi] [xxii]

People of Color

People of Color may face additional obstacles to preparing for and recovering from a flood event, due to historic and ongoing racism. The grouping together with the term People of Color (POC) should not be taken to mean that people of different ethnicities and races experience the same burdens. Present and historical inequities in economic, political, and social systems result in adverse impacts to populations of color, including higher instances of adverse health conditions, higher likelihood of living in housing of inadequate quality and/or in a hazard zone, limited economic opportunities and access to the decision-making process, tenuous relationships with first responders, and more. The Race Counts initiative, launched in 2017, quantifies racial disparities in California across numerous topic areas. Across the U.S., mortality rates from asthma—which is worsened by mold growing in damp or wet structures—for Black populations are 3 times higher than for White populations.[xxiii] Research following a 2006 flood in El Paso, Texas identified Hispanic ethnicity as a significant risk factor after controlling for other socioeconomic factors such as age and housing quality. [xxiv] A similar characteristic is used in the Stronger Housing, Safer Communities project and MTC's Communities of Concern. [xxv xxvi xxvii xxviii xxix xxx xxxi]

Very Low Income

Income level affects most aspects of life. Lower income lessens the ability to prepare for, respond to, and recover from a hazard event. Inadequate or unsafe housing, societal marginalization, inadequate infrastructure and access to services all afflict the poor. Poor people have been found more vulnerable to hazards in many ways, including being less likely to evacuate during a hazard.[xxxii] In some regions, higher incidences of vector-borne disease have been found in low-income populations.[xxxiii] Populations with lower incomes have less access to insurance and entitlement programs, lower ability to pay for medical care, are more likely to live in housing in poor condition, have less options for rebuilding and/or relocating housing.[xxxiv] A similar characteristic is used in the Stronger Housing, Safer Communities project, CalEnviroScreen 3.0, DWR disadvantaged community designation, and MTC's Communities of Concern. [xxxv xxxvi xxxvii xxxviii xxxix xl xli xlii xliii]

Without a Vehicle

During a flood or hazard event, services such as public transportation may be disrupted. Access to a vehicle is important for evacuation during emergencies, and also for mobility if a transit service used for commuting or activities is disrupted, particularly if this is the sole route. This vulnerability may be compounded when elderly populations and people with disabilities may be unable to drive, and low-income households are less likely to own a vehicle, and increasingly households are encouraged to go car-free to contribute to reductions in greenhouse gas emissions. A similar characteristic is used in the Stronger Housing, Safer Communities project, and MTC's Communities of Concern. [xliv] [xlv] [xlvi] [xlvii]

People with Disability

People with disabilities experience impairments in cognitive, physical, and/or sensory functions. While the needs of people with disabilities are specific and varied, all will face disproportionate impacts from climate change and face greater obstacles in society in general. Obstacles include exclusion in the workforce and limited economic opportunities, and reduced capacity to adapt to societal and economic changes. Changes which require relocation are detrimental to people with disabilities as they disrupt personal support networks, healthcare services, accessible and safe housing, and more.[xlviii] Specific accommodations are needed for the safe evacuation and shelter of people with disabilities during an emergency. [xlix] The needs of people with disabilities are often not adequately addressed in disaster relief and recovery plans, if they are addressed at all,[l] and often experience "invisibility" to decision-makers.[li] Communication materials and methods often do not adequately accommodate those with impaired cognitive function, hearing, or vision,[lii] and information available to first responders may be limited about the location and specific needs of people with disabilities. People with disabilities are more likely to rely on delivered medical supplies and services and need continued electricity for the functioning of equipment and are therefore more vulnerable to power outages. A similar characteristic is used in the Stronger Housing, Safer Communities project, and MTC's Communities of Concern. [liii] [liv] [lv] [lvi] [lvii] [lviii] [lix]

Single Parent Families

Single-parent households are more stressed financially and socially, impacting many aspects of livelihood, including the ability to cope during and after an emergency or hazard. As the single

parent must balance work with care for dependents, their ability to continue to meet the specific care needs of dependents, particularly those of young children, and pay for childcare is lowered, which may be problematic both during an emergency or hazard event and during recovery. Single-parent households are more likely to require public assistance, more affected by a disruption of services, more at risk of income loss, and face other obstacles during recovery. There can be limited information available about the locations and specific needs of single parent household families, and they can experience more difficulties in evacuation. A similar characteristic was used in Communities of Concern designation.[lx] [lxi]

Limited English Proficiency

Limited English proficiency has been found to result in racial discrimination, and the discrimination combined with language difficulties have been associated with reduced socioeconomic status and quality of life, and stress.[lxii] Linguistically isolated households face disproportionate environmental hazard risks, and have been independently related to cancer risk and proximity to toxic facilities.[lxiii] Limited English speakers are more likely to report difficulties in accessing medical care, accessing health-related information, and are more likely to delay access to care.[lxiv] Planning activities and materials are often not conducted and prepared in appropriate languages, restricting the political power of Limited English proficiency communities, and putting them at greater risk during hazard events. Other materials are frequently English-only, including communication during emergencies and information about aid available during the following recovery. In the Bay Area, many Limited English proficiency communities are also resource-constrained renters often living in overcrowded housing, resulting in intensified.[lxv] Limited English proficiency is limited to immigrant communities, further heightening risk. A similar characteristic was used in Stronger Housing, Safer Communities, CalEnviroScreen 3.0, and MTC's Communities of Concern designation.[lxvi] [lxvii] [lxviii] [lxix] [lxx] [lxxi] [lxxii] [lxxiii]

Without a High School Degree

Higher educational attainment relates to many aspects of resilience and wellbeing, such as, but not limited to, higher access to government services and the political system, greater lifetime earnings, greater mobility, and has been associated with better health outcomes.[lxxiv] Hazard warning information, recovery materials, and planning processes are often not written for

audiences with lower educational attainment. A similar characteristic was used in both Stronger Housing, Safer Communities and CalEnviroScreen 3.0. [lxxv] [lxxvi] [lxxvii] [lxxviii] [lxxix] [lxxx] [lxxxi] [lxxxii]

Severely Housing-cost Burdened

Housing affordability is important to health, resilience, and wellbeing.[lxxxiii] [lxxxiv] Housing affordability for both renters and owners is an existing challenge in the Bay Area that will compound the number of community members displaced by a natural disaster. Much of the region is cost-burdened with regard to housing already, spending 50% or more of income on housing. After a disaster, if many housing units are lost, a constrained market may drive up the cost of housing even further. Loss or damage of housing that results in increased costs to either renters or home-owners will likely increase the number of permanently displaced Bay Area residents as finding housing that is affordable and near jobs, schools, medical facilities, and other services on which they rely will be challenging (Stronger Housing, Safer Communities). Rental households which are housing cost burdened have been associated with adverse health conditions and lower educational outcomes in children.[lxxxv] Conditions where many households are severely housing cost burdened and other unaffordable housing situations can contribute to community instability and crime.[lxxxvi] A similar characteristic was used in Stronger Housing, Safer Communities, CalEnviroScreen 3.0, and MTC's Communities of Concern designation.[lxxxvii] [lxxxviii]

ART Contamination Ranking

Contamination burden ranking followed a similar methodology to socially vulnerability. For each block group, the number of characteristics (in this case, pollution types) in the 70th and 90th percentiles, determined the contamination vulnerability rank.

Contamination indicators represent degradation or threats to communities and the natural environment from pollution. The presence of contaminated lands and water raises health and environmental justice concerns, which worsen with flooding and sea level rise. A percentile score for the severity of contamination in each block group was calculated using data compiled by CalEPA Office of Environmental Health Hazard Assessment for use in the Environmental Effects category of CalEnviroScreen 3.0. In CalEnviroScreen calculations, the Environmental Effects component is weighted half when incorporated into the total pollution burden. By looking

at the Environmental Effects components isolated from the CalEnviroScreen total score, specific risk to contamination becomes clearer. The 5 specific types of contamination are:

- Land with hazardous substances undergoing cleanup actions, original source data from Dept. Toxic Substances Control and US EPA (Superfund Sites)
- Sites that may impact groundwater and require cleanup, original source data from State Water Resources Control Board
- Presence of hazardous waste generators and permitted facilities that are involved in the treatment, storage, or disposal of hazardous waste, original source data from DTSC
- Water bodies that do not meet water quality standards, listed as impaired under Section 303(d) of the Clean Water Act. Data from State Water Resources Control Board.
- Presence of solid waste sites and facilities, original source data from CalRecycle and DTSC

Rankings of social vulnerability were assigned by looking at the distributions of the data. Block groups labeled “Highest contamination vulnerability” have:

- 4 or more contamination indicators with rates in the 90th percentile, relative to the state; and/or
- Total contamination score above 90th percentile, relative to the state

Block groups labeled “High contamination vulnerability” don’t meet criteria in “Highest” category, and have:

- 5 indicators in the 70th percentile; and/or
- Total contamination score between 80th – 90th percentile

Block groups labeled “Moderate contamination vulnerability” don’t meet criteria in “Highest” and “High” categories, and have:

- 4 indicators in the 70th percentile; and/or
- Total contamination score between 70th – 80th percentile

Block groups labeled “Lower contamination vulnerability” don’t meet any of the criteria above.

Methodology

Indicators were developed as a regional screening tool to help identify locations where households are at greater risk of impacts from sea level rise due to existing social and economic conditions. Locations are identified using a triggering level methodology developed by the Metropolitan Transportation Commission (MTC) to identify Communities of Concern (CoC). The triggering level methodology identifies US Census block groups that are above a specific

concentration of individuals or households with a particular characteristic. The triggering levels, which are reported as a percent, are determined for each indicator by calculating the regional mean + ½ standard deviation. This methodology only looks at the co-occurrence of these factors individually and does not address intersectionality of any confluence of characteristics.

Calculations and threshold determinations are based on data from the nine county Bay Area region. Many complementary tools work at the state or national scale, and therefore generate percentiles of vulnerability for a given location relative to the rate in the state or country. When working with socioeconomic data—such as looking at income, housing costs—it is more representative to compare bay area geographies with bay area geographies, as "statewide scoring can mask important within-region inequities, which can make these areas fall below the regulatory radar screen."[lxxxix]

This methodology is appropriate for local to regional scale planning but should not be used for project reviews or environmental assessments. Screening tools generate a total vulnerability "score" which may or may not satisfactorily represent vulnerability in any given location and may not be the best characteristics for understanding each community's unique challenges. Conducting supplemental analysis to the screening analysis can provide a more comprehensive understanding.

The data is compiled for use in macro-scale (regional) analysis, hazard planning and research, and can be overlaid and intersected with different geospatial extents of hazard zones—such as future elevated water levels due to sea level rise. Locational precision is useful in these overlay analyses, and so the smallest geographical unit available for the data, block group, [xc] is used. Estimates from the ACS at the block group scale have greater uncertainty than estimates at larger scales, as the aggregates of larger numbers of survey responses will result in smaller margins of error. It is recommended to use both the estimate and the margin of error provided for each characteristic in the dataset, generating a range instead of a definitive count. Additionally, even the smallest available spatial unit of analysis from the census is not able to capture variabilities from individual household to household or all differences among neighborhoods. ArcGIS shapefiles are available for use in mapping and analysis and can be downloaded from the ART Program's Maps and Data Products page.

The triggering methodology uses the following percentages for each social vulnerability indicator:

Socioeconomic characteristics that may increase vulnerability					
Populations or households that are:	Measure	70th pctl rate	90th pctl rate	2012-2016 American Community Survey (ACS) table number	ACS Universe
Renters	% Renter occupied households	58%	81%	**B25003**: Tenure	Occupied housing units
Under 5	% People under 5	7%	10%	**B01001**: Sex by age	Total population
Very low income	% People under 200% poverty rate; and/or % Households with income less than 50% of Area Median Income	30% ; 35%	50% ; 52%	**C17002**: Ratio of income to poverty level in the past 12 months; and/or **B19001**: Household income in the past 12 months (in 2016 inflation-adjusted dollars) with Dept. of Housing and Community Development State Income Limits for 2016	Population for whom poverty status is determined & Households
Not U.S. citizens	% People not U.S. citizens	17%	26%	**B05002**: Place of birth by nativity and citizenship status	Total population
Without a vehicle	% Households without a vehicle	9%	22%	**B25044**: Tenure by vehicles available	Occupied housing units
People with disability	% Households with 1 or more persons with a disability	26%	35%	**B22010**: Receipt of food stamps/snap in the past 12 months by disability status for households	Households

Single parent families	% Single parent families	11%	21%	**B11004**: Family type by presence and age of related children under 18 years	Families
Communities of Color	% People of Color	70%	91%	**B03002**: Hispanic or Latino origin by race	Total population
65 and over living alone	% Households with 1 or more people 65 years and over	11%	19%	**B11007**: Households by presence of people 65 years and over, household size and household type	Households
Limited English proficiency	% Limited English speaking household	11%	21%	**C16002**: Household language by household limited English speaking status	Households
Without a high school degree	% People 25 years and older without a high school degree	15%	30%	**B15003**: Educational attainment for the population 25 years and over	Population 25 years and over
Severely housing cost burdened	% Households spending greater than 50% income on housing; renter-occupied and/or owner-occupied	32% ; 20%	47% ; 33%	**B25070**: Gross rent as a percentage of household income in the past 12 months & **B25091**: Mortgage status by selected monthly owner costs as a percentage of household income in the past 12 months	Renter-occupied housing units & Owner-occupied housing units

Limitations

This analysis should be considered a starting place. “Ground truthing” in the areas identified through a robust, community-driven engagement process is the first step to using this analysis

to properly inform planning. In-depth vulnerability assessments at the site scale, conducted in partnership with the communities being assessed, will yield critical additional insight.[xci]

In attempting to define and map social vulnerability, several programmatic limitations within ART emerged that should be considered carefully when using this tool:

- Lack of resources for community engagement and ground-truthing during the course of the project
- Results are tied to impact on the populations considered only where people's homes are, not all of the various systems they rely on
- The analyst team, in general, has a lack of lived experience and expertise with social and contamination vulnerability characteristics as studied
- The ART program dealt with turnover and, at times, patchy continuity in relationship building and assessment
- Due to the nature of this type of approach, there is a top-down and external definition of social vulnerability that was broached with but not vetted though the communities that were mapped
- The approach does not include positive qualitative characteristics, such as community cohesion and social capital, which also could have benefitted from further community engagement

Within our programmatic scope, we determined the best methodology for mapping and comparison. The following also presented limitations to our methodology that should be considered:

- Characteristics included are only those with publicly-available data that can be consistently compared (quantitatively) across the 9 County Bay Area region. Not all characteristics that influence community vulnerability are included in this dataset.
- Residential sea level rise exposure was calculated using the most current data available in 2018, and exposures to very high levels of sea level rise (which correspond with later time horizons) should be used cautiously as they were not calculated using population projections.

Use limitations to consider when working with American Community Survey (ACS) data

ACS estimates are available by geographical unit, in this dataset the block group, and do not represent where people actually live within that block group. Statistical testing to determine

significance is recommended to definitively state that values in one block group are different than another block group. Statistical testing was not conducted for every block group in the Bay Area, as this dataset functions as a regional screening tool. ACS data are reported with an estimate and a margin of error, which represents 90% confidence that the actual value is within that range. In instances where the margin of error represents over half the estimate, this data should be treated as unreliable. For more information, refer to: ACS Handbook for Data Users (Researchers)

Complementary Community Vulnerability Screening Tools Included in the ART project

CalEnviroScreen 3.0

Disadvantaged communities have a specific definition in California law. CA Senate Bill 535[xcii] directs funds from the State's cap-and-trade program to benefit "disadvantaged communities" and tasked CalEPA with the responsibility to develop the method to identify these communities. CalEPA Office of Environmental Health Hazard Assessment (OEHHA) created and updates the CalEnviroScreen tool, which combines pollution burden and population characteristics to generate a percentile score by census tract, relative to other tracts around the state. Funds directed to disadvantaged communities was increased with CA Assembly Bill 1550.[xciii] CalEnviroScreen3.0 is the most recent version. In addition to the 5 contamination indicators described in the previous section, CalEnviroScreen3.0 includes data about direct exposure to Drinking water contaminants, Diesel PM, PM2.5, Ozone, Pesticides, Traffic, Toxic releases from facilities. Population characteristics used are rates of Asthma, Cardiovascular disease, Low birth-weight infants, Educational attainment, Housing burdened low income households, linguistic isolation, unemployment, poverty.

MTC Communities of Concern

The Metropolitan Transportation Commission (MTC) is a partner of the ART Program also working at the regional scale. MTC works to prepare Plan Bay Area (PBA), the integrated Sustainable Communities Strategy and Regional Transportation Plan for the San Francisco Bay Area. If implemented, PBA works to reduce greenhouse gas emissions from passenger vehicles

through coordinated transportation, housing, and land use planning, as instructed by CA Senate Bill 375 (SB 375).[xciv] MTC convened a regional equity working group to develop Communities of Concern (CoC), designed to represent where communities may be disadvantaged or exhibit vulnerabilities now, and in response to future growth. The equity analysis of PBA 2040 analyzes the positive and negative impacts of PBA strategies on CoCs, compared with impacts on the remainder of the region. The ART approach includes (and supplements) the same characteristics as CoCs, and CoCs are at the larger geographic unit of census tract.

UC Berkeley Displacement Project

Displacement screening was added to this dataset after the ART Bay Area project working group made clear that it is necessary to consider displacement in early stages of the project—during researching community vulnerability, and not only considered when evaluating the impacts of potential adaptation strategies later in the project. This dataset is used in the Local Assessments section at the functional community scale. UC Berkeley Center for Community Innovation Regional Early Warning System for Displacement and Gentrification Typologies were developed for use in evaluating gentrification and displacement risks associated with transit-oriented development, relevant to the implementation of SB 375. The typologies and associated mapping tool are supported by case studies of nine communities, developed in collaboration with MTC's Bay Area Regional Prosperity Plan. Regression models were developed identify indicators that can serve as predictors for loss of low income households and gentrification processes, and includes data about the age of buildings, employment density, housing market, and presence of rail station.

The Governor's Office of Planning and Research guide Defining Vulnerable Communities in the Context of Climate Adaptation provides an overview and comparison of more community vulnerability screening approaches.

Metropolitan Transportation Commission Communities of Concern

The Metropolitan Transportation Commission (MTC) is the regional transportation planning, financing, and coordinating agency for the nine county Bay Area. MTC and the Association of

Bay Area Governments (ABAG) prepare Plan Bay Area, the integrated Sustainable Communities Strategy and Regional Transportation Plan for the San Francisco Bay Area. If implemented, PBA works to reduce greenhouse gas emissions from passenger vehicles through coordinated transportation, housing, and land use planning, as instructed by CA Senate Bill 375 (Sustainable Communities Act, Chapter 728, Statutes of 2008).[xcv]
Staff from MTC and ABAG convened a regional equity working group to develop the Communities of Concern (CoC) designation and equity framework for Plan Bay Area (PBA) 2040.[xcvi] CoCs are designed to represent where communities may be disadvantaged or exhibit vulnerabilities now, and in response to future growth. The equity analysis of PBA 2040 analyzes the positive and negative impacts of PBA strategies on CoCs, compared with impacts on the remainder of the region. The equity report also examines the distribution of transportation investments, to comply with federal requirements for environmental justice (E.O. 12898)[xcvii] and disparate impact and nondiscrimination (Title VI of the Civil Rights Act of 1964) analyses as recipients of federal funds. In establishing local funding priorities for One Bay Area Grants, projects located in a CoCs are "favorably considered."[xcviii]

In MTC's Draft 2018 Public Participation Plan engagement priorities for Plan Bay Area 2050 include prioritizing communities underrepresented in planning processes, such as those which are limited English proficiency, low-income, and minority. MTC staff will work to reach these communities "where they are" by integrating with existing events and collaborating with community-based organizations.

Description of Data

Communities of concern designation is given to census tracts that have a concentration of *both* minority *and* low-income residents, and to census tracts that have a concentration of low-income residents and *any three or more* of the following six disadvantage factors: persons with limited English proficiency,[xcix] zero-vehicle households, seniors 75 years and over, persons with one or more disability, single-parent families,[c] and renters paying more than 50 percent of their household income on housing.[ci] Data is from the US Census American Community Survey 5-year estimates for 2005-2009 and 2010-2014; 2012-2016 available for download: http://opendata.mtc.ca.gov/datasets/mtc-communities-of-concern-acs-2012-2016-2018.

Disadvantage Factor	Share of Regional Population 2009	Share of Regional Population 2014	Concentration Threshold*
Minority	**54%**	**59%**	**70%**
Low-Income	**23%**	**25%**	**30%**
Limited English Proficiency	9%	9%	20%
Zero-Vehicle Household	9%	10%	10%
Senior	6%	6%	10%
People with a Disability	18%	9%	25%
Single-Parent Family	14%	14%	20%
Cost-Burdened Renter	10%	11%	15%

(*Concentration thresholds are between the regional average and one standard deviation for each disadvantage factor.)

Bay Area Air Quality Management District (Air District) Community Air Risk Evaluation (CARE) Program

The Air District is the regional air pollution control agency for the nine county Bay Area. Its CARE Program works to reduce health disparities related to air pollution. A component of the CARE Program is to map locations with higher amounts of air pollution and consequent adverse health impacts, and work with these impacted communities to reduce health and pollution disparities. Locations identified through CARE mapping inform Air District activities and resources, such as through the continued prioritization of enforcement actions and grant funding in impacted communities, prioritized research, technical assistance, partnerships, and pollution mitigation work in impacted communities, and general programs and policy development and refinement.

To identify impacted communities, the Air District created a pollution-vulnerability index (PVI) representing the cumulative impacts of:

- Cancer risk from toxic air contaminants (TAC)
- Hospitalizations and mortality rates by cause of PM2.5 and ozone above background
- Health costs from ER visits

Boundaries of impacted communities contain zip codes[cii] that are within the top 15% of the PVI and follow major county boundaries, roads, shorelines.

Some areas outside the cumulative impact boundaries experience poor air quality on individual days when state and federal air quality pollution standards are exceeded. These episodic exceedance areas are mapped for high PM2.5 and high ozone. The exceedance maps complement the cumulative impact maps, and contribute to programs such as Spare the Air. Assembly Bill 617 was passed to prioritize work in communities most affected by poor air quality, and will be implemented through the Community Air Protection Program. In addition to directing resources and increasing scrutiny to accelerate air quality improvement in the most impacted areas, the program strives for a ground-up approach in emissions reduction planning, air quality monitoring programs, and other community-led processes. Information about the process for identifying impacted communities and program development guidance is available in the Community Air Protection Program Framework Concept Paper.

To identify these communities most in need, the Air District used CARE boundaries overlaid with CalEnviroScreen scores and the California Healthy Places Index—particularly focusing on life expectancy. Communities can self-nominate and provide input on the process during a series of public workshops. In August 2018, communities will be selected for the first 5 years of the program.

Description of Data:

Air pollution data inputs to calculate PVI include:

- Regionally modeled[ciii] Toxic Air Contaminant (TAC)[civ] levels in 2015
- Annual average PM2.5 above background levels, estimated using regional air quality modeling and monitoring site observations
- Mean 8-hour ozone above background levels, interpolated from monitoring site observations[cv]

Health records data inputs included baseline rates of mortality, ER visits, and hospital admissions. Socioeconomic data was not directly incorporated to identify population vulnerability, but a supporting analysis did find a correlation between PVI and education, income, and race. Information about air pollution and health records data inputs: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CARE%20Program/Documents/ImpactCommunities_2_Methodology.

ArcGIS shapefiles for 2014 Episodic 24-hr PM2.5 Exceedance Map & Episodic 8-hr Ozone Exceedance Map; 2013 (Updated Version 2) CARE Cumulative Impact Boundaries Map; 2009 (Version 1) CARE Impacted Communities Map available: http://www.baaqmd.gov/plans-and-climate/community-air-risk-evaluation-care-program/data-files.

Online map viewer and CARE Program overview: http://www.baaqmd.gov/plans-and-climate/community-air-risk-evaluation-care-program.

CARE Program documents, including download of impacted areas by zip code: http://www.baaqmd.gov/plans-and-climate/community-air-risk-evaluation-care-program/documents.

CA Department of Water Resources (DWR) Disadvantaged Communities (DAC) and Economic Distressed Area (EDA) Mapping Tools

Work in the Department of Water Resources (DWR) Integrated Regional Water Management (IRWM) planning groups and other programs recognized a disparity between the activities of the traditional water community and the needs of the members of disadvantaged communities. In response to these concerns, DWR initiated disadvantaged community grant projects to identify more effective means of engaging with and responding to the water-related needs of disadvantaged communities. The DWR Proposition 1 IRWM Disadvantaged Community Involvement Program (DACIP) is designed to ensure the involvement of disadvantaged communities (DACs), economically distressed areas (EDAs), or underrepresented communities (URCs)—collectively referred to as DACs—in IRWM planning efforts.

In the Bay Area IRWM, the Environmental Justice Coalition for Water (EJCW) is administering funding for DACIP through 2019, and has refined the definition of URCs as

> "groups that do not meet the state definition of a Disadvantaged Community (DAC) or Economically Distressed Area (EDA), but are below the median household income for the nine-county San Francisco Bay Area. URCs are also defined as groups that have a history of disproportionately less representation in water policy and/or projects and include, but are not limited to, African-Americans, Asian/Pacific Islanders, Native

> Americans, California Indian Tribes, Hispanic, Middle-Eastern, LGBTQ, homeless, new immigrant, disabled, youth and elderly populations, unincorporated communities, and small, independent organizations."

Another example of a definition of disadvantaged community which builds off an income-only definition is by the SF Bay Restoration Authority for use in awarding Measure AA grants, where one of 11 criteria for prioritization is for projects which "benefit economically disadvantaged communities," using the following definition:

> "An economically disadvantaged community (EDC) is defined as a census tract with a median household income less than 80% of the area median income (AMI). Within this set of low-income communities, high priority EDCs are further defined as groups that are historically underrepresented in environmental policymaking and/or projects; most economically and environmentally impacted by heavy industrial activity and development; most vulnerable to climate change impacts, due to lack of resources required for community resilience; and severely burdened by housing costs, increasing the risk of displacement."

Description of Data

Proposition 84 IRWM Guidelines (2015) defines disadvantaged communities. Census Place, Census Tract, and Census Block Groups with annual median household income (MHI) less than 80% of the statewide level receive DAC designation (PRC Section 75005(g)), and census geographies with annual MHI less that 60% of the statewide level receive Severely Disadvantaged Communities (SDAC) designation. The tool used data from the US Census American Community Survey 5-year estimates for 2010-2014.

DAC mapping tool: http://gis.water.ca.gov/app/dacs/.

DAC data download:
https://d3.water.ca.gov/owncloud/index.php/s/zx1U3UA68Vv70uQ/download.

Proposition 1, the Water Quality, Supply, and Infrastructure Act of 2014, defines EDAs[cvi]:
"Economically distressed area" means a municipality with a population of 20,000 persons or

less, a rural county, or a reasonably isolated and divisible segment of a larger municipality where the segment of the population is 20,000 persons or less, with an annual median household income that is less than 85 percent of the statewide median household income, and with one or more of the following conditions as determined by the department:

(1) Financial hardship.
(2) Unemployment rate at least 2 percent higher than the statewide average.
(3) Low population density.

EDA mapping tool: https://gis.water.ca.gov/app/edas/.

EDA data download: https://d3.water.ca.gov/owncloud/index.php/s/KvE3fukHKCv9oZD/download.

UC Berkeley Center for Community Innovation Regional Early Warning System for Displacement Typologies.

The Urban Displacement Project brings together research from UC Berkeley, UCLA, and Portland State University about the relationship between investments and neighborhood transformations—such as gentrification and displacement. Gentrification includes transformations of the build environment and demographic composition of the community, which is related yet distinct from the displacement of low income people from their communities. The Regional Early Warning System for Displacement (REWS) was developed for use in evaluating gentrification and displacement risks associated with transit oriented development. In implementing SB 375 and prioritizing the development and investments in urban areas near transit, there is a need to evaluate affects to existing communities. While new investments may benefit existing residents, such as through improved mobility,[cvii] there is a risk that investments will result in low income residents being displaced. REWS developed a regional mapping tool to improve understanding of the stages of gentrification and displacement in communities, and to help with suitable strategies for action. The regional mapping efforts were supported by case studies of nine communities, developed in collaboration with MTC's Bay Area Regional Prosperity Plan.

The typologies were determined through regression models were developed identify indicators that can serve as predictors for loss of low income households and gentrification processes.

Census tracts with population greater than 500 classified into 8 neighborhood displacement typologies:

Not Losing Low-Income Households (For Low Income[cviii] Tracts in 2015)	• Not classified as **At Risk of**, **Ongoing**, or **Advanced Gentrification** (three categories below)

At Risk of Gentrification (For Low Income Tracts in 2015)	• Vulnerable to gentrification in 2000[cix]
	• Has 2 out of 4 risk factors:
	  ○ Rail station in tract
	  ○ % of units in pre-1950 buildings > regional median
	  ○ Employment density (2014) > regional median
	  ○ "Hot housing market"[cx]
	• Not currently undergoing displacement or ongoing gentrification

Ongoing Gentrification / Displacement of Low-Income Households (For Low Income Tracts in 2015)	• Vulnerable to gentrification in 2000
	• Loss of Low Income households 2000-2015
	• Has 1 out of 2:
	  ○ "Hot housing market"
	  ○ Low income migration rate (percent of all migration to tract that was low income) in 2015 < in 2009
	• Or gentrified in 1990-2000 or 2000-2015[cxi]

Advanced Gentrification (For Low Income Tracts in 2015)	• Gentrified in 1990-2000 or 2000-2015
Not Losing Low-Income Households (For Moderate to High Income Tracts in 2015)	• Not classified as At Risk of, Ongoing, or Advanced Exclusion
At Risk of Exclusion (For Moderate to High Income Tracts in 2015)	• Has 2 out of 4 risk factors: ○ Rail station in tract

	○ % of units in pre-1950 buildings > regional median ○ Employment density (2014) > regional median ○ "Hot housing market" • Not currently undergoing exclusion
Displacement of Low-Income Households / Ongoing Exclusion (For Moderate to High Income Tracts in 2015)	• Loss of Low Income households 2000-2015 • Has 1 out of 2: ○ "Hot housing market" ○ Low income migration rate (percent of all migration to tract that was low income) in 2015 < in 2009
Advanced Exclusion (For Moderate to High Income Tracts in 2015)	• Low and declining proportion of Low Income households since 2000 • Low Low Income migration in 2015

CA Environmental Protection Agency (CalEPA) and CA Office of Environmental Health Hazard Assessment (OEHHA) CalEnviroScreen 3.0

In 2012, CA Senate Bill 535 (De León, Chapter 830, Statutes of 2012) directed funds from the State's cap-and-trade program[cxii] to benefit "disadvantaged communities"—at least 10% of funds given to projects located in these communities and at least 25% for projects that benefit them. The legislation designated CA Environmental Protection Agency (CalEPA) to develop a method for identifying "disadvantaged communities." The minimum percent of funds allocated to projects located in disadvantaged communities was increased in 2016 to 25%, and another 10% allocated specifically to low-income communities and households with CA Assembly Bill 1550 (Gomez, Chapter 369, Statutes of 2016). CalEPA created the CalEnviroScreen tool to geographically identify disadvantaged communities. Proceeds from the cap-and-trade program have been used in disadvantaged communities to weatherize homes, converting diesel buses to electric, build affordable housing close to transit, among other projects. In addition to identifying areas to distribute cap-and-trade proceeds, CalEnviroScreen informs other areas of CalEPA

decision-making, such as prioritizing resources and cleanup actions, and in allocating other grants from state agencies.

Description of Data

CalEnviroScreen 3.0 is the most recent version, released in 2017. Pollution burden and population characteristics are combined to generate a CalEnviroScreen score by census tract. The score for each census tract is relative to all other census tracts around the state, reported as a percentile. Twenty indicators in four themes are considered:

1. Pollution Burden: Exposures. Contact with pollution.
    a. Air Quality: Ozone
    b. Air Quality: PM2.5
    c. Diesel Particulate Matter
    d. Drinking Water Contaminants
    e. Pesticide Use
    f. Toxic Releases from Facilities
    g. Traffic Density
2. **Pollution Burden: Environmental Effects**. Adverse environmental conditions caused by pollution.
    a. Cleanup Sites
    b. Groundwater Threats
    c. Hazardous Waste Generators and Facilities
    d. Impaired Water Bodies
    e. Solid Waste Sites and Facilities
3. **Population Characteristics: Sensitive Populations**. Populations with biological traits that may magnify the effects of pollution exposures.
    a. Asthma
    b. Cardiovascular Disease
    c. Low Birth Weight Infants
4. **Population Characteristics: Socioeconomic Factors**. Community characteristics that result in increased vulnerability to pollution
    a. Educational Attainment
    b. Housing Burdened Low Income Households
    c. Linguistic Isolation
    d. Poverty

e. Unemployment

Endnotes

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[iii] “BARHII Bay Area Regional Health Inequities Initiative.”

[iv] “The Resilient Communities Initiative (RCI).”

[v] “Bay Area.”

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[viii] Cutter, Boruff, and Shirley, “Social Vulnerability to Environmental Hazards*.”

[ix] Zoraster, “Vulnerable Populations.”

[x] Rufat et al., “Social Vulnerability to Floods.”

[xi] Bahram Fazeli, “Cumulative Impacts: Changing Regulatory Culture to Address Environmental Injustice and Environmental Racism.”

[xii] Kirsten Schwind, “Mapping Our Future: A Work Plan for Public Engagement and Equity in Climate Adaptation Planning in the San Francisco Bay Area.”

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[lxxxii] When looking at housing cost burden, CoC and CES only consider renters, while the ART method calculates housing cost burden for renters and owners, and also includes renters as its own category to layer with the other characteristics. Other social vulnerability mapping, including CES, uses the poverty measure. Geographic differences in housing costs are not accounted for in the official poverty measure calculated by the US Census Bureau. Therefore using income and housing cost-burden are more representative of local conditions

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[xc] Census tracts are small, relatively permanent statistical subdivisions of a county or equivalent. Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people. Block groups are statistical divisions of census tracts and are generally defined to contain

between 600 and 3,000 people.Census tracts and block groups are delineated by local participants prior to each decennial census as part of the Census Bureau's Participant Statistical Areas Program. The Census Bureau delineates census tracts or block groups in situations where no local participant existed or where state, local, or tribal governments declined to participate. Census tract boundaries are delineated with the intention of being maintained over a long time so that statistical comparisons can be made from census to census. Census tracts occasionally are split due to population growth or merged as a result of substantial population decline. Census tracts and block groups usually cover a contiguous area; however, the spatial size varies widely depending on the density of settlement.
https://www.census.gov/geo/reference/terms.html

[xci] Sadd et al., "The Truth, the Whole Truth, and Nothing but the Ground-Truth."

[xcii] De León, Chapter 830, Statutes of 2012

[xciii] Gomez, Chapter 369, Statutes of 2016

[xciv] Sustainable Communities Act, Chapter 728, Statutes of 2008

[xcv] http://www.leginfo.ca.gov/pub/07-08/bill/sen/sb_0351-0400/sb_375_bill_20080930_chaptered.pdf

[xcvi] MTC Resolution No. 4217

[xcvii] Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations directs each federal agency to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations…"

[xcviii] MTC Resolution No. 4035

[xcix] Populations above the age of 5 years that can speak less than "well" as defined by the US Census

[c] As a share of all families regardless of whether or not they have any children

[ci] As a share of all households regardless of occupancy status (renter or owner)

[cii] Geographical unit of analysis is different than the census geographies used in other community vulnerability tools because health data is available by zip code

[ciii] Inputs used in application of CAMx (Comprehensive Air Quality Model with Extensions) model: TAC emissions; meteorological inputs such as winds; and TAC concentrations at the inflow boundaries of the modeling region. More information: http://www.baaqmd.gov/~/media/files/planning-and-research/research-and-modeling/care-2015-modeling-document.pdf

[civ] Certain air pollutants have been classified as toxic air contaminants because they are known to increase the risk of cancer and/or other serious health effects, ranging from eye irritation to neurological damage

[cv] Since ozone modeling was only available for a few time periods and since ozone concentrations change more gradually from one location to another than PM2.5 concentrations, using measurements only was found to produce more realistic results for predicting mean 8-hour ozone levels than using a combination of modeling and measurements (CARE Retrospective 2014 report)

[cvi] California Water Code § 79702 (k)

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[cviii] Income below 80% of county median

[cix] Vulnerable to gentrification in 1990 or 2000 have at least 3 out of 4 indicators:

- % low income households > regional median
- % college educated < regional median
- % renters > regional median
- % nonwhite > regional median

[cx] "Hot housing market" in 2000 or 2015:

- Change in median real rent > regional median, or
- Change in median value for owner-occupied homes > regional median

[cxi] Gentrification from 1990 to 2000 or 2000 to 2015:

- Vulnerable in base year (as defined above)
- Demographic change between base and end years (at least 2 of 3 occurring):
    - Growth in % college educated > regional median
    - Growth in real median household income (percent change) > regional median
    - Lost low-income households
- LI migration rate (percent of all migration to tract that was LI) in 2015 < in 2009 (only used for 2000-2015 time frame)
- "Hot market" (defined above)

[cxii] CA Global Warming Solutions Act of 2006 (AB 32) authorized the cap-and-trade program. Funds generated from the program (collected in the Greenhouse Gas Reduction Fund) are used to continue reducing emissions and improve public health, quality of life, and economic activity through energy efficiency, public transit, affordable housing, and more.