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MINETA TRANSPORTATION INSTITUTE

Incorporating Public Health into Transportation Decision Making

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Mineta Transportation Institute

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16. Abstract

Investments in transportation have the potential to significantly affect public health outcomes. Decisions to build highways, transit, or bikeways, for example, influence how residents and visitors move around a metropolitan area. Personal travel habits and proximity to transportation infrastructure play a role in how likely people are to be physically active or be exposed to dangerous traffic and toxic pollution. For this study, the research team reviewed the literature that links transportation infrastructure, the surrounding built environment context, and public health outcomes such as chronic heart and lung diseases, obesity, and death. The team then researched publicly available data that planners could use to inform decision-makers about the public health effects of funding certain investments. Finally, the team reviewed the guidelines of existing discretionary grant programs administered by the California Transportation Commission (CTC), and proposed improvements that would better incorporate available data on public health for consideration. These steps can positively influence funding decision-making for better public health outcomes in California.

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1. Purpose

The purpose of the project is to assist in the development of performance measures and metrics for public health, against which prospective transportation projects can be evaluated. This project is intended to be useful for the California Transportation Commission (CTC), especially in its administration of Senate Bill (SB) 1 programs including the Trade Corridor Enhancement Program, Local Partnership Program, and Solutions for Congested Corridors Program. However, it may also be useful for other work by the CTC and other California state agencies.

2. Public Health Considerations in other Transportation Agencies

2.1 Metropolitan Planning Organizations

The Sacramento Area Council of Governments (SACOG) has used a Project Performance Assessment tool to review projects according to performance measures. The tool allows for the consideration of projects of various types, from freeway expansions to bike lanes on specific user-defined segments in the planning area. The tool comes loaded with built environment and social variables that can aid users in estimating the expected public health-related outcomes in multimodal travel and traffic safety. Although the tool does not model outcomes on its own, it does enable decision-makers to verify the alignment of projects with agency goals and priorities (Sacramento Area Council of Governments, 2020). If an agency has a stated goal of improving public health, the tool can be revised to include additional data sets demonstrated to correlate with public health outcomes.

Access to essential goods and services is an important foundational aspect of public health. Available transportation to health care, healthy food, recreation, parks, trails, schools, grocery stores, and affordable housing have been identified as critical performance measures by researchers and public agencies (Litman, 2013; San Diego Association of Governments, 2018; Southern California Association of Governments, 2020).

Health equity with respect to transportation may involve measuring the accessibility and transportation choices provided for low-income, minority, disabled, aging, and other populations of concern (Nashville Area Metropolitan Planning Organization, 2010).

2.2 State Departments of Transportation

The California Department of Transportation (Caltrans) advances public health through the Air Quality, Environment & Health Branch of the Office of Regional Planning's Division of Transportation Planning. This branch is responsible for regulatory compliance for air quality and environmental standards and implementing the California Health in All Policies Healthy Transportation Action Plan. Work includes incorporating health into Caltrans' planning documents and supporting research linking transportation with health outcomes (Caltrans Division of Transportation Planning, 2020).

2.3 United States Department of Transportation

The National Roadway Safety Strategy is a plan authored by the United States Department of Transportation that outlines safety steps for the reduction of serious injury or fatalities on the nation's roads, highways, and streets, with an ultimate goal of zero roadway fatalities. This plan focuses on five objectives: safer people; safer roads; safer vehicles; safer speeds; and post-crash care. The objectives are intended to: encourage safe and responsible behavior by people who use roads; help design roads to mitigate human error; further improve vehicle safety features; promote safer speeds on all roads through education and enforcement; and boost the survival rate of crashes through improved access to medical care. This strategy is a collaborative effort between the United States Department of Transportation and the Federal Highway Association, the Federal Motor Carrier Safety Administration, the Federal Railroad Administration, the Federal Transit Administration, the National Highway Traffic Safety Administration, and the Pipeline and Hazardous Materials Safety Administration (U.S. Department of Transportation, 2022).

3. Literature Review

The facets of public health most easily connected to transportation planning include: the categories of physical activity and mental health; traffic safety; environmental quality and pollution exposure; and accessibility to health-promoting goods and services. A transportation project is likely to influence one or more of these aspects, although the effects on the region may be different from, and possibly in the opposite direction of, those in the immediate vicinity of a project. For example, modifying an existing arterial/expressway with occasional intersections into a limited-access highway may improve traffic safety, but the benefits may be outweighed by reduced physical activity, increased pollution exposure, and/or increased risk to traffic safety in other areas.

Active transportation, primarily walking and bicycling, can be a significant source of physical activity, and it can be understood via publicly accessible or easily collected data. Commute mode share, commuter counts, crash rates, and derived measures like multimodal level of service (LOS) can be used to indicate the level of active transportation and physical activity achieved by a population (United States Environmental Protection Agency, 2011). Proximity to high-quality public transit infrastructure and service is also connected to physical activity, since all transit trips involve physical activity at one end of the trip or the other (Miller et al., 2015). This proximity may be measured by the population of residents or employees within a given radius of transit service, the number of destinations accessible by walking or bicyclist from a location such as one's home, or the number of potential employees who could access an employment center (United States Environmental Protection Agency, 2011). Researchers have identified aspects of the built environment, Complete Streets, and overall walkability that contribute to public health outcomes among certain segments of the population, finding lower rates of obesity (Frank et al., 2004; Sallis et al., 2012), type II diabetes and cardiovascular disease (Ewing et al., 2014; Glazier et al., 2014), and increased sense of community (French et al., 2014). Contributing aspects include the presence of a walkable and grid-like street network, specific land uses such as park and recreational facilities, the mixing of land uses within neighborhoods, traffic and traffic control infrastructure, and opportunities for social engagement (Appleyard & Appleyard, 2021; French et al., 2014; Laddu et al., 2021).

Higher street connectivity, which provides shorter and more direct paths, is widely recognized as one of the most important features of an urban environment for promoting physical activity (Appleyard, 2012, 2016; Berrigan et al., 2010; McCormack & Shiell, 2011). It includes density of intersections, short street blocks between intersections, and frequency of four-way intersections. In a meta-analysis of studies linking built environment characteristics to travel behavior, intersection density was the strongest predictor of more walking, and a strong predictor of more transit use and fewer vehicle miles of travel (Ewing & Cervero, 2010).

Researchers have established connections between transportation and public health through aspects such as vehicle crashes, pollution exposure, physical activity and fitness, access to health-related goods and services, and mental health impacts (Litman, 2013). Public health has also been overlooked as a consideration in traditional transportation planning practices. Whereas traffic safety, road design, and emissions control have been improving in recent decades on a per-mile basis, the additional auto travel encouraged by transportation investments seems to have offset the public health benefits of these improvements (Litman, 2003).

The health outcomes that may be attributed to transportation are numerous. Public agencies have identified: cardiovascular disease; respiratory diseases, such as asthma and lung cancer; colon cancer; breast cancer; and diabetes as related to transportation (California Transportation Commission, 2017).

Physical and socioeconomic environments are affected by transportation and can create health problems. Measurements of air quality through levels of ozone, particulates, and recognized carcinogens may be used as performance indicators (Orange County's Healthier Together, n.d.).

Transportation projects may also be judged for their contributions to climate adaptation and economic opportunity (Southern California Association of Governments, 2020), and either vehicle miles travelled (VMT) or carbon dioxide emissions per capita (United States Environmental Protection Agency, 2011).

Safety is important for all users of the transportation network. However, it is especially important for people traveling outside of vehicles. People walking, biking, and using other modes of personal mobility are known as vulnerable road users because of their susceptibility to injury or death, even when traveling at low speeds or simply being present near moving vehicles. Traffic injuries and fatalities for vulnerable road users are particularly common in areas with high-speed arterial roads, low-income populations (Morency et al., 2012), and older populations (Tournier et al., 2016). Even where injuries and fatalities do not occur, the level of traffic stress caused by higher speeds and insufficient time to cross streets is a significant worry for older people (Asher et al., 2012; Duim et al., 2017; Shaw et al., 2012).

Complete Streets policies may lead to reduced vehicle traffic and less exposure to air pollution (Bigazzi & Rouleau, 2017). Evidence shows that such policies help to calm traffic and reduce the per capita risk of injury (Ewing & Dumbaugh, 2009; Lee & Maheswaran, 2010). Both safety from collisions and security from crime are significantly influenced by the street environment, and influence travel decisions and health outcomes as a result (Appleyard & Ferrell, 2015; MacDonald, 2015).

The accessibility or economic benefits of a project that increases vehicle speeds may be outweighed by its traffic safety drawbacks. Thus, it is prudent to consider the potential impacts to traffic safety of a proposed transportation project.

Vehicle emissions reduce air quality, especially within the vicinity of busy streets and freeways, leading to adverse health effects such as cardiovascular and respiratory diseases (California Transportation Commission, 2017). Additional detractors from environmental quality include noise and vulnerability to adverse weather events. Transportation infrastructure can contribute to each of these aspects by encouraging vehicle noise, through designing high speed facilities, and by contributing to climate change through the support of greenhouse-gas-emitting vehicles. We also need to recognize how road projects induce demand and increase overall emissions. Transportation infrastructure can also exacerbate weather events such as extreme heat through the heat island effect, and flooding using impermeable pavement. However, transportation infrastructure may also improve communities' resilience to adverse weather events by incorporating appropriate shade and stormwater treatments.

In discussing public health and transportation, it is important to recognize how almost all road projects present a collection of negative impacts on public health. Whether these negative impacts are (or arise from) obesity rates associated with driving (Frank et al., 2004), induced demand and associated air quality and climate change impacts from road expansion projects (Milam et al., 2017), or inequities in traffic injuries and fatalities (Morency et al., 2012), they are so extensive that we should consider placing a surgeon general-like warning on every roadway and vehicle.

In discussing public health and transportation, we also ought to recognize the positive public health benefits of transit projects (Miller et al., 2015). Recent research has shown that transit users engage in more physical activity than non-transit users (Freeland et al., 2013; Lachapelle & Frank, 2009; Lachapelle & Noland, 2012). Several studies have found that higher density of transit stops/stations leading to shorter distances from home to transit are associated with more physical activity and lower body weight (Forsyth et al., 2008; Hoehner et al., 2005; Rundle et al., 2007). From increasing physical activity to lowering obesity rates and cardiovascular disease (Frank et al., 2004)), it is clear that the public health benefits from lessening our reliance on driving are extensive.

The ability for transportation investments to stimulate changes in public health outcomes seems to depend on the context of the built environment, its density, its mixture of uses, and its urban design. Investments in active transportation-supportive infrastructure are likely to encourage physical activity if built in active transportation-supportive environments. One study has found causal relationships between the installation of a greenway in an urban setting and both increased physical activity and decreased sedentary behavior (Frank et al., 2019). However, the effects may be less pronounced in other environments. The likelihood of increasing physical activity, for example, may correlate well with the Walkability Index. Alternatively, it may correlate well with a location efficiency index such as the Smart Location Index (SLI) (US EPA, 2014), or Location Efficient Neighborhood Design (LEND) Index (Frost et al., 2018).

An extensive review of relevant data sets and online tools is provided in the Appendix.

4. Existing CTC Program Guidelines

Competitive grant programs administered by the CTC require applicants to provide information about the predicted effects of transportation projects. These performance measures document the extent to which projects will contribute, positively or negatively, to a variety of factors, such as congestion, emissions, and economic development. Much of the information consists of quantitative performance metrics, allowing for relatively easy comparisons among project applications. Additional evaluation criteria are qualitative, providing applicants the space for information in narrative form. This is especially useful when performance metrics are unreliable or unavailable. Certain project impacts have so far evaded simple numerical explanation. This report aims to provide a basis for qualitative justifications of the effects of transportation projects on public health, as well as a proposed set of criteria for quantitative performance metrics of public health.

This section provides a brief overview of the various CTC programs, ways they currently address public health, and how they could be improved.

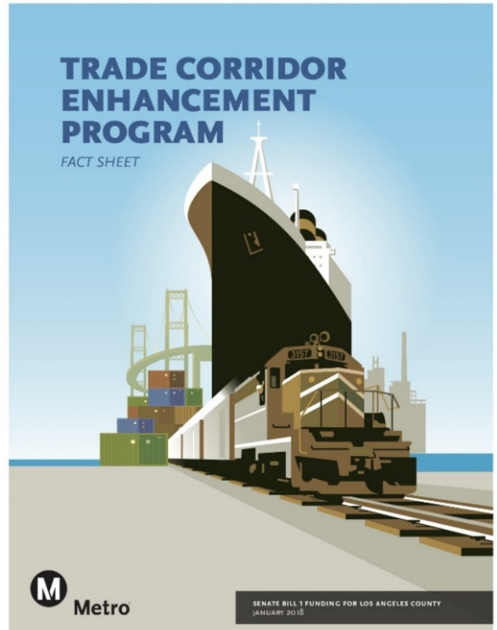
After this study began, CTC staff consulted with the California State Transportation Agency (CalSTA) and the California Department of Transportation to ensure that Senate Bill 1 program guidelines were aligned with the Climate Action Plan for Transportation Infrastructure (CAPTI) created by CalSTA. In addition, CTC staff consulted with California Air Resources Board (CARB) staff to ensure the Senate Bill 1 program guidelines included information needed by CARB for their review of projects. With the exception of the Active Transportation Program, the Senate Bill 1 programs affected by this effort are the programs included in this report. This effort resulted in requests for information in the following areas:

- **Accessibility:** Project improves access to jobs or key destinations, improves access for specific populations, or improves transportation options. (Accessibility was a performance metric in the previous program cycles, but as a result of feedback from a technical workgroup, this subject was shifted to the narrative of the guidelines and more options and flexibility for how to quantify accessibility were provided.)

- **Climate Change Resilience and Adaptation:** Project identifies and includes project features or strategies to mitigate the impacts of climate change.

- **Protection of Natural and Working Lands, and Enhancement of the Built Environment:** Does the project minimize the impact on natural and working lands (e.g., forests, rangelands, farms, urban green spaces, wetlands, and soils) or incorporate natural and green infrastructure?

4.1 Trade Corridor Enhancement Program (TCEP)



TCEP is a CTC program for freight projects in California. Projects should advance the statewide freight system as well as the transportation system more broadly. Although the program guidelines do not have a formal set of evaluation criteria for public health, they do include several public health-related measures.

- "Safety – Project increases the safety of the public, industry workers, and traffic" (California Transportation Commission, 2020d). Metrics include quantitative fatality and injury data from the FHWA Safety Performance Measure.

- "Air Quality Impact – Project reduces local and regional emissions of diesel particulate (PM 10 and PM 2.5), carbon monoxide, nitrogen oxides, greenhouse gases, and other pollutants" (California Transportation Commission, 2020d). Metrics include quantitative PM2.5, PM10, CO_2, VOC, SOx, CO, NOx concentrations from the California Life-Cycle Benefit/Cost Analysis Model.

- Community Engagement – In alignment with the CTC's Racial Equity Statement, projects will be evaluated based on their ability to demonstrate meaningful and effective public participation in decision making processes, particularly by disadvantaged or historically impacted and marginalized communities.

- Zero-Emission Infrastructure – The project supports zero-emission freight infrastructure.

Improvements

Public health could also be included as an additional safety component prioritizing project designs that remove or alleviate conflicts between freight vehicles and other travel modes. Including, for example, protected intersection designs or signal phasing in locations with existing freight/active transportation conflicts which would improve safety and support physical activity. The Performance Metrics Guidebook, released by the California Transportation Commission in 2022, allows applicants to capture such project features as part of the safety performance metrics, when estimating project safety benefits.

Environmental quality and pollution exposure could be addressed through information already required on applications such that only projects with reductions in toxic air pollutants be allowed in the most polluted and/or vulnerable communities. For example, under a proposed guideline, projects expected to increase toxic air pollutants could not be approved in the state or region's most disadvantaged communities, measured by the CalEnviroScreen or Healthy Places Index. The draft cycle 3 guidelines include an "Equity Supplement" that explains for applicants how to identify disadvantaged communities and other priority communities.

4.2 Active Transportation Program (ATP)

The ATP predates, but was augmented by, SB 1. It supports projects, non-infrastructure programs, and plans likely to result in increased walking and bicycling, with explicit goals of increasing safety and mobility for non-motorized users, enhancing public health, and ensuring "that disadvantaged communities fully share in the benefits of the program" (California Transportation Commission, 2020e). The program has a built-in requirement that 25% of funds benefit disadvantaged communities, and definitions from numerous sources may be used to satisfy the requirement. The California Healthy Places Index and CalEnviroScreen tool, which are discussed in the Appendix, may be used to identify communities lacking in healthy conditions. The program currently considers public health-related measures through the following evaluation criteria:

- "Need. Potential for increased walking and bicycling, especially among students, … and including increasing and improving connectivity and mobility of non-motorized users" (California Transportation Commission, 2020e). Applicants are requested to justify the amount of increased active transportation and physical activity gained by connecting specific locations through the project. Applicants are specifically scored on the project's potential to improve public health. Applicants must discuss specific local health concerns and social determinants of health, provide local public health data/statistics, and discuss how the project will address those concerns. Applicants are also scored on whether they consulted a local public health or community-based organization in the development of the project, and whether that agency or organization will continue to be involved in the project. The program establishes a direct connection between the agency and a local public health department. See the ATP Scoring Rubrics and Application for more information: https://catc.ca.gov/programs/active-transportation-program.

- "Safety. Potential for reducing the number and/or rate or the risk of pedestrian and bicyclist fatalities and injuries, including the identification of safety hazards for pedestrians and bicyclists" (California Transportation Commission, 2020e). Applicants are requested to respond to existing safety concerns and justify the project's safety improvements. Applicants must provide bike/pedestrian collision data (via the ATP TIMS tool or, if they lack data, through other sources such as police reports, crowdsourced maps such as Street Story, etc.), and provide a robust analysis of the causes of collisions and other safety issues. They then must demonstrate how their countermeasures address the collision patterns and safety issues shown in the data. See the ATP Scoring Rubrics and Application for more information: https://catc.ca.gov/programs/active-transportation-program.

Improvements

The program could also incorporate additional public health measures by including a place type index, such as the Location Efficient Neighborhood Design (LEND), the Smart Mobility Framework (SMF), or the Smart Location Index. Projects likely to encourage mode shift to active transportation and physical activity could be prioritized in locations where they are likely to be most effective. As noted in the literature review, areas with high street connectivity and a mix of land uses are likely to facilitate physical activity, and be considered active transportation-supportive environments. Specific suggested improvements to the ATP are limited because all active transportation projects are expected to have a positive, or at least non-negative, effect on public health.

4.3 Local Partnership Program (LPP)

The LPP provides supplementary funding for local or regional jurisdictions that have imposed taxes or fees for specific transportation projects. Public health-related measures currently taken into consideration through the LPP include the following:

- "Air Quality & Greenhouse Gases. The nomination should address how the proposed project will reduce greenhouse gas emissions and criteria pollutants and advance the State's air quality and climate goals" (California Transportation Commission, 2020b). Metrics include quantitative PM2.5, PM10, CO_2, VOC, SOx, CO, and NOx concentrations from the California Life-Cycle Benefit/Cost Analysis Model.

- "Safety. The nomination should address safety issues and concerns, including actual reported property, injury, and fatality collisions for the last five full years. Demonstrate how the proposed project increases safety for motorized and non-motorized users. Identify and discuss other safety measures the project will address, including health impacts" (California Transportation Commission, 2020b). Metrics include quantitative fatality and injury data from the FHWA Safety Performance Measure.

- Accessibility. The project improves access to jobs or key destinations, improves access for specific populations, or improves transportation options.

- Noise Level is also considered, but only for soundwall projects. In this case, Number of Decibels is one quantitative metric (California Transportation Commission, 2020b).

Improvements

Public health could also be added through the inclusion of a place type index, such as the Location Efficient Neighborhood Design (LEND), the Smart Mobility Framework (SMF), or the Smart Location Index. Projects likely to encourage mode shift to active transportation and physical activity could be prioritized in locations where they are likely to be most effective. Conversely, projects geared more toward congestion reduction through the provision of additional roadway space for vehicles could be disincentivized in mixed-use, walkable, and efficient locations. Vehicular capacity and speed-increasing projects tend to be detrimental to physical activity, environmental quality, and pollution exposure because they degrade the experience of non-motorized transportation along the corridor.

The Solutions for Congested Corridors Program (SCCP) land use efficiency supplement considers land use efficiency as a project performance measure. That document includes options to consider existing and planned land uses, VMT, transit service, or housing policy (California Transportation Commission, 2020a). This performance measure could be implemented for LPP with additional consideration for jurisdictions making investments in their most disadvantaged communities consistent with local and regional-specific goals and measures. For example, projects intended to improve safety in the communities already experiencing the highest rates of fatal and severe injury-causing crashes could be given priority. Projects intended to reduce air pollution in the communities already experiencing the highest levels of exposure to air pollutants could be given priority as well. The LPP version of the land use efficiency supplement could both concentrate on land use efficiency as a means of making effective investments, and advance equity by employing measures to provide the greatest public health benefit in jurisdictions actively working to address disparities. The draft cycle three guidelines allow applicants to identify disadvantaged communities, safety impacts and air quality benefits of a project, and land use decisions.

4.4 The Solutions for Congested Corridors Program (SCCP)

SCCP provides funding for achieving a balanced set of transportation, environmental, and community access improvements to reduce congestion throughout the state. Public health-related measures currently considered during the application process include the following:

- "Safety. The nomination must address safety issues and concerns in the corridor, including actual reported property, injury, and fatality collisions for the last five full years. Demonstrate how the proposed project increases safety for motorized and non-motorized users. Identify and discuss other safety measures the project will address, including health impacts" (California Transportation Commission, 2020c). Metrics include quantitative fatality and injury data from the FHWA Safety Performance Measure.

- Accessibility. The project improves access to jobs or key destinations, improves access for specific populations, or improves transportation options.

- "Air Quality & Greenhouse Gases. The nomination must address how the proposed project will reduce greenhouse gas emissions and criteria pollutants and advance the State's air quality and climate goals. What other environmental benefits will the project provide?" (California Transportation Commission, 2020c). Metrics include quantitative PM2.5, PM10, CO_2, VOC, SOx, CO, and NOx concentrations from the California Life-Cycle Benefit/Cost Analysis Model.

Improvements

Public health could also be addressed using a place type index, such as the Location Efficient Neighborhood Design (LEND), the Smart Mobility Framework (SMF), or the Smart Location Index. Projects likely to encourage mode shift to active transportation and physical could be prioritized in locations where they are likely to be most effective. Additionally, strategies that reduce congestion without increasing roadway capacity for private vehicles could be prioritized to the extent allowable in statute. Vehicular capacity and speed-increasing projects tend to be detrimental to physical activity, environmental quality, and pollution exposure because they degrade the experience of non-motorized transportation along the corridor.

The SCCP land use efficiency supplement considers land use efficiency as a project performance measure. That document includes options to consider existing and planned land uses, VMT, transit service, or housing policy (California Transportation Commission, 2020a). The criterion could be improved by allowing applicants to demonstrate improved physical activity through active transportation facilitated by accessibility, connectivity, and safety improvements.

4.5 Comprehensive Multimodal Corridor Plans (CMCP)

Projects funded through SCCP must be included in CMCPs transportation plans that address corridor congestion via a multimodal approach. As the subject of planning efforts, CMCPs enable planning agencies to assess various scenarios and project types to achieve designated goals and objectives. Potential projects, serving a variety of modes and with variable extents and levels of investment, may be assessed by many performance measures at once. Public health-related measures currently recommended for consideration by the CTC include the following:

- Safety – metrics include quantitative fatality and injury data.

- Accessibility – metrics include "Access to multi-modal choices (e.g. access to traveler information, availability of connections between modes, convenience of multiple transportation choices, vehicle ownership); Number of households within 45-minute transit ride of major employment center or college; Travel time reliability (e.g. commute trip travel time by transit and car); First-mile/Last-mile considerations; [and] consideration of complete streets policies and the creation of networks of non-motor vehicle facilities (e.g. pedestrian, cycling) that connect residential, recreational, and employment opportunities" (California Transportation Commission, 2018).

- Regional Air Quality and Greenhouse Gas Emissions – metrics include "Reduction of criteria pollutants" and greenhouse gas emissions (California Transportation Commission, 2018).

- Efficient Land Use – metrics include non-single-occupant-vehicle mode share, non-vehicle mode share, support for multimodal choices, and climate adaptation, among others (California Transportation Commission, 2018).

Improvements

Public health indicators could also be included in CMCP performance measures through physical activity estimated via walkability index, traffic safety enabled via Complete Streets or traffic calming features in high-activity areas, and protection against pollution exposure by reducing pollutants in areas with sensitive populations. It may also be important to define environment types by their community context. CMCPs constitute a unique forum for the incorporation of public health because they are focused on transportation corridors. Whereas individual projects considered in competitive grant programs described in earlier sections are concerned with narrowly defined transportation facilities, corridors connect numerous communities and have broader areas of influence. Therefore, projects that address public health may take different forms within or between communities. Within communities, presumably the higher-activity areas, Complete Streets and traffic calming measures may be appropriate. Between communities where walkability is less of a priority and higher-speed travel is acceptable, health-conscious projects may be better focused on separating motorized and non-motorized traffic to reduce exposure to pollution.

5. Proposed Public Health Guidelines

Below is language that could be used as the basis for content added to Senate Bill 1 program guidelines in a specific "public health" section.

Sufficiently assessing the negative and positive impacts on public health for a transportation project requires an examination of the context on many fronts. To begin examining the anticipated effects, it will be useful to suggest equity as a basis in answering the following questions, ordered by importance according to the selected public health performance measures in these main areas:

- Physical Activity and Mental Health
- Traffic Safety
- Environmental Quality and Pollution Exposure
- The Negative Public Health Impacts of Road Projects
- The Positive Public Health Impacts of Transit Projects.

In the application, please include the following information:

- A summary statement about what type of physical activity improvement the project is making. Physical activity improvements may include:
    - Complete Street project components that create safer spaces for pedestrians and bicyclists.
    - Improving travel times for residents by active modes to jobs or key destinations.

    - Adding a road, bus, or train route that provides additional options and better travel times.
    - Adding new access points to transit, such as a new transit stop.
    - Improving connections, by building a bike path, an overpass, a better off-ramp, a walking trail, etc.
    - Improving access for a specific type of community, such as a low-income or disadvantaged community.
    - Provide complete networks for bicycling and walking that separated active modes from cars (AKA a "layered mobility network")
- Specific examples that demonstrate how physical activity is being improved. Examples may include:
    - Creating a bike path that connects a low-income community to a local middle or high school.
    - Installing a new transit stop that connects a community to a local grocery store or hospital.
- A map showing relevant areas that helps demonstrate the likely physical activity improvement.
- A summary statement about what type of traffic safety improvement the project is making. Traffic safety improvements may include:
    - Separating road users according to their mode of travel or speed.
    - Complete Street projects that give more space to pedestrians and bicyclists.
    - Decreasing opportunities for interaction between vehicles and vulnerable road users.
    - Slowing traffic in areas of high activity among vulnerable road users.
    - Improving traffic safety for a specific type of community, such as a low-income or disadvantaged community.
- Specific examples that demonstrate how traffic safety is being improved such as:
    - Creating a bike path that connects a low-income community to a local middle or high school.

- Building more robust sidewalks and bikeways, protected by elevation changes or rigid barriers.

- Creating better protected crossings for both pedestrians and bicyclists, including such treatments as pedestrian activated flashing beacons, curb bulb outs, pedestrian refuges, etc.

- A map showing relevant areas that helps demonstrate the traffic safety improvement.
  - This map can show the levels of traffic stress (LTS) in the area.
- Any relevant data (collisions, injury severity) or statistics that supports your claim.
- A summary statement about what type of environmental quality improvement the project is making. Environmental quality improvements may include:
  - Transportation Systems Management projects that improve the overall capacity of a roadway.
  - Introducing projects and programs that favor low- or zero-emission vehicles.
  - Slowing traffic in areas with sensitive land uses and communities nearby.
  - Transportation demand management (TDM) projects that reduce vehicle emissions. This could include land use projects that support the three Ds (density, diversity, design) (Ewing & Cervero, 2010).
  - Increasing the walkability and bikeability of an area through street improvements.
- Specific examples that demonstrate how environmental quality is being improved. These may include:
  - Using noise-reducing pavement types and sound walls.
  - Addition of green spaces and flood resistant infrastructure.
  - Improvements to sewage and stormwater management (green streets).
- A map showing relevant areas that helps demonstrate the environmental quality improvement.
- A summary statement about what type of impacts your project may have. Such impacts may include:

    - The amount of traffic induced (using the induced travel calculator: https://travelcalculator.ncst.ucdavis.edu).
    - The level of traffic stress on the surrounding access points of your project.
    - The increased speed in traffic in areas of high activity among vulnerable road users.
    - The impacts on low-income or disadvantaged communities.
- Specific examples that demonstrate how public health can be harmed. Examples may include:
    - Adding a lane(s) to a surface arterial, without adding provisions for pedestrians or bicyclists.
    - Building a new road project that primarily supports sprawling development.
- Any relevant data or statistics that supports your claim. If you have already provided information in response to another section that also applies here, please state that.

5.1 Evaluation Guidance

Physical Activity and Mental Health

The considerations below could be used by evaluators to assess the public health impacts of a project.

When evaluating a project's likely contribution to physical activity, consider the following questions:

- How walkable and bikeable is the project area currently?
    - Walkability Index
    - Walk Score
- Will the project improve walking and biking network connectivity?
    - Intersection Density
- How will the project improve accessibility to activity centers for people walking and biking?
    - Walkability Index
- Will the project support an increased diversity and mixture of land uses?
    - Smart Location Index
    - Location Efficient Neighborhood Design Place Types (Caltrans' Smart Mobility Calculator)
    - Land Use Diversity Index
- How will the project support multimodal transportation options?
    - Narrative Provision
- How will the project contribute to increased community severance or barrier effects?
    - Increase in Traffic Volumes
    - Increase in Road Width
- How will the project create more opportunities for social engagement?
    - Narrative Provision

Consider the type of place in which the project will be located and the current levels of physical activity in the community using the proxy of active transportation commuters. Accessibility via walking and intersection density (a proxy of walkability), are correlated to active transportation (Berrigan et al., 2010). Similarly, the three Ds (density, a diversity of land uses, and design) increase the utility of active transportation (Ewing & Cervero, 2010). Projects are likely to increase physical activity if they are built in places where people are already physically active, and if they make it easier for people to walk and bike to their destinations. But we also ought to recognize how places can be transformed into active transportation areas through the right treatments.

Based on the applicant's response to the "Protection of Natural and Working Lands, and Enhancement of the Built Environment" section, evaluate how well the applications considered the existing and planned land uses near the project which could be accessed via the project. Did the applicant discuss the types of land uses that would likely be supported by the transportation project? For example, a highway project would likely support a sprawling area of lower density relative to the more compact area served by a transit project of similar magnitude. The resulting conditions would contribute to physical activity for the area's residents and visitors.

Traffic Safety

When evaluating a project's likely contribution to traffic safety, consider the following questions:

- What are the current levels of traffic volume/speed/stress, and will the project improve them? To get an idea of this, review the
    - Person Hours of Travel Time Saved (All Projects)
    - Daily Vehicle Hours of Delay (for TCEP)
    - Velocity (for TCEP)
    - Vehicle Miles Travelled (for ATP, SCCP and LPP)

- Does the project area have more or fewer collisions than other communities of its type? Evaluators should consider the safety metrics and place typologies (LEND Index or SMF, using Caltrans' Smart Mobility Calculator: https://smartmobilitycalculator.netlify.app).

- Does the project area have high-speed arterial roads? Federal statistics indicate that arterial roads have the highest number of fatalities, both in absolute terms and as a rate based on VMT (U.S. Department of Transportation, 2022). Some of the useful measures to determine the safety of roads are as follows:

    - Speed Limit

    - Functional Classification

    - Level of Traffic Stress

    - Annual Average of Daily Traffic

- Is the project area in a low-income community or does it contain a significant population of older people? This information is also covered in the SB 1 Competitive Programs Transportation Equity Supplement.

    - Median household income: community is less than 80% of the statewide median based on the most current census tract level data from the American Community Survey.

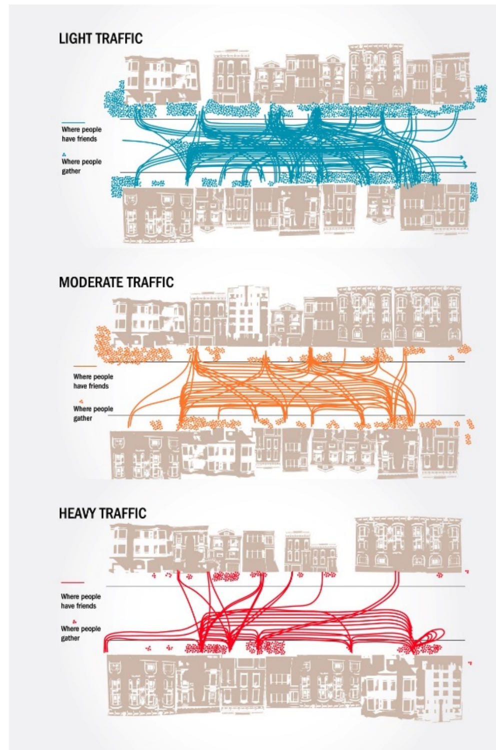
    - Older people: persons aged 65 years and over, as a percent, is greater than the statewide median based on the most current Census Tract level data from the American Community Survey.

    - Existing disadvantaged community definitions used by the CTC, including median household income, SB 535 Disadvantaged Communities Map (CalEnviroScreen 3.0), National School Lunch Program, Healthy Places Index, federally recognized tribal lands, or regional or other definition.

Consider the type of place in which the project will be located and the current levels of traffic. To evaluate this, you can use the Location Efficient Neighborhood Design (LEND) and Smart Mobility Framework (SMF) place types in Caltrans' Smart Mobility Calculator (https://smartmobilitycalculator.netlify.app). Even with safety improvements in place, higher vehicle speeds put vulnerable road users at greater risk. Complete separation of vehicles from vulnerable road users is the only way to ensure traffic safety. However, the sharing of the public right-of-way between walking infrastructure, biking infrastructure, and vehicle infrastructure with minimal physical separation will likely remain a regular practice, at least at lower speeds.

The benefits of transportation improvements do not accrue equally to all members of a community or region, and this is certainly true for traffic safety. Applicants should consider equity in relation to traffic safety, calling attention to risks for vulnerable road users in communities with documented higher rates of injuries and fatalities.

The Negative Impacts of Traffic on Community Cohesion



This graphic from Livable Streets 2.0 (Appleyard and Appleyard, 2020) show that, as traffic increases, social networking and neighboring decreases. The light traffic neighborhood (at the top) shows people having twice as many friends and three times many acquaintances as the high traffic neighborhood (at the bottom). Essentially, light trafficked streets knit a community together while heavily trafficked streets (at the bottom) rip them apart.

Environmental Quality/Pollution Exposure

When evaluating a project's likely contribution to environmental quality and pollution exposure, consider the following questions:

- How is the air quality in the project area currently?
    - Existing Air Quality Performance Metrics
- Will the project worsen air quality in the local project area, or regionally and in the long run? (This can be calculated using the following induced travel calculator: https://travelcalculator.ncst.ucdavis.edu).
    - Existing Air Quality Performance Metrics
- How noisy is the project area?
    - Noise Level in dB
- Will the project increase noise levels in the local project area?
    - Noise Level in dB
- How will the project leave communities more vulnerable, or better protected, from adverse weather events?
    - Depending on the adverse weather events likely to occur in the project area, applicants can identify how the project protects communities. Applicants can use the CCHVIZ tool to create an appropriate query combination of exposure and sensitivity (California Department of Public Health, n.d.).

Consider the type of place in which the project will be located and the current levels of environmental quality and pollution exposure. Local conditions should influence the appropriate responses to the unique challenges present in project areas.

Applicants should consider equity in relation to environmental quality and pollution exposure. CalEnviroScreen 3.0 may be used to identify a community's existing exposure and vulnerability to sources of pollution (California Office of Environmental Health Hazard Assessment, 2018). The tool is used to indicate disadvantaged communities for the purposes of Senate Bill 535 as the 25th percentile of most impacted communities of the state (California Office of Environmental Health Hazard Assessment, 2017). Similarly, the Smart Mobility Calculator (https://smartmobilitycalculator.netlify.app) can also be used to identify disadvantaged communities.

Negative Public Health Impacts of Road Projects

The Senate Bill 1 programs currently rely on metrics such as air quality, safety, vehicle miles traveled, and community engagement to evaluate the potential negative impacts of road projects to public health. If the CTC decided to specifically call this out in the guidelines, the following could be used to evaluate this criterion.

When evaluating a project's likely negative impacts on public health, consider the following questions:

- Will the project keep another road project from being built? Is the project improving the performance of existing roads in a way that will negate the need for another road project, such as transportation system management projects, some overpasses, bike projects, etc.?

- Will the health burdens imposed by the project be borne disproportionately by disadvantaged communities?

- How much traffic will be induced (using the induced travel calculator: https://travelcalculator.ncst.ucdavis.edu)?
- How will the project contribute to increased community severance or barrier effects?
- What are the current levels of traffic volume/speed/stress, and will the project increase them?
- Will the project worsen air quality in the local project area, or overall and in the long term?
- Will the project increase noise levels in the local project area?
- Will the project leave communities more vulnerable, or better protected, from adverse weather events?
- Is the project area in a low-income community or contains a significant population of older people?
    - Use Caltrans' Smart Mobility Calculator: https://smartmobilitycalculator.netlify.app
- Will the project increase vehicle speeds on highway or non-highway facilities?

Public Health Benefits of Transit Projects

When evaluating a transit project's likely benefits on public health, consider the following questions:

- How much walking and/or bicycling will be increased by the transit project?

    - Projected Ridership

- What are the current levels of traffic volume and congestion along the proposed transit corridor?
    - Annual Average Daily Traffic
    - Level of Service
    - Travel Time Reliability Index
- What are the provisions for bicycling on the transit vehicles and at the stations?
    - Level of Traffic Stress
- For Bus Rapid Transit (BRT), will the project have priority lanes and intersection priority treatments?

In the application, please include the following information:

- A summary statement about what type of impacts your project may have. Such impacts may include:
    - The increase in walking and bicycling (including e-bicycling).
    - Increase in transit ridership and automobile trip substitution from the project.
    - The amount of air pollution and GHG emissions saved by the project.
- Specific examples that demonstrate how public health can benefit. Examples may include:
    - Building a transit line along a congested corridor that will lead more people to take transit, walk, and bicycle.
    - Creating a bus or BRT lane that will encourage transit ridership, bicycling, and walking.

5.2 Mitigation Measures

It is unlikely that a project will have only positive health impacts. Thus, it would be wise to require or encourage mitigation measures. If the project cannot, by design, improve public health overall, then mitigation measures most appropriate to the project should be employed. In addition, they should correspond to the likelihood and severity of the impacts created by the project. Suggestions include improving other infrastructure facilities (e.g., sidewalks and bike lanes), improving network connectivity through prioritizing gap closures, traffic calming, Complete Streets, railroad crossings and grade separations, and improving lighting/sidewalks/transit stops/tree canopy through context-appropriate means. These may be considered on a corridor level where necessary, as in the case where impacts to one facility cannot be feasibly mitigated by a parallel facility.

5.3 Performance Metrics

Below is a sample table containing transportation indicators attributed to public health. These indicators throughout California are available via the source listed. However, the geography for each indicator may not be appropriate for all projects or for all areas of the state. Other tools contain additional indicators and are likely to be improved over time, so this list should not be updated as more data becomes available and easier to use. For further discussion on candidate performance metrics and data sources, see the Appendix.

Table 1. Performance Metrics by Source

Indicator	Source	Physical Activity	Traffic Safety	Environmental Quality / Pollution Exposure	Negative Impacts of Road Projects	Positive Impacts of Transit Projects
% Bike for Job Commute	CNK/CARB	X	X			
Clunker Vehicles (Percentile)	CNK/CARB		X	x		
% Public Transportation for Job Commute	CNK/CARB	X	X			x
% Walk for Job Commute	CNK/CARB	X	X			x
All Traffic Collisions (Percentile)	CNK/CARB	X	X		x	
Asthma Prevalence	CNK/CARB			x	x	
Availability of Parks & Public Open Space per Population (Percentile)	CNK/CARB	X				
Availability of Weighted Bikeways per Population (Percentile)	CNK/CARB		X			x
Average Commute VMT (Percentile)	CNK/CARB		X		x	x
Average VMT per Household (Percentile)	CNK/CARB		X		x	
Cardiovascular Disease (Percentile)	CNK/CARB	X		x		
High-Quality Transit Locations (Percentile)	CNK/CARB	X	X			
Newer Clean Vehicles (Percentile)	CNK/CARB		X	x		
Older Clean Vehicles (Percentile)	CNK/CARB		X	x		
Vehicles per Household	CNK/CARB	X				x
Walkability Index	CNK/CARB	X		x	x	x
Intersection Density	EPA SL Data	x		x	x	x
Level of Traffic Stress	Applicant	x	X	x	x	
Smart Location Index	EPA SL Data	x				x

Indicator	Source	Physical Activity	Traffic Safety	Environmental Quality / Pollution Exposure	Negative Impacts of Road Projects	Positive Impacts of Transit Projects
Location Efficient Neighborhood Design	TBD	x				x
Land Use Diversity Index	TBD	x				x
Traffic Volumes (AADT)	Check with MPO		X	x	x	
Road Width	Check with MPO		X		x	
Speed Limit	Check with MPO		X		x	
Roadway Functional Classification	Check with MPO	x	X		x	
Fatal crashes	SWITRS/TIMS		X		x	
Fatal crash rate	SWITRS/TIMS		X		x	
Severe injury crashes	SWITRS/TIMS		X		x	
Severe injury crash rate	SWITRS/TIMS		X		x	
Non-motorized fatal and severe injury crashes	SWITRS/TIMS	x	X		x	
Median Household Income	ACS		X			x
Older People	ACS		X	x		x
Disadvantaged Community	Various		X	x	x	X
Noise Level (dB)	TBD			x		X
Induced VMT	Calculator			x		
Ridership Projected	Applicant					X
LEND/SMF Place Index	Caltrans' Smart Mobility Calculator	x	x	x	x	X

6. Next Steps

It is clear from a review of the literature and practices from other public agencies that physical activity, traffic safety, and pollution exposure are important aspects of public health that are affected by transportation networks, facilities, and projects. However, the effects of interventions on health outcomes as a function of the built environment context are still difficult to predict with great certainty. It is reasonable to assume that certain project types, such as bike lane installations, will positively influence public health through greater physical activity. However, the amount of active transportation the project is likely to induce will depend on how supportive the surrounding environment already is. Statistical analysis of built environment variables can determine if, and to what extent, a location index should be used to assume the influence of a transportation project on public health outcomes.

Finally, a major missing piece of the puzzle is greater exploration of existing datasets and mapping tools. This research has incorporated potentially useful information, including built environment variables, air quality measurements, and prevalence of diseases in communities by location and socioeconomic factors. However, the application of this information to a formal and actionable process requires significant attention. It is likely that future work will incorporate the CNK/CARB Transportation Disparities Mapping Tool, EPA Smart Location Mapping Tool, and CDC National Environmental Public Health Tracking Network Query Tool, and Caltrans' Smart Mobility Calculator (https://smartmobilitycalculator.netlify.app) among others. Developing a deeper understanding of the relationships between variables will allow transportation decision-makers to better prioritize public health through future improvements to competitive grant program guidelines.

Appendix

Data Sets and Map Tools

The correlations between built environment variables and public health outcomes have been demonstrated in the literature. However, it is not always clear that the provision of certain built environments will lead directly to better health. The use of mapping and modeling tools can provide insight into the expected behavior changes and resulting health outcomes ultimately brought about through transportation projects.

The existing ITHIM and HEAT modeling tools are relatively simple in that they rely on user input of active transportation levels and calculate the resulting health outcomes on a societal level. The gap is in determining the active transportation levels likely to occur from specific projects in specific locations.

Transportation Disparities Mapping Tool (TDMP)

This is a free online mapping tool available here:

> https://experience.arcgis.com/experience/9c13f35df3904dcb80530d0df49bdf9e/page/Transportation.

This mapping tool displays many indicators related to transportation and public health in California census tracts. Access to, and quality of, various forms of transportation are shown. Measures include household access to private vehicles, as well as their age, reliability (assumed through the number of "clunker" vehicles, those that are greater than 20 years old based on model year), emissions cleanliness, and usage by household and worker. Access to transit, bikeways, parks, and jobs are shown. Additional socioeconomic and housing affordability metrics round out the presumed predictors of health outcomes. The only documentation, available as a draft most recently updated May 16, 2021, provides information on the use of the tool and possible applications (California Air Resources Board & UCLA Center for Neighborhood Knowledge, 2021). However, further analysis likely could include calculating various regressions of the indicators to see how strongly each input predicts the health outcomes.

EPA Smart Location Mapping Tool

This is a free online tool available here: https://www.epa.gov/smartgrowth/smart-location-mapping. The Smart Location Database summarizes more than 90 different indicators associated with the built environment and location efficiency. Indicators include density of development, diversity of land use, street network design, and accessibility to destinations as well as various demographic and employment statistics. Most attributes are available for all U.S. block groups.

CDC National Environmental Public Health Tracking Network Query Tool

This is a free online tool available here: https://ephtracking.cdc.gov/DataExplorer/. The National Environmental Public Health Tracking Network brings together health data and environment data from national, state, and city sources and provides supporting information to make the data easier to understand. The Tracking Network has data and information on environments and hazards, health effects, and population health. On the Tracking Network, you can: use the "Data Explorer" to view interactive maps, tables, and charts. You can also view "Info by Location" for county level data snapshots. There are two maps displayed at once, so it is possible for the user to compare different health conditions by location to each other. Both national and state views by county allow for visual mapping at each level of government.

Integrated Transport and Health Impact Model (ITHIM) USA and California

This is a free online tool available here: https://skylab.cdph.ca.gov/HealthyMobilityOptionTool-ITHIM/. ITHIM considers the public health impacts of alternatives to the business-as-usual transportation and lifestyle choices of Americans. It considers outcomes based on various possible scenarios over timelines out to 35 years from the baseline of 2015. The outcomes are given in terms of "fine particulate air pollution from vehicle exhaust, physical activity from walking and cycling, and injuries from traffic collisions. ITHIM calculates the change in deaths, years of life shortening and disability, and costs due to these changes in air pollution, physical activity, and traffic injuries." The recommendation of the United States Surgeon General, that at least 50% of Americans engage in one-hundred and fifty minutes of moderate-intensity activity weekly, is saved as an example scenario. Other means of manipulating the 2015 baseline activity levels are provided for what-if scenario testing. The scenarios consider data for the entire United States. Health outcomes are based on disability-adjusted life years (DALYs), a concept that puts deaths and disabling injuries on the same scale. The output data is coarse-grained with respect to the effects on population groups, but users can upload data to perform equity analysis (Maizlish, 2020).

Similarly, ITHIM California provides the same analysis at the regional and county level in the State of California and has additional scenarios. Pre-loaded scenarios include the California Air Resources Board 2017 Climate Change Scoping Plan Update, 2030, Caltrans Strategic Management Plan 2015-2020, and Sustainable Communities Strategies, 2040 (State of California, 2020). It is possible to upload user-define scenarios, with the inputs including per capita mean daily travel distance by travel mode (bike, walk, bus, car driver, etc.) and the proportion of vehicle miles by mode and facility type (car–arterial, car–highway, truck–local, etc.). Outputs of the model include forecasts of the number of deaths and diseases in the population as well as monetary treatment costs. These data can be useful, but the model is only applicable for projects that are forecast to change user behavior.

World Health Organization Health Economic Assessment Tool (HEAT)

The Health Economic Assessment Tool (HEAT), published by the World Health Organization (WHO), calculates the number of premature deaths prevented by a user-defined scenario of increased active transportation among a population relative to the reference population and physical activity level. The user inputs the additional amount of walking or cycling, and the tool generates the impacts on mortality. The change in mortality is then monetized for an economic value. The tool considers impacts on mortality from up to three factors. Increased physical activity prevents premature death, while air pollution and crashes cause premature deaths. Carbon emissions, which are reduced by the substitution of motorized transportation for active transportation, are also monetized. The overall effects on mortality and carbon emissions are dependent on the comparison case (increased active transportation) and the reference case (no change from population as it is now), and consequently the monetary value of the scenario can vary (Kahlmeier, 2017).

CalEnviroScreen Data File

This is a free online datafile that is available here: https://data.ca.gov/dataset/calenviroscreen-3-0-results. This Microsoft Excel file organizes data by census tract number and by county. It has many helpful datasets that can be used in demonstrating access. For example, it has a "Poverty" column (column AW) that can be used to determine low-income populations near transit.

Caltrans Smart Mobility Calculator (CSMC)

This is a free online tool that displays important data for sustainability, livability, and equity such as VMT per capita, obesity levels, and the location of disadvantaged communities, as per SB 535. It can be found here: https://smartmobilitycalculator.netlify.app.

Induced Travel Calculator

This is a free online tool available here: https://travelcalculator.ncst.ucdavis.edu. This calculator allows users to estimate the VMT induced annually as a result of adding general-purpose lane miles, high-occupancy vehicle (HOV) lane miles, or high-occupancy toll (HOT) lane miles to publicly owned roadways, like those managed by the California Department of Transportation (Caltrans), in one of California's urbanized counties (counties within a metropolitan statistical area (MSA)). The calculator applies only to facilities with Federal Highway Administration (FHWA) functional classifications of 1, 2 or 3. That corresponds to interstate highways (class 1), other freeways and expressways (class 2), and other principal arterials (class 3).

California Healthy Places Index (HPI)

This is a free online tool, available here: https://map.healthyplacesindex.org. It allows users to explore numerous health-related indicators by census tract. These include economic, educational, transportation, social, and additional factors that contribute to an overall HPI score, such that the least healthy places, those tracts with the lowest scores, can be easily identified. Census tracts are displayed by their score relative to those throughout the state. HPI also has data on health and behavioral outcomes that could be reasonably considered dependent on the health factors that contribute to the HPI score. This data set is a great source of health inputs and outputs that can be measured for relationships.

Climate Change & Health Vulnerability Indicators for California (CCHVIz)

This is a free online tool available here: https://skylab.cdph.ca.gov/CCHVIz/. It allows users to visualize the effects of climate change on various communities through the lenses of exposure and sensitivity. Extreme exposures to climate change impacts may be based on broad geographical, topographical, and meteorological factors, but the effects on populations depend on preexisting factors such as the presence of older and younger children, disabled people, and households without air conditioning. The ability to endure extreme conditions can vary greatly within metropolitan regions and throughout the state and perpetuate disadvantage through climate change-related health outcomes. This data set can be particularly useful in identifying communities at risk for current and future impacts that should be considered in significant infrastructure investments (California Department of Public Health, n.d.).

United States DOT Transportation and Health Tool

This is a free online tool available here: https://www7.transportation.gov/transportation-health-tool/indicators. The tool is a limited data set with indicators available for the state, metropolitan area, and urbanized area levels. The data is somewhat out of date, with the most recent update in 2016, but it contains useful indicators, such as land use mix, physical activity from transportation, and road traffic fatalities by mode and exposure rate (*Transportation and Health Indicators*, n.d.).

Additional Resources

(American Public Health Association & Transportation for America, n.d.)

(National Association of Regional Councils, 2012)

(Zimmerman, 2019)

(U.S. Department of Transportation, 2022)

Abbreviations and Acronyms

3 Ds	Density, diversity, design
AADT	Annual average of daily traffic
ACS	American Community Survey
ATP	Active Transportation Program
BRT	Bus rapid transit
Caltrans	California Department of Transportation
CCHVIz	Climate Change & Health Vulnerability Indicators for California
CDC	Centers for Disease Control
CMCP	Comprehensive Multimodal Corridor Plan
CO	Carbon monoxide
CO2	Carbon dioxide
CSMC	Caltrans Smart Mobility Calculator
CTC	California Transportation Commission
DALYs	Disability-adjusted life years
EPA SL	(United States) Environmental Protection Agency Smart Location
FHWA	Federal Highways Administration
GHG	Greenhouse gas
GIS	Geographic information system
HEAT	Health Economic Assessment Tool
HOT	High-occupancy toll
HOV	High-occupancy vehicle
HPI	Healthy Places Index
ITHIM	Integrated Transport and Health Impact Model
LEND	Location Efficient Neighborhood Design
LOS	Level of service
LPP	Local Partnership Program
LTS	Level of traffic stress
MPO	Metropolitan planning organization
MSA	Metropolitan statistical area

NOx	Nitrogen oxides
PM10	Coarse particulate matter (10-micron diameter or less)
PM2.5	Fine particulate matter (2.5-micron diameter or less)
SACOG	Sacramento Area Council of Governments
SB	Senate Bill
SCCP	Solutions for Congested Corridors Program
SLI	(United States Environmental Protection Agency) Smart Location Index
SOx	Sulfur oxides
SWITRS	Statewide Integrated Traffic Records System
TCEP	Trade Corridor Enhancement Program
TDM	Transportation demand management
TDMP	Transportation Disparities Mapping Tool
TIMS	Transportation Injury Mapping Systems
U.S. DOT	United States Department of Transportation
U.S. EPA	United States Environmental Protection Agency
VMT	Vehicle miles traveled
VOC	Volatile organic compounds
WHO	World Health Organization

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