CALIFORNIA
Water Boards

APPENDIX:
MEDIAN HOUSEHOLD INCOME (MHI) AND ECONOMIC STATUS DETERMINATION METHODOLOGY

LAST UPDATED: JUNE 2025

SUMMARY

Median Household Income (MHI) is a measurement of the annual income level earned by the median household in a specified geographic area. The median household income represents the threshold that divides the income distribution into two equal parts, with half of the households in the specified area earning less than the MHI and half earning more.[1] Unlike the average (or mean), which can be skewed by a small number of very high-income households, the median gives a better sense of what a "typical" household earns. Because it focuses on the middle point of the income range, the median is often considered a more reliable way to understand income in a community – especially when some incomes are much higher than most. This may be particularly common in rural areas, where the income of second homes or vacation homes may be very different than the typical income earned by full-time residents. For this reason, MHI is commonly used in socioeconomic analyses and policy assessments to approximate the typical economic situation of households in a particular geographic area.

The American Community Survey (ACS) conducted by the U.S. Census Bureau is the most comprehensive and consistently available data source for estimating income at small geographic scales. The ACS provides 5-year estimates for census block groups, census tracts, and places (in addition to other geographic levels, such as counties and metropolitan statistical areas), which collectively cover the entire state of California and allow for localized analysis.

However, there are important limitations to consider. The ACS relies on a rolling sample survey methodology, meaning data are collected continuously over five years and reflect estimates based on randomly selected households during that period. The most recently published estimates are the 2023 5-Year Estimates, meaning they are based on data collected between 2019 and 2023. As a result, year-to-year comparisons can be imprecise, since different households are sampled in each cycle, and short-term economic shifts or demographic changes may not be fully captured. Additionally, even the smallest available geographic unit – the block group – may still encompass diverse economic conditions within its boundaries, especially in sparsely populated areas where block groups tend to be geographically large. Data coverage can be inconsistent, and populated areas tend to have more precise estimates and better data availability than sparsely populated areas.

Despite these challenges, MHI derived from ACS data is still one of the most widely accepted metrics for estimating income in policy settings. The data are publicly available, updated regularly, and can be used to group communities into distinct socioeconomic categories for further analysis.

MHI is used to track the economic status of water systems and general economic trends over time. In the context of the Needs Assessment, MHI is critical for assessing the

[1] Median Household Income: https://www.census.gov/quickfacts/fact/note/US/INC110221

affordability of water service provided to a system's customer base, captured by the %MHI indicator.[2] The State Water Resources Control Board also relies on MHI to determine Disadvantaged Community (DAC) and Severely Disadvantaged Community (SDAC) status, where DACs are defined as communities with an MHI less than 80% of the statewide MHI[3], and SDACs as less than 60%.[4]

Required Data Points & Sources:

- Water system Service Area Boundary Layer: SABL[5]
- Median Household Income in the Past 12 Months (data table B19103): 2019-2023 5-Year Estimates from U.S. Census Bureau's American Community Survey for block groups, census tracts, and places. Earlier ACS 5-Year Estimates (2016-2020, 2018-2022 and 2017-2021) were used selectively to address missing or suppressed data.[6]
- Census Geography Boundaries for Block Groups, Census Tracts, and Places: 2023 TIGER/Line Shapefiles[7]
- Income Surveys accepted by the State Water Board[8]

Water system-level Median household income (MHI) is calculated using data from the 5-Year ACS Estimates and spatial data on water system service area boundaries. Spatial analysis is performed in R using the sf package by intersecting the water system service area boundary layer with Census geographies. For each water system, an area-weighted average MHI is calculated based on the portions of geographic areas that fall within the system's service area boundary (for more information, see *Appendix: GIS Methodology for Calculating Data*[9]). When available, income surveys conducted within the last five years and accepted by the State Water Board are used to determine a water system's MHI rather than the area-weighted approach. 26 valid income surveys have been conducted since 2021 and are used for MHI determination.

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[2] %MHI is an indicator utilized by the Risk and Affordability Assessments that measures the annual system-wide average residential customer charges for 6 hundred cubic feet (HCF) of drinking water usage per month relative to the annual median household income within a water system's service area. 6 HCF (4,488 gallons) of indoor water usage per month is roughly equivalent to 50 gallons per person per day for a three-person household for 30 days.

[3] Health & Saf. Code, § 116275, subd. (aa)

[4] Water Code § 13476, subd. (j)

[5] California Drinking Water System Boundaries
https://gispublic.waterboards.ca.gov/portal/home/item.html?id=fbba842bf134497c9d611ad506ec48cc

[6] American Community Survey Data Tables
https://data.census.gov/table

[7] 2023 TIGER/Line shapefiles (U.S. Census Bureau): https://www.census.gov/cgi-bin/geo/shapefiles/

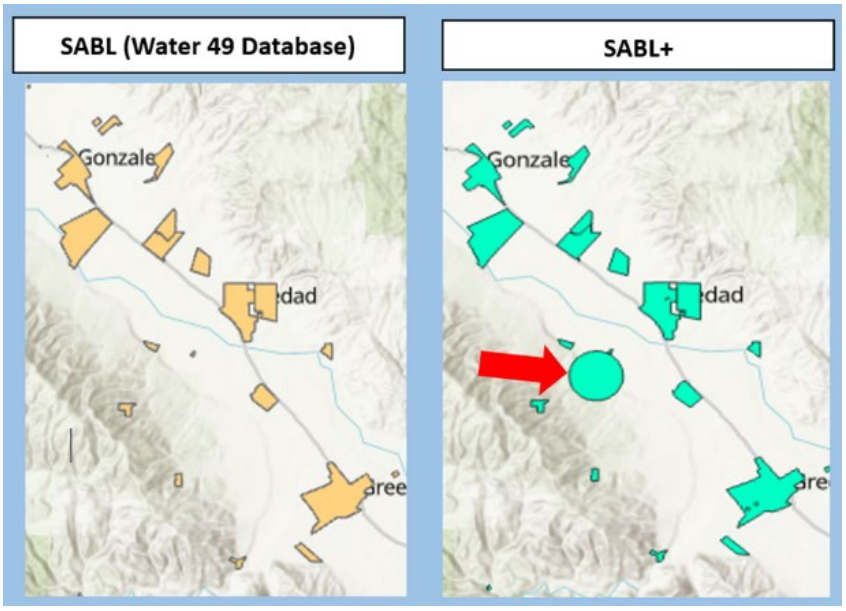
[8] The income surveys used by the State Water Board are not publicly available and must be requested. Only valid surveys conducted after 2021 are used as a water system's MHI estimate (26 total valid income surveys since 2021).

[9] Appendix: GIS Methodology for Calculating Data
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/2025-needs/general-gis-methodology.pdf

Calculation Steps:

Create System Area Boundary Layer+ (SABL+): First, existing water system boundaries from SABL were combined with artificial boundaries for water systems that did not have a known boundary in SABL. Artificial boundaries were generated for the purposes of the Needs Assessment by creating a 0.5-mile buffer around the location of the water system's distribution system facility. The boundaries from SABL joined with the artificial boundaries are referred to as SABL+ and this layer is used in risk indicator calculations that require spatial analysis.[10]

Figure 1: Visual comparison of the Standard SABL layer to the SABL+ layer. Note the addition of the estimated water system boundary for the missing system (see red arrow)



Supplement Missing ACS Data: For any Census geography (block group, census tract, or place) missing MHI in 2023, previous years of ACS data for that geography were used to improve data coverage for missing areas. Missing data were substituted with the most recent available corresponding MHI estimates from 2020 to 2022 (e.g., 2022 MHI would be substituted before 2021 MHI, if both were available). For a small number of areas, MHI estimates are reported as an open-ended range for very high and low values of income (either $2,500- or $250,000+) and the margin of error (MOE) is not computed for medians in these income ranges. When available, past ACS estimates were also used to improve precision for the areas with MHI in the lower or upper range in 2023. The incorporation of previous years of ACS data significantly reduced the

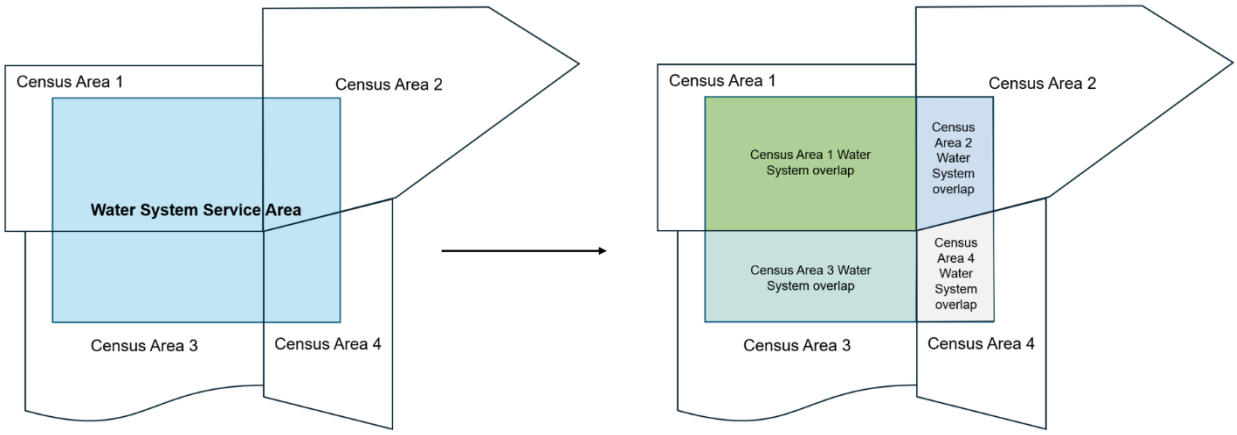
[10] SABL_Plus - Overview (ca.gov)
https://gispublic.waterboards.ca.gov/portal/home/item.html?id=0e4c019a46454725b058edd90538732a

number of Census areas with missing MHI data, resulting in more precise water system-level income approximations.

Join ACS data with Census Geographies: To prepare spatial data for analysis, supplemented MHI data from ACS was then joined to the corresponding TIGER/Line shapefiles for block groups, census tracts, and places using geographic identifier fields (GEOID).

Intersect Water System Boundaries and Census Geographies: Service area boundaries from SABL+ were then intersected with block group, census tract, and place-level boundaries containing MHI data using the sf (Simple Features) package in R. This analysis produced three new shapefiles, containing the geographic overlap between the service areas and each of the three spatial levels (block group, tract, place).

Figure 2: Illustration of Census Area-Weighting Method



Determine Intersection "Weight": For each water system, intersection weights were calculated based on the portion of the system overlapping Census areas containing valid MHI data. When a system intersected multiple Census areas (e.g., block groups), and one or more of those areas had missing MHI values, only the intersecting areas with non-missing values were included in the weighting. The total intersecting area with valid MHI data was used as the denominator to calculate each area's share of the system-level weight. This ensured that missing data did not distort the final area-weighted MHI calculation.

Margin of Error Adjustment: The ACS MHI data includes a margin of error (MOE) for each estimate, which was used to adjust MHI estimates for uncertainty. Following the procedure established by State Water Board's Division of Financial Assistance (DFA), the MOE is used to calculate a "lower bound MHI" for each Census area, meaning that the MOE is applied *only downward* by subtracting the MOE from the MHI. This approach ensures that potential error (reflected by the MOE) does not lead to an

overestimation of household income and instead errs on the side of capturing more potentially low-income communities.

Because some of the MOE estimations are quite large and would result in unrealistic lower bound MHI, the Needs Assessment also followed DFA's guidance on "maximum usable MOE".[11] The Census area MOE provided by ACS was adjusted to the maximum usable MOE based on the population of the water system intersecting with the Census. The maximum usable MOE is capped at $15,000 for systems with a population of 500 or less, and $7,500 for systems with a population greater than 500.

Area-Weighted MHI Calculation: After determining the lower bound MHI for each area of intersection, the system's overall MHI was calculated by weighting each intersecting lower bound MHI by the percentage of each area that intersected with the water system.[12] This ensured that MHI values were accurately represented based on the geographic overlap with the water system. The formula for this weighting is found in Equation 1.

Equation 1: Water System Area-Weighted MHI Calculation

$$\underset{\text{(Census Area−Weighted)}}{\textbf{Median Household Income}} = \sum\left(\left(\frac{\text{Intersection Area}}{\text{Total Non−Missing Area}}\right) \times \text{Census Area Median Household Income}\right)$$

Select MHI for Water System: The area-weighting described above resulted in three sets of water system-level MHI estimations for each of the Census geography levels (block group, census tract, and place).[13] The procedure for selecting the final MHI for each water system depends on the availability of additional income data and the Census area that best corresponds with the system's service area boundaries.

If an income survey accepted by the State Water Board has been conducted in the last five years (2021 or after), the reported MHI from the survey was used.

If no income survey data is available, the "area of best fit" (block group, census tract or place) was determined for each water system service area for the calculation of area-weighted MHI. The selection process accounted for the extent of overlap between the

[11] DFA Policy for Developing the Fund Expenditure Plan https://www.waterboards.ca.gov/water_issues/programs/grants_loans/sustainable_water_solutions/docs/2024/final-policy-for-dev-fep-sadwf.pdf

[12] This method implicitly assumes that the population of each water system is evenly distributed across its service area. In other words, if 50% of a system's area overlaps with a given Census area, it is assumed that 50% of the system's population resides within that Census area. While this area-weighting approach is commonly used due to data availability and straightforward calculation, it does not account for the actual distribution of people within the service area. This assumption may be particularly problematic in rural areas, where Census geographies tend to cover large expanses with sparse or uneven population densities. The State Water Board is actively working to develop alternative MHI estimation methods that incorporate population distribution to better reflect these realities.

[13] Because Census places are not spatially continuous, not every water system analyzed in the Needs Assessment corresponds with a Census place. Therefore, there are significantly fewer systems that have a place area-weighted MHI.

water system and the respective Census geographic areas, prioritizing the highest percentage of overlap. For example, if a place-level estimate overlapped 90% of the water system, this estimate was considered a better fit than multiple smaller census tracts or block groups, each overlapping only 10% of the service area. This process also selected the best fit area that minimized the number of geographies that must be combined to calculate an estimate, favoring single, high-overlap geographies over complex aggregations when possible.

Once the area of best fit was determined, the area-weighted MHI for that Census geography is compared to the MHI threshold that defines disadvantaged communities (DAC), 80% of the statewide MHI. In 2023, the ACS reported the California statewide MHI as $96,334, making the DAC cutoff for the 2025 Needs Assessment $77,067. Because identifying DACs is critical for targeting resources and support to communities in need, the MHI methodology was intentionally designed to make conservative determinations – meaning it erred on the side of identifying a water system as disadvantaged when there was reasonable evidence to support that classification.

If the area of best fit MHI is lower than the DAC threshold, this MHI value was used as the final MHI for the water system. If the area of best fit MHI was not below the DAC threshold, the lowest available MHI was chosen from the available block group, census tract, and place area-weighted estimates.