DRAFT FOR PUBLIC COMMENT

STATE OF CALIFORNIA
EXTREME HEAT ADAPTATION INTERIM GUIDANCE DOCUMENT

Developed by the Heat Adaptation Workgroup of the Public Health Workgroup, California Climate Action Team (CAT)

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STATE OF CALIFORNIA EXTREME HEAT ADAPTATION GUIDANCE DOCUMENT: Planning for Health and Heat

Background, Purpose, and Intended Use

This document provides guidance for incorporating extreme heat projections into planning and decision making in California based on current climate change models. This guidance focuses on the human health aspects of increasing temperature in California, including longer and more frequent extreme heat events, which pose substantial additional risk of illness and death to the state's residents, especially to vulnerable populations. It also provides recommendations for consideration by state agencies related to extreme heat preparedness and response and to strategies for cooling the built environment and mitigating the effects of urban heat islands.

Development of this Document

The Climate Action Team Public Health Workgroup convened a subcommittee on heat adaptation to develop this document. Its underlying premise is that as the climate changes in California, extreme heat is increasing likely to cause many harmful economic, ecological, physical, and social impacts and that considering extreme heat in agency decisions can help mitigate some of these impacts.

The Heat Adaption Workgroup was co-chaired by the California Department of Public Health and the California Environmental Protection Agency and includes staff from the following state entities:

- California Air Resources Board (CARB)
- California Department of Forestry and Fire Protection (CAL FIRE)
- California Department of Industrial Relations, Division of Occupational Safety and Health (Cal/OSHA)
- California Department of Public Health (CDPH)
- California Department of Transportation (Caltrans)
- California Emergency Management Agency (Cal EMA)
- California Energy Commission (CEC)
- California Environmental Protection Agency (Cal/EPA)
- California Natural Resources Agency (CNRA)
- Governor's Office of Planning and Research (OPR)
- Office of Environmental Health Hazard Assessment (OEHHA)

Staff from these state entities worked collaboratively to develop this guidance document and reached agreement on the document's recommendations. Other agencies were interviewed or consulted to assist the Heat Adaptation Workgroup in understanding specific issues that related to the development of the guidance and the Recommendations section.

The Heat Adaptation Workgroup worked with scientists affiliated with the California Energy Commission's Public Interest Energy Research program to ensure this document was informed by the best available science. The Workgroup obtained climate

model data on heat from scientists at the Scripps Institution of Oceanography, University of California, San Diego, using the same temperature data incorporated into Cal Adapt (http://cal-adapt.org/) – a web-based adaptation planning tool developed by the California Natural Resources Agency, the California Energy Commission, and the UC Berkeley Geospatial Innovation Facility. Climate change models show that increased temperature will occur throughout the southwestern United States, including California.

Heat ranks as the deadliest of all natural hazards (Borden et al, 2008). Even though heat-related deaths and illnesses are largely preventable, many people annually succumb to extreme heat. In a 10-day California heat wave in 2006, over 650 people died due to heat-related conditions. In 2003, during an extended heat wave impacting much of Europe, over 70,000 died. Other U.S. and European heat waves with significant mortality are shown in Table 1.

Table 1

Extreme Heat incident	Deaths
Philadelphia heat wave, 1993	118
Chicago heat wave, 1995	739
European heat wave, 2003	70,000
California heat wave, 2006	650
Russian heat wave, 2010	11,000-50,000

This guidance provides an overview of current climate projections for increased temperature and extreme heat conditions for California, describes the health effects of extreme heat, and presents recommendations for state and local planners, local governments, emergency response, and public health and health care professionals and institutions. The early integration of extreme heat projections into plans, policies and projects will lessen the potential impacts of the state's warming climate, as will modifications made to cool the built environment of urbanized areas where over 95% of California's population lives.

In addition, this guidance addresses the direct health effects of increasing temperature and extreme heat events (with some mention of the indirect effects of air pollution). The Workgroup did not attempt to look at the many indirect effects of increased temperature (wildfire, drought, changes in agricultural production, etc.), which are expected to pose additional challenges to human health and wellbeing in California.

Climate Change and Extreme Heat Projections for California

Characteristics of Extreme Heat Events

The National Weather Service (NWS) issues an Excessive Heat Warning/Advisory when an extreme heat event (a "heat wave") is expected within the next 36 hours. Typically, the NWS issues these warnings based on a "Heat Index" - a combination of heat and humidity - that is predicted to be 105 ºF or greater for two or more consecutive days, although the temperature cut-off varies for different regions. In California, local weather forecast offices may use different criteria for Excessive Heat Warning/Advisories based on maximum temperatures, nighttime temperatures, and other methods. Although the NWS generally uses a certain Heat Index cut-off for their Excessive Heat Warnings, many experts recommend using relative - rather than absolute - temperature to define extreme heat events. For example, the Centers for Disease Control and Prevention define extreme heat as "summertime temperatures that are substantially hotter and/or more humid than average for that location at that time of year". Under this approach, which is used by most health organizations, a mid-summer extreme heat event in San Francisco may have a similar Heat Index as an average autumn day in Fresno. The lack of acclimatization to heat in areas that are generally cooler means that people living in those areas are at risk of heat-related illness at cooler temperatures than people who have had time to become more acclimatized to heat and who also have more access to air conditioning. Acclimatization is a process whereby the healthy body gradually adapts to heat by various physiologic mechanisms over a period of several weeks of recurrent exposure to heat.

To make projections of expected impacts of heat events on human health, one must first have an estimate of how heat events will change in the future due to effects of climate change. Several characteristics of heat events are of public health concern: (1) how extreme the events will become; (2) how frequently they will occur; (3) whether or not the duration of the events will change; (4) whether or not the seasonality of the events will change, (i.e., whether heat events are expected to occur earlier or later in the annual cycle), and (5) whether the geographical extent of the events will change.

Heat Event Projections for California in a Changing Climate

In order to project how heat events will change in the future, climatologists first examine several global climate models, based on different assumptions, rather than one model, to obtain a more complete picture based on a range of projections. These models exhibit variability due to differences in representing how greenhouse gas (GHG) emissions will affect the climate.

Secondly, climatologists look to different emission scenarios to estimate how (GHG) emissions may change in the future. Different emission scenarios lead to different levels of heating. Finally, the temperature projections are downscaled from a coarse level to a finer spatial scale in order to be useful at a regional or local level.

For California, most projections of heat events have been conducted with cooperation from the Scripps Institute of Oceanography, University of California, San Diego. Table 2 summarizes the research on projecting temperature increases in California. The models have been consistent in projecting increases in annual average temperature of

up to 5° F by the 2030s and up to 10° F by the end of the century or sooner, although not every day will be hotter. This work has also indicated that extreme temperature events will occur more frequently.

Table 2. Summary of Temperature Projections for California

Model	Findings
Hayhoe, et al.2004	Increase of 3°-5° F in state-wide average temperature by 2030s and up to 9° F for summer average by 2050s under high emission scenario
Drechsler, et al.2006	Summer daily maximum temperatures would increase by 2.2°–7.6° F by 2035–2065
Cayan, et al.2009	Increase in state-wide annual average temperature between 2.8°-10.8° F by end of century
Mastrandea, et al.2009	Extreme temperatures currently estimated to occur once every 100 years would occur annually under high emission scenario
Ostro, et al.2011	Statewide changes in annual average temperature of 1.9° F in 2025 and 4.6° F in 2050 would translate to 2,100 to 4,300 excess deaths in 2025 and 6,700 to 11,300 excess deaths in 2050.

Cal-Adapt (http://cal-adapt.org/) is an online resource funded by the California Energy Commission to display climate change data at a local level. Cal-Adapt currently uses Scripps' model data to display local level projections for increases in temperatures. For example, Cal-Adapt shows average maximum temperature projections by month and day for a specific location. It also shows projections of increases in extreme heat days and heat waves, which is of great importance for public health planning.

Cal-Adapt defines extreme heat days as above the 98th percentile of the computed maximum temperature for each location using 1961-1990 data for the May to October warm season. These data are useful for targeting heat illness prevention and for estimating health impacts from increasing heat events.

Cal-Adapt projects that urban and rural population centers throughout California will experience an average of 40 to 53 extreme heat days by 2050 and an average of 40 to 99 days by 2099. This compares to a historical average of 4 per year. Table 3 shows several examples. Although it is not surprising that the high temperatures in historically hotter areas in California will rise still higher, the models predict a greater relative increase in extreme heat days in coastal cities compared to inland areas. The coastal areas will still remain cooler than inland areas, but the number of relatively hot days is expected to significantly increase.

Table 3. Model Estimated Extreme Heat Days

May 1 to Oct 1 in Selected California Cities*, 2050 and 2099

City	2050	2099
Bakersfield	48	93
El Centro	60	101
Fresno	46	90
Los Angeles	78	110
San Francisco	39	126
Redding	35	75
Sacramento	44	85
San Diego	76	129
San Jose	71	111
Truckee	41	83

* High emission scenario A2 using average of 4 models
Number of days exceeding 98th percentile of baseline temperatures, based on a 1961-1990 baseline of 4 extreme heat days per year
Source: Analysis based on Cal-Adapt

Populations in cooler areas in California may be at greater risk of heat-related illness because (a) individuals are less acclimatized to heat, (b) people are less aware of the risk or protective behaviors that can reduce exposure (e.g., reduce activity level or go to an air conditioned location) or physiologic stress (e.g., hydration), and (c) the built environment is not designed for warmer conditions (e.g., homes, workplaces and institutions are less often equipped with air conditioning or it is inadequate for extreme or prolonged heat events). In addition, communities in these locations, inadequately aware of the risk, may not have plans or capacity for emergency mitigation measures. For example, during the 2006 California heat wave, a greater increase in emergency room visits and hospitalizations for heat-related illnesses occurred in the normally cooler coastal counties.

Urban Heat Islands and the Built Environment

Temperatures in most urban areas are significantly higher than in surrounding, less urbanized areas, due to the Urban Heat Island (UHI) effect (Imhoff, et al, 2010). Urban areas consistently have higher temperatures than surrounding, more-vegetated areas, because pavement and building materials absorb sunlight and heat.

Daytime temperatures in urban areas are on average 1-6° F higher than in rural areas, while nighttime temperatures can be as much as 22º F higher as the heat is gradually released from buildings and pavement (U.S. EPA, 2008). Pavements cover a third of a typical U.S. City (Akbari et al., 2009), mostly with asphalt, which reflects only 10 percent of the sunlight shining upon it. If we take Sacramento's urban fabric as representative of California cities, then parking lots comprise roughly 15% of total urban land area (Akbari

et al., 1999). Building density, design and materials, heat from industrial operations, machinery, air conditioners and vehicles, road pavement, and lack of vegetation all contribute to the creation of heat islands.

The concentration of heat under UHI conditions creates health risks both because of heat exposure and the enhanced formation of air pollutants, especially ozone. The strong influence of UHI on nighttime temperatures limits the ability of people to cool down and recover before the heat of the next day, and therefore adds to the risk of illness and fatalities.

The most intense urban heat island effects are often seen in neighborhoods where dense land use and impervious, paved surfaces predominate and trees, vegetation and parks are less common. Access to the cooling effects of urban greening and open space is most limited for low-income urban communities. Strategies that can reduce the Urban Heat Island effect include increasing urban greening (such as trees, parks, and green roofs), and using lighter-colored or cooler materials (such as porous pavements and cool roofs[1]). These strategies can make a significant difference in temperatures, and consequently in health risks, in urban areas.

Shading of buildings, asphalt and other dark surfaces with trees can reduce the UHI effect. Tree planting requires adequate space, water, and maintenance, and the correct selection of trees. Direct shading of buildings also reduces heat in buildings in the event of power outages in an extreme heat event.

Restoration of streams attains the combined public health benefits of reduced heat island effects by increasing vegetated riparian areas as well as reduced surface water contamination through biological processes inherent in natural aquatic systems. Ideally stream restoration measures would be coordinated under a watershed management plan.

California's Building Standards contain both mandatory and voluntary green building standards. The more aggressive voluntary standards are often adopted by local governments that have made a commitment to higher levels of energy efficiency and sustainable built environments beyond what is required in the statewide building code. These voluntary standards can be an important roadmap to document the "next steps" that should be taken in future mandatory building codes. While the Green Building Standards Code does not have a formal process to move the voluntary measures into the mandatory requirements, cost effectiveness has been identified as one important aspect. Hardscape alternatives that reduce the heat island effect are a good example of a voluntary measure that could become mandatory in future updates to the Green Building Standards Code.

[1] A cool roof is one that reflects the sun's heat and emits absorbed radiation back into the atmosphere. The roof literally stays cooler and reduces the amount of heat transferred to the building below, keeping the building a cooler and more constant temperature. A cool roof need not be white. There are many "cool color" products which use darker-colored pigments that are highly reflective in the near infrared (non-visible) portion of the solar spectrum. (www.coolroofs.org)

Cool roofing contributes to reduced energy consumption and an associated reduction in GHG emissions. Cool roofing also contributes to mitigating UHI effects which is important to protecting human health. Recent studies suggest that significant climate cooling would arise with increased application of cool roofing in urban areas. In addition to cool roofs, some energy efficiency measures in houses and small commercial buildings can help to keep the indoor environment within comfortable temperature conditions without use of air conditioning during extreme heat events. These measures (e.g. roof deck insulation, wall insulation, high performance windows, and building orientation) are also important to include in building designs because they are "passive" – they work without reliance on electrical power.

Health Effects from Heat

Heat-related illness includes a spectrum of illnesses ranging from heat cramps to severe heat exhaustion and life-threatening heat stroke. Heat-related illness results from the "body's inability to dissipate heat produced by metabolic activity, often as a result of increased ambient temperature" (Wexler, 2002).

Heat-related illnesses
Heat cramps involve severe painful cramping of the muscles in the arms, legs or abdomen often accompanied by swelling of the legs and feet. It is not immediately dangerous, but is a signal of significant stress on the body from heat. If heat cramps are not treated with cooling and hydration, the person is at risk of developing heat exhaustion and heat stroke.

Heat exhaustion: is more serious and generally includes an elevated core body temperature that is less than 104°F. Symptoms of heat exhaustion include generalized malaise, weakness, nausea, vomiting, headache, irritability, confusion, rapid heart rate and sweating (often with cold, clammy skin). Active cooling of the affected individual is necessary. Untreated heat exhaustion can progress to heat stroke within minutes or hours.

The most serious illness is **heat stroke**, a severe and life-threatening failure of the body's ability to cool (e.g., sweating ceases), with core temperature generally over 104° F. Heat stroke includes severe mental status changes, seizures, loss of consciousness, kidney failure and abnormal cardiac rhythm. This catastrophic illness can be distinguished from heat exhaustion by two factors: changes in mental status (ranging from delirium to coma) and hot, dry skin. Elevated temperature over a specific cutoff is not necessary for the diagnosis of heat stroke. Heat stroke is an extreme medical emergency that if not promptly treated frequently results in death or permanent neurological impairment. With prompt and appropriate emergency medical treatment, survival can approach 100%.

Because no standardized definition for heat-related death currently exists in the US, heat-related deaths are severely under-reported. They may only be reported during a heat wave although they also occur on hot days that are not defined as heat waves (Basu and Samet, 2002; Basu, 2009). California has no statewide, real-time surveillance system for heat illness and/or death. The state has no central state medical examiner able to quickly produce data on fatalities. Current death data resides in the files of coroners and medical examiners in each of the 58 counties, and also in death certificates. Existing methods lack the detail and timeliness needed to describe the effects of fast moving events, such as a heat wave.

Employers are required to report work-related deaths and/or serious illness, including those due to heat, to their local Cal/OSHA district office. These reports trigger an enforcement investigation and have been used in the past for statewide surveillance activities. However, insufficient resources are available to maintain ongoing surveillance and epidemiologic surveillance using these data. Workers' compensation

records have also been used to conduct retrospective analysis of heat illness cases in the workplace.

A study of the California heat wave of July 2006 (Ostro et al. 2009) reported that the number of deaths following a heat wave was severely underestimated by coroners' reports (which reported 140 deaths), and that the actual number of deaths was three to five times higher than deaths that would be expected during other time periods (Basu et al. 2008, Basu and Ostro 2008; Basu et al., 2011). A follow-up study by the California Department of Public Health estimated that 655 excess deaths occurred during the 2006 heat wave (Hoshiko et al. 2010).

Populations at Risk from Heat

Heat-related illness can be classified as "exertional" or "classic," and different populations are at risk for each type.

The majority of non-working victims during heat waves suffer from "classic" heat-related illness. Several studies have found that these are acute illnesses and deaths with the greatest risk on the same day as exposure. The following groups are mainly at risk of "classic" heat related illness: young children, the elderly, persons with pre-existing chronic diseases (e.g. respiratory, cardiovascular, diabetes) (Green, 2010), pregnant women (Basu et al, 2010), those who are socially isolated and those who have a disability. The elderly are at higher risk due to reduced ability to acclimatize to changing temperatures, for example reduced sweating, diminished thirst response even when they are dehydrated and higher likelihood of pre-existing chronic health conditions. Heat-related deaths have been shown to be greater for those with cardiovascular diseases, as well as for African-Americans, infants, children and the elderly (Basu and Ostro, 2008).

"Exertional" heat-related illness generally affects persons engaged in vigorous physical activity, which causes the body to generate internal heat, and occurs during hot and/or humid environmental conditions that reduce the body's ability to dissipate heat. This type of heat illness affects workers (outdoor and indoor), outdoor athletes (especially young athletes) and military personnel.

For workers, exertional heat illness occurs across a wide age range and in numerous industries and occupations, including: agriculture, construction, firefighting, warehousing, delivery, and service work. Although a significant number of California workers have experienced severe heat-related illness and death during heat waves in recent years, exertional work-related heat-illness is believed to be under-reported and not well captured by existing data systems.[2] Since 2005, California employers have been required to provide basic elements to protect outdoor workers—adequate water, shade, rest breaks, training and emergency procedures.[3] Such provisions can mean

[2] CCR Title 8 Section §3395. Reporting Work-Connected Injuries, (http://www.dir.ca.gov/title8/342.html).
[3] CCR Title 8 Section §3395. Heat Illness Prevention, (http://www.dir.ca.gov/title8/3395.html).

the difference between life and death. In 2010, the standard was strengthened to include a high heat provision that must be implemented by five industries (agriculture, construction, landscaping, oil and gas extraction and transportation or delivery of agricultural products, construction material or other heavy materials) when temperatures reach 95° F.

Heat emergencies impact service provision by government, business, and community organizations. Information on vulnerable populations they serve may improve the prioritization, timing, geographic coverage, communication, coordination, and evaluation of these services.

Air Conditioning: A Dilemma

During extreme heat events when power shortages are more likely to occur, utilities request that consumers and businesses decrease their use of electricity to reduce demand on the energy grid, especially during peak load hours. In some cases, excessive energy demand may result in rolling blackouts affecting part or all of service areas.

During extreme heat events public health officials recommend that members of vulnerable groups stay inside or move to cooler locations, such as an air conditioned dwelling (the most common and convenient place) or a mall, library, community center or designated “cooling center”. Heat warnings and public service announcements identify key actions such as staying hydrated, wearing light clothing, checking on elderly neighbors/relatives and other behavioral changes to reduce risks of heat illness. Several studies have shown an unequal access to air conditioning across California based on income and race in areas subject to extreme heat. Some renters may not have access to air conditioning or may face obstacles to installing and paying for their own units. Coastal areas, cooled by ocean influences and fog, have not “needed” air conditioning as much as inland areas.

The cost of air conditioning may be a barrier to low income and vulnerable populations even when it is available and recommended. Not all members of vulnerable groups currently know about or access utility or government (Low Income Home Energy Assistance Program) energy subsidy programs

On the one hand, during extreme heat events, utilities are telling the public to turn off the air conditioner during the peak period. On the other hand, public health officials encourage vulnerable populations to seek air conditioning. Access to air conditioning should be more thoroughly studied in light of changing heat projections throughout regions of the state.

Air Quality and Heat Exposure

Degradation of air quality will compound the health hazards posed by increases in temperature. Higher temperatures favor the formation of ground-level ozone and other secondary air pollutants created from chemical reactions with pollutants directly emitted from power plants, motor vehicles, and other sources. Poor air quality can adversely

affect the health of many Californians, with a disproportionate disease burden among the populations at risk previously mentioned. With the projected increased occurrence of extreme heat events, demand for electric power generation will increase. This may contribute to further degradation of air quality despite efforts to control power plant emissions. In addition, recent evidence has linked extreme storms due to climate change to destruction of the protective ozone layer in the upper atmosphere. This could result in increased risk of skin cancer and other health problems.

Additional Risk Factors

As the climate in California changes, prolonged heat events are likely to impact areas currently unaccustomed to heat waves such as communities in California's coastal region, more northern latitudes and higher elevations. Houses, schools and workplaces in these communities, as well as older buildings throughout the State (e.g., in older urban neighborhoods and in rural areas), generally do not have insulation or air conditioners or have air conditioning units that do not provide adequate cooling under extreme heat conditions. Some vulnerable subpopulations, such as the poor or elderly, may not have access to air conditioning or they may choose to not use it to avoid expenses to limited, fixed incomes. In addition, the very young and the elderly, as well as people with various illnesses, are less able to become acclimatized to heat over time, so they remain at risk of heat illness when healthy people may successfully adapt to higher temperatures.

Recommendations

California faces temperature increases throughout the state over the next 80 years that will pose considerable health risks to our population, especially to a number of vulnerable groups. Preparing for these changing conditions will require a combination of strengthening our preparedness for extreme heat events and adaptation by modifying and cooling the built environments in which we live.

The Heat Adaptation Workgroup developed the following recommendations to guide the state's efforts to become more prepared and resilient to increasing temperature and ultimately to protect the health and well-being of our population today and in the future. **The recommendations are primarily aimed at state government agencies**. While many existing state and local plans, policies and programs are already in place to address heat and other natural hazards, incorporating updated climate change information, the goal of these recommendations is to ensure that the public and all levels of government are prepared, coordinated, and have the resources to respond to hotter, longer and more frequent extreme heat events.

These recommendations present several priority research and evaluation needs. Partnerships and multi-disciplinary efforts between state and local government, the public health and health sectors, social service agencies, business, labor, utilities and representatives of the most vulnerable populations are highlighted in specific areas.

SECTION I. Heat Resilient and Cooler Communities

1. **Review state and local regulations, codes and industry practices for buildings, land use and design elements to identify opportunities to accelerate the adoption of cooling strategies for both indoor and outdoor environments, to the extent feasible.**
   Lead Agency: *California Energy Commission, Governor's Office of Planning and Research.*
   Other Agencies and Stakeholders: *Air Resources Board, Building Standards Commission, local and regional planning agencies.*

   i. **Update Title 24, Part 11: California's Green Building Standards in CA Building Code.** Update Title 24, Part 11 to include measures that should be required in the future to mitigate the health risks of extreme heat events in the built environment. Incorporate consideration of health impacts as part of that process.
   ii. **Update Title 24, Part 6: Building Energy Efficiency Standards.** Consider measures which both cool internal building space and contribute to larger environmental cooling to reduce the build-up of heat via UHI mechanisms.
   iii. **Incorporate cooling strategies in land use.** Work with local governments to consider cool land use elements as part of sustainable community planning and implementation, especially for areas where dense building (infill, transit oriented development, transit corridors, etc.) patterns might contribute to more urban heating.
   iv. **Prevent building dampness.** Address explicitly risks from indoor dampness, which may be exacerbated by some weatherization practices. Elements of building moisture control are addressed in various codes and guidelines (e.g., CalGreen, U.S. Green Building Code, LEED, etc.)

2. **Examine and expand the use of porous pavements where possible.**
   Lead Agency: *Caltrans, Governor's Office of Planning and Research, Department of General Services.*
   Other Agencies and Stakeholders: *Local governments, local transportation departments.*

   Expand the use of porous pavements in parking lots, to lower night time surface temperatures as compared to other pavements, which also provides water quality benefits. DGS is responsible for state-owned parking facilities. Caltrans is responsible for park and ride lots and maintenance station parking areas. DGS and Caltrans specifications can provide a template for local government and the private sector to use.

3. Promote and expand urban greening and the use of green infrastructure as part of cooling strategies in public and private spaces.
Lead Agency: *CAL FIRE, Department of Parks and Recreation, Governor's Office of Planning and Research, California Department of Public Health.*
Other Agencies and Stakeholders: *Natural Resources Agency, Caltrans, California Energy Commission, Department of Fish and Game, Department of Conservation, State Water Resources Control Board, local governments, local parks departments and districts, local health departments, urban greening and trees non-governmental organizations.*

- **i. Plant trees.** Increase tree canopy cover percentage, especially for high impact areas like the Inland Empire and San Joaquin Valley, and especially for areas with highest UHI contribution: large parking lots, arterial roads, dark roofs on buildings.
- **ii. Use vegetation**. Use alternative vegetative solutions to alleviate UHI: for example, green walls and green roofs where trees are not possible. These solutions are more costly then trees, but still provide significant benefit.
- **iii. Shade green open space.** Use trees to provide shade at outdoor work sites and places where people recreate. This could be a cost effective solution for agriculture as well as for parking lots, parks, bike paths, and tracks.
- **iv. Restore urban streams.** Where possible, restore natural geomorphic and hydrologic features to failing culverted and channelized streams in urban areas.

SECTION II: Preparedness and Response to Extreme Heat Events

1. Assess state and local hazard mitigation plans, heat contingency plans and other hazard planning documents in consideration of potential heat health risks posed by climate change.
Lead Agency: *California Emergency Management Agency.*
Other Agencies and Stakeholders: *California Department of Public Health, Cal/OSHA, local emergency managers and planners, local health departments, health care sector.*

- **i.** Consider how to integrate heat projections from climate models (Cal Adapt) into the plan. Use the Adaptation Planning Guide as a source of adaptation strategies.
- **ii.** Strengthen considerations of climate impacts in hazard assessment planning, implementation priorities, and emergency response.
- **iii.** Review emerging best practices from other areas where climate change impacts have been integrated into Heat Response Plans (e.g. Euro HEAT, Health Canada, Minnesota, Philadelphia, New York City, others).
- **iv.** Evaluate current strategies intended to protect the health of the California population, especially vulnerable populations, against the additional risks of climate-related extreme heat events. (e.g., cooling centers, public warnings and messages, air conditioning).

2. Improve Heat-Health Alert Warnings.
Lead Agency: *California Department of Public Health, Office of Environmental Health Hazard Assessment, California Emergency Management Agency.*
Other Agencies and Stakeholders: *Office of State Climatologist at Department of Water Resources, Cal/OSHA, National Weather Service, Centers for Disease Control and Prevention.*

Work collaboratively with the National Weather Service to incorporate health outcomes into heat warning products for routine use by the state and local California jurisdictions, leveraging technical expertise of California agencies' staff.

3. Improve community resilience for increasing heat, especially for vulnerable populations.

Lead Agency: *California Department of Public Health, Health and Human Services Agency, California Emergency Management Agency.*

Other Agencies and Stakeholders: *Office of Environmental Health Hazard Assessment, local health agencies, local emergency management, local social services.*

Convene health and social service providers from multiple sectors, including state and local agencies, and researchers who are developing state-of-the-art vulnerability mapping techniques and other information to:

- **i.** Identify best practices for developing and using vulnerability maps for service delivery;
- **ii.** Identify additional information to strengthen vulnerability mapping and the process of service delivery;
- **iii.** Use statistical approaches to determine vulnerable subgroups (i.e., by race/ethnic group, age, education level) for regions or counties.

4. Protect the energy grid.

Lead Agency: *Natural Resources Agency.*

Other Agencies and Stakeholders: *California Public Utilities Commission, California Energy Commission, California Department of Public Health, Emergency Medical Services Authority, California Independent System Operator, local governments, local health departments, health care facilities.*

Work with utilities to protect power to cooling centers and other essential services, wherever possible.

5. Protect vulnerable populations from high temperatures.

Lead Agency: *California Department of Public Health, California Emergency Management Agency*

Other Agencies and Stakeholders: *California Public Utilities Commission, California Occupational Safety and Health, Cal/OSHA, local governments, local energy planners, local public health departments, utilities.*

- **i.** **Improve access to air conditioning**. Improve the availability of air conditioning to those who do not currently have access.
- **ii.** **Incentivize the use of air conditioning.** Work with local governments and utilities to review the adequacy of programs designed to help vulnerable populations stay cool during heat waves, with attention to ways to offset the economic impacts on seniors and low income groups.

Section III. Public Health and Health Care Sector Readiness

1. Increase the health care system's extreme heat preparedness and resiliency.
Lead Agency: *California Department of Public Health, Emergency Medical Services Authority.*
Other Agencies and Stakeholders: *Health and Human Services Agency, Department of Managed Health Care, California Hospital Association.*

Convene key healthcare agencies and partners representing the health care sector to review this guidance, assess additional risks to the health sector and identify any new or modified strategies necessary to become more heat prepared and resilient.

2. Improve the timeliness and completeness of heat illness and death surveillance activities in order to understand the impact of heat events and guide real time public health planning and responses.
Lead Agency: *California Department of Public Health.*
Other Agencies and Stakeholders: *Office of Environmental Health Hazards Assessment, Emergency Medical Services Authority, local health departments, hospitals, health care providers, coroners, local emergency medical services.*

- **i.** Convene key stakeholder and health representatives to identify changes that could improve the state's capacity to detect and monitor health effects during a heat wave.
- **ii.** Review CDPH's Electronic Death Registration System (EDRS) to determine how it could be modified to include a heat report supplement to collect additional vital information during heat waves.
- **iii.** Consider whether other early detection surveillance programs might be expanded to include heat illness for statewide surveillance. (e.g., BioSense).
- **iv.** Examine new developments in Health Information Exchange that may present opportunities to collect heat illness data from electronic medical records (e.g., use of the early-detection surveillance module).
- **v.** Identify resources to support more timely and accurate statewide reporting and surveillance of health that can prioritize needs and evaluate the effectiveness of interventions.
- **vi.** Continue discussions with state public health department personnel and the national Council of State and Territorial Epidemiologists (CSTE) regarding making heat death and/or illness a reportable condition.

Section IV. Measures to protect workers at risk of extreme heat

1. **Evaluate Cal/OSHA's Heat Illness Prevention Standard (Title 8, California Code of Regulations, Section 3395) to determine its effectiveness and whether revisions are necessary.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Food and Agriculture, California Department of Public Health, labor, business.*

2. **Promote greater coordination by state and local agencies, industry, schools, clinics/hospitals and media to convey necessary worker protection measures.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Food and Agriculture, California Department of Public Health, local health departments, labor, health care providers, business.*

3. **Augment training of employers and workers in industries with outdoor work, including assurance of adequate water, shade, rest breaks and training on heat risks.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Food and Agriculture, Labor, business.*

Section V. Research Needs

1. **Identify the characteristics of vulnerable populations and communities that are highly resilient to heat.**
   Lead Agency: *California Department of Public Health.*
   Other Agencies and Stakeholders: *Office of Environmental Health Hazard Assessment, Climate Action Team Research Working Group.*

2. **Identify heat adaptation strategies with health co-benefits.**
   Lead Agency: *California Department of Public Health.*
   Other Agencies and Stakeholders: *Air Resources Board, Office of Environmental Health Hazard Assessment.*

3. **Conduct research on population acclimatization to heat in a changing climate.**
   Lead Agency: *California Department of Public Health.*
   Other Agencies and Stakeholders: *Academic and medical research partners.*

   How will various populations especially vulnerable groups acclimatize to increasing heat? How do we incorporate acclimatization into plans to "increase adaptive capacity"?

4. **Evaluate strategies that could provide protection to vulnerable populations that are not based on energy intensive air conditioning.**
   Lead Agency: *California Energy Commission, California Public Utility Commission.*
   Other Agencies and Stakeholders: *Cal/OSHA, utilities.*

5. **Evaluate occupational health risks and strategies to reduce those risks.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Food and Agriculture, Labor, business.*

   i. Evaluate and reduce exposures to process-related heat sources.
   ii. Evaluate work organization such as reducing physically demanding work during hot times of the day, and addressing the work/rest cycle during periods of high heat. This should include identifying and removing factors that discourage workers from taking those rest periods.

6. **Assess the extent and severity of the Urban Heat Island Effect for California cities such that the cities (e.g., GIS mapping) can have a quantifiable goal for reduction**.
   Lead Agency: *California Environmental Protection Agency, Air Resources Board.*
   Other Agencies and Stakeholders: *California Department of Public Health, Caltrans, CAL FIRE, academic researchers.*

7. **Conduct research to quantify the cost and benefits associated with higher-albedo pavement.**
   Lead Agency: *California Environmental Protection Agency, Air Resources Board.*
   Other Agencies and Stakeholders: *Caltrans.*

8. **Evaluate the effectiveness of early heat warning systems geared toward working populations at high risk.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Public Health, Office of Environmental Health Hazard Assessment, California Emergency Management Agency.*

9. **Perform high-resolution tree canopy analysis of the state's urban areas.**
   Lead Agency: *CAL FIRE.*
   Other Agencies and Stakeholders: *Local governments.*

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- California Department of Transportation (Caltrans)
- California Emergency Management Agency (Cal EMA)
- California Energy Commission (CEC)
- California Environmental Protection Agency (Cal/EPA)
- California Natural Resources Agency (CNRA)
- California Public Utilities Commission (CPUC)
- Department of Community Services and Development (CSD)
- Department of Water Resources (DWR), Office of the State Climatologist
- Division of Occupational Safety and Health (Cal/OSHA)
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- Lawrence Berkeley National Laboratory (LBNL), Urban Heat Island Group
- National Weather Service (NWS), Sacramento Weather Forecasting Office and Western Region Headquarters, Salt Lake City
- Office of Environmental Health Hazard Assessment (OEHHA)

Other Stakeholders

- California Independent System Operator (CAISO)
- Centers for Disease Control and Prevention (CDC)
- Climate Action Team (CAT)
- Department of Community Services and Development (CSD)
- Department of Conservation (DOC)
- Department of Fish & Game (DFG)
- Department of Housing and Community Development (HCD)
- Department of Managed Health Card (DMHC)
- Emergency Medical Services Authority (EMSA)
- Health and Human Services Agency (HHS)
- State Water Resources Control Board (SWRCB)
- Strategic Growth Council (SGC)

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