Health Impact Assessment of a Cap-and-Trade Framework

California Department of Public Health

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Executive Summary

Faced with the economic, environmental, and public health threats posed by climate change, California passed the Global Warming Solutions Act in 2006, also known as Assembly Bill 32 (AB 32). AB 32 established a binding goal to reduce greenhouse gas emissions to 1990 levels by the year 2020. In addition to the bold environmental goals established by AB 32, the bill also explicitly states the need to maximize additional public health co-benefits, and to ensure that low-income communities are not disproportionately impacted by efforts to reduce greenhouse gas emissions.

In 2008, the California Air Resources Board (ARB) issued its Scoping Plan and detailed a series of regulatory measures to achieve emission reduction goals. Included in these measures was a cap-and-trade program to engage market mechanisms to lower greenhouse gas emissions. By engaging the efficiency of market forces, a cap-and-trade program is intended to lower greenhouse gas emissions at a cost lower than other policy efforts.

In Fall of 2009, the Climate Action Team Public Health Workgroup (CAT PHWG) decided to undertake a health impact assessment (HIA) of a cap-and-trade program in California. Health impact assessment is a practical approach for bridging scientific data, health expertise, and public input with a public decision-making process. HIA is a valuable, data-driven tool that identifies the health risks and benefits of a proposed project or policy, like the California cap-and-trade regulations, and then offers solutions to implement the policy in a way that makes communities a healthier place to live, learn, work and play.

With input from Climate Action Team PHWG participants and other environmental, economic, health, and industry professionals, potential health pathways were scoped. Cap-and-trade program impacts with the greatest potential to effect health were chosen for a more detailed health assessment. Social, environmental, and economic changes of greatest concern included:

- Changes in emissions;
- Changes in employment and labor demand;
- Changes in energy costs;
- Economic, environmental, and health impacts from specific offset projects; and
- The distribution of allowance revenue towards community investments.

The ARB assessed the impact of direct and indirect emissions as part of the regulatory process. The California Department of Public Health, supported by a grant from the Health Impact Project, a collaboration of the Robert Wood Johnson Foundation and The Pew Charitable Trusts, assessed the potential health effects that may stem from changes in employment, energy costs, community investments, and various offset projects. Particular attention was given to assessing the distribution of potential health effects, and to the protection of communities that have existing health vulnerabilities, including low-income populations, young children and the elderly, and socioeconomically disadvantaged communities of color. This report articulates these findings, suggests mitigation efforts to minimize potential negative health effects, and provides recommendations for improving health co-benefits associated with a cap-and-trade program.

Overall, the potential negative health effects from a cap-and-trade program in California are expected to be negligible to minor, and readily mitigated with targeted mitigation efforts. Potential positive health effects are likewise small, and can be improved upon by limiting the

use of offsets to no more than 49% of total emission reductions, maximizing the auction of allowances, and directing community investments to California's most vulnerable communities. The mitigations strategies below are intended to mitigate potential negative health effects, maximize public health co-benefits, and to monitor unknown program impacts to ensure that no population bears a disproportionate health impact from a cap-and-trade program.

Health Effects from Changes in Employment

Health effects from employment transitions include changes in insurance; stress and related diseases; changes in household income and related issues such as changes in household food security and housing quality; and changes in workplace morbidity/mortality. Persons of color, low-income households, and individuals with low educational attainment are most likely to be negatively impacted by labor transitions as employment opportunities shift between job sectors.

Overall, net changes in employment are expected to be minimal, and the use of offsets for 49% of total emission reductions helps maintain smooth labor transitions by increasing program efficiency. However, labor transitions for 90,000 Californians may have minor negative health effects for some households. Efforts should be made to ensure that all impacted populations are prepared for economic transitions. A portion of allowance revenue should be devoted to worker transition assistance programs. Investments in worker transition assistance, adult education, and temporary insurance offer displaced workers the time, resources, and skills to pursue a career in a new industry. These worker investments will reduce the potential adverse health impacts that are related to job dislocation and job insecurity, including health insurance gaps, stress, and the reduced ability to purchase health-promoting resources such as nutritious foods and quality housing.

Health Effects from Changes in Energy Costs

Health effects from increases in residential fuel costs are mixed. Increases in energy costs can send a price signal to conserve energy, improving air quality and meeting core emission reduction goals. However, for low-income households, increases in residential fuel costs can mean an increased risk for utility shut-off, increased strain on a limited household budget, household stress, and a greater risk for heat-related morbidity during heat waves.

Overall, net health effects are expected to be negligible to minor, while some positive health effects may result from residential energy conservation. The majority of California households would not be negatively impacted, but negative health effects are likely to accrue in low-income households who already spend a disproportionate percentage of their budget on household utilities and who have limited capacity to adjust to increased home utility costs. A portion of allowance revenue should be used to fund household energy efficiency programs and subsidize utility expenses in low-income households. An over-dampening of price signals across all households may limit positive health co-benefits associated with energy conservation; mitigation efforts should be targeted to low-income households with the greatest energy burden.

Co-benefits Associated with Offset Projects

Overall, the health effects associated with offset projects are expected to be positive, small, and localized. The positive health effects associated with urban forestry are likely to be the most substantial, and include impacts on air quality, heat exposure, and cardiovascular disease,

among other health outcomes. Health effects associated with ozone depleting substances and manure management practices are likely positive, but less positive than co-benefits from urban forestry. Positive impacts from forestry projects are likely positive but modest and on a much longer time-scale; positive water quality and air quality impacts are most likely. Offset projects that occur within California—particularly urban forestry—are most likely to spur employment opportunities, positively impact air quality, reduce urban heat islands, and improve environmental quality. Efforts should be made to develop positive offset projects in California, and to target projects to vulnerable communities when there is an existing need.

The use of offsets has a net positive effect on economic-related health impacts, but there is a trade-off: the use of offsets allows the number of on-site emission reductions to be reduced, limiting positive local air quality impacts associated with on-site emission reductions. Limiting offsets to 49% of total reductions will allow for some of the positive health co-benefits associated with offset projects while not undermining positive air quality impacts in communities with large stationary emitters.

Potential to Impact Community Health

Overall, statewide health effects associated with a cap-and-trade program are expected to be negligible to minor, with low-income households most likely to accrue potential negative health effects. However, there are uncertainties for community-level variations in health effects. Some will likely benefit more, while other communities may be negatively impacted. Mitigation measures should address this uncertainty by:

1) Enhancing local and statewide surveillance of environmental health risks;
2) Addressing existing health disparities that increase a community's vulnerability to economic and environmental health risks; and
3) Investing in communities to increase long-term resiliency to environmental health risks and to promote a community's capacity to adapt to climate change.

Local mitigation efforts and community investments should include community participation whenever feasible and commence with the beginning of the program in 2012. Among all elements of a cap-and-trade program, targeted community investments of allowance revenue have the greatest potential to positively impact health while simultaneously reducing environmental health risks. Maximizing the auction of allowances will ensure that sufficient community investments can be achieved.

1. INTRODUCTION

1.1 Overview

With the passage of Assembly Bill 32, the Global Warming Solutions Act of 2006, California took a first comprehensive step towards addressing one of the largest public health threats of this century: climate change. Climate change has the potential to drastically alter California's social and environmental landscape. It is one of the most significant public health challenges of this century, and will impact the health and well-being of all Californians. California's historically disadvantaged communities—already facing an inequitable proportion of poor health outcomes—are most likely to be impacted by climate change and have the most limited ability to adapt to the negative environmental, economic, and health impacts of climate change. Given the potential for climate change to disrupt public health, the health benefits associated with a broad-based program to reduce greenhouse gas (GHG) emissions to slow or prevent catastrophic climate change are great.

An important focus of this effort, however, is to ensure that efforts to mitigate climate change do not come at the cost of the public's health today. Where feasible, climate change policies should:

- Promote and capitalize upon health co-benefits—those positive health effects that result from GHG emissions reductions strategies;
- Monitor and address any negative health impacts that may occur as a result of implementing climate change mitigation strategies; and
- Promote the health, resilience, and adaptive capacity of California's most disadvantaged communities, and protect low-income, highly impacted communities from any adverse consequences of climate mitigation strategies.

The AB 32 Scoping Plan proposes a package of measures to decrease statewide emissions in a comprehensive, multi-sector and cost-efficient manner. Cap-and-trade—an initiative that creates a market for carbon emissions, spurring market-based incentives to reduce greenhouse gas (GHG) emissions—is a cornerstone feature of the Scoping Plan's comprehensive approach. A cap-and-trade program has the potential to decrease emissions at the lowest cost by providing flexibility in timing, technology and efficiency improvements by each facility. Yet, there is concern in many communities that a cap-and-trade program may lead to negative health impacts for some communities.

The California Department of Public Health has thus undertaken a health impact assessment (HIA) to identify possible health effects, both positive and negative, associated with a cap-and-trade program in California. The assessment is supported by a grant from the Health Impact Project, a collaboration of the Robert Wood Johnson Foundation and the Pew Charitable Trusts. HIA is a systematic, structured practice that uses the best available theory and evidence to make reasoned judgments on the prospective health impacts of policy decisions, including projects, plans, programs, and policies undertaken by government or the private sector. The goal of HIA is simple—"to make visible the potentially significant human health consequences of public decisions"—and thus to incorporate a health lens into public policies.[1] This HIA was performed concurrently with the development of the proposed regulation. Therefore, this is not an HIA of the specific cap-and-trade regulation put forth on October 28, 2010, but rather an HIA based on preliminary data from the *AB 32 Scoping Plan* and the *Updated Economic Analysis* of the Scoping

Plan. In some instances, footnotes have been added to highlight relevant proposals within the "Proposed Regulation to Implement the California Cap-and-Trade Program".[i] These proposals have not been assessed here, and they do not change the overall findings of the HIA unless otherwise stated.

The goal of this HIA is to identify possible positive and/or negative health impacts that may be associated with implementation of a cap-and-trade program, mitigate potential negative health effects, and develop actionable strategies to maximize the benefits of a cap-and-trade program, particularly for segments of the population that are more vulnerable to adverse effects from a cap-and-trade program.

This assessment is focused on the health effects of implementing a cap-and-trade program—not on the health effects of climate change itself. The long-term health benefits of slowing or minimizing climate change are hugely significant and important, but are outside the scope of this document. A brief review of these health impacts is included below, but the remainder of this HIA focuses on the health effects of implementing a cap-and-trade program in California.

1.2 Climate Change and Health

Climate change is a major cross-cutting public health issue that will significantly increase disease burden in California. The myriad health impacts of climate change have been well described elsewhere, and include increased exposure to heat and extreme weather events such as floods and storms; changes in the frequency and distribution of vector borne, food borne, and water borne diseases; increases in illnesses related to air pollution and UV radiation exposure; global food and economic insecurity, mass migrations and social disruptions; national security and resource conflicts; and consequent mental health impacts.

Climate change is likely to contribute to substantial changes in sea level. A 1.4 meter sea level rise would put nearly a half-million people in California at risk from impacts of flooding, according to a recent report by The Pacific Institute. Low-income and minority groups will be especially at risk, as these populations often have diminished access to private vehicles, often have limited ability to speak English, and often live near hazardous waste facilities.[2]

An increase in heat-related weather events is another likely outcome of climate change in California. According to the U.S. Global Change Science Program, the number of heat-wave days in Los Angeles is expected to double by the end of the century.[3] In the 2006 heat wave in California, 16,166 excess emergency department visits and 1,182 excess hospitalizations occurred statewide.[4] Nationally, excessive mortality due to heat waves is expected to total $5 billion over the next 75 years.[5]

Increases in heat will also mean increases in ozone in California. According to the Bay Area Air Quality Management District, the projected increase in ozone due to climate change from year 2000 to 2050 would offset about 15 years of progress in reducing ambient ozone levels.[6] Such reductions in air quality greatly contribute to avoidable healthcare costs. A 2010 assessment

[i] The "Proposed Regulation to Implement the California Cap-and-Trade Program" is available at http://www.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm.

found that the failure to meet federal clean air standards in California led to nearly 30,000 hospitalizations from 2005-2007. Three-quarters of these hospitalizations were due to increases in particulate matter, and one-quarter were due to elevated ozone levels. Public insurers paid for the majority of emergency room visits and hospitalizations, costing Medi-Cal and Medicare a total of $132 million over from 2005-2007. Air related health costs totaled $56 million for private insurers during the same time period.[7]

Climate change is also causing earlier Sierra snow pack melt in California, reducing water storage in reservoirs and affecting water availability, with more flooding in the winters and more drought conditions in the summer. Drought and changes in water runoff patterns can alter water quality significantly, and could impact California's agricultural capacity. Further, rapid runoff of water during the winter results in the drying out of soils, which leads to increased wildfire risk. Drought conditions, combined with dry soils and higher temperatures, are leading to earlier fire seasons. In recent years there has been an increase in the number and size of wildfires, with resulting injuries, population displacement, and worsening air quality.[8]

This is not an extensive list of health impacts associated with climate change, though the potential for climate to systematically change public health globally and within California is clear. Climate change mitigation entails reducing greenhouse gas emissions to slow the rate of climate change and to prevent the most catastrophic climate change; adaptation is the process of adjusting to and reducing the harms caused by the environmental impacts of climate change. Because climate change is already happening and more change is unavoidable, adaptation alone is insufficient for dealing with the health challenges that climate change will bring. Adaptation must be coupled with climate change mitigation efforts to protect public health. Assembly Bill 32 is a landmark step in California's efforts to mitigate greenhouse gas emissions and prevent climate change.

1.3 Assembly Bill 32: The Global Warming Solutions Act of 2006

1.3.1 AB 32 Goals and the Protection of Vulnerable Communities

On September 27, 2006 Governor Arnold Schwarzenegger signed into law Assembly Bill 32, the Global Warming Solutions Act of 2006. The bill requires a reduction in greenhouse gas (GHG) emissions to 1990 levels by 2020. In 2007, the California Air Resources Board (ARB) established early actions to reduce GHG emissions and set the 2020 emissions reduction target. Under AB 32, greenhouse gas emissions in 2020 will be 40% lower than if AB 32 were not implemented, or about 11% from current emission levels.

In 2008, ARB adopted a Scoping Plan that outlined the State's strategy for achieving emission targets, incorporating input and recommendations from partners on the Climate Action Team, the Environmental Justice Advisory Committee (EJAC), the Market Advisory Committee (MAC), and the Economic and Technology Advancement Advisory Committee (ETAAC). Measures in the Scoping Plan included:

- Expanding and strengthening existing energy efficiency standards;
- Achieving a renewable energy mix of 33%;
- Developing a California cap-and-trade program linked with the Western Climate Initiative;
- Pursuing policies that target reductions in transportation-related GHG emissions;
- Implementing clean car standards and a Low Carbon Fuel Standard (LCFS);

- Developing programs to implement broad-based energy efficiency improvements, including retrofitting existing residential and commercial structures;
- Pursuing measures to reduce emissions from high global warming potential (GWP) gases; and
- Developing a fee to fund the State's commitment to AB 32 implementation.[9]

Taken together, the measures set out in the Scoping Plan can achieve reductions in GHG emissions, improve air quality, and benefit the health of all Californians. Previous analyses by the ARB have estimated that in 2020 these measures would result in 780 fewer premature deaths, nearly 12,000 avoided incidences of asthma and lower respiratory illness, and 77,000 work loss days avoided as a result of air quality improvements.9

In addition, AB 32 mandates that the regulatory framework is implemented, to the extent feasible, in a manner that protects health, encourages co-benefits, and equitably distributes the benefits of the program without negatively impacting low-income communities:

- The State Air Resources Board is to design emissions reduction measures that "maximize additional environmental and economic co-benefits for California, and complements the state's efforts to improve air quality" {California Health and Safety Code §38501(h)};
- The state board shall "ensure that activities undertaken to comply with the regulations do not disproportionately impact low-income communities" {CHSC §38562(b)(2)};
- The state board shall "consider overall societal benefits, including reductions in other air pollutants, diversification of energy sources, and other benefits to the economy, environment, and public health" {CHSC §38562(b)(6)};
- "The state board shall ensure that the greenhouse gas emission reduction rules, regulations, programs, mechanisms, and incentives under its jurisdiction, where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California and provide an opportunity for small businesses, schools, affordable housing associations, and other community institutions to participate in and benefit from statewide efforts to reduce greenhouse gas emissions" {CHSC §38565};
- The state board shall "consider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution" {CHSC §38570 (b)(1)}; and
- That state board shall "design any market-based compliance mechanism to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants" {CHSC §38570 (b)(2)}.[10]

1.3.2 Complementary Measures and Linkage to Other Cap-and-Trade Programs

AB 32 and the ARB's Scoping Plan set forth a coordinated set of emission reduction strategies that will be necessary to meet statewide goals. The measures complement and reinforce one another, while also providing a safety net to ensure that final emission reduction targets will still be met even if some emission control strategies fall short.

Many of these complementary measures may have substantial health impacts and/or co-benefits. For example, improvements in land use and regional planning that lead to reductions in vehicle miles traveled will reduce transportation-related air pollution and related illness, increase physical activity, reduce traffic-related injuries and fatalities, and possibly improve transportation access in underserved communities.[11] This HIA remains focused on the health impacts potentially associated with the cap-and-trade program, while acknowledging that there

are limitations in assessing any single GHG reduction measure alone. In addition, the potential health impacts of linking broader national and international climate change mitigation efforts are not assessed. Linking such programs may provide California with the opportunity to decrease emissions more cost-effectively and with greater economic stability than would otherwise occur if California were to act alone, but are not specifically assessed here.[9]

1.4 Cap-and-Trade Program

The cap-and-trade program will be a major component of the overall strategy to reduce statewide emissions to 1990 levels by the year 2020. Cap-and-trade alone would not deliver the most effective reduction strategy for California. However, in concert with other complementary measures, reductions can be achieved in an efficient manner that also encourages the development of new clean energy technologies.[12]

The goal of cap-and-trade is simple: to reduce greenhouse gas emissions to a known level using a carbon emissions market. A cap-and-trade program establishes a maximum permissible limit on greenhouse gas emissions, or a *cap*. As the years progress, this cap is then reduced until the target emissions level is reached—in this case, the proposed cap-and-trade regulation sets the cap at 334.5 $MMTCO_2e$ in the year 2020.

The carbon cap functions through the issuance of allowances. Each allowance is the equivalent of one metric ton of CO_2e. At the beginning of each compliance period, a set number of allowances will be distributed (either by auction or given away freely) to facilities that must come into compliance under the statewide cap. By releasing a pre-determined number of allowances, regulatory agencies can set the acceptable amount of GHG emissions for a given compliance period, thereby governing the reduction of the cap to a known emissions level. Those entities that can reduce emissions at least cost will do so, leaving allowances that can then be sold to another emitting facility for which reduction opportunities are more expensive—hence, the allowances can be *traded* on an emissions market. Therefore, the allowance value is a function of the number of allowances in circulation and the cost of reducing emissions by one metric ton of CO_2e. As the cap is lowered over time and allowances become scarcer, the value of allowances will rise. And as the price for purchasing allowances becomes higher, more investments will be made towards clean energy technologies and energy efficiency.

The first step in establishing a cap-and-trade program is deciding who must comply with the declining cap. In California, the proposed regulation phases in coverage as follows:

- Beginning in 2012, all electrical-generating facilities and all large industrial facilities that emit over 25,000 metric tons CO_2e per year must come comply with cap-and-and trade regulations. Imports of electricity from out of state electrical generating facilities that are not capped as part of the Western Climate Initiative are also covered.
- Beginning in 2015, distributors of fuels will be covered to capture emissions from transportation fuels and residential, commercial, and small industrial use of natural gas and other fuels. When capped fuels do not originate in California, they will be capped at the point at which they enter the State economy.

In addition to deciding who must comply under cap-and-trade, the rules governing the compliance system must also be devised. Several key program design elements that are used to create an emissions market and drive reduction goals are highlighted below:

Emissions Cap

The emissions cap may be the most important feature of cap-and-trade—it establishes the ultimate emissions reduction goal. The cap for 2020 is set at 334.5 $MMTCO_2e$ in the proposed regulation. The initial level of the cap is being set at the level that emissions are expected to be from covered sources in 2012 (and from those added in 2015), and will be gradually lowered each year to 334.5 $MMTCO_2e$ in 2020. These progressive reductions in the cap determine the total number of greenhouse gas allowances that will be issued for a given compliance period.

Allowance Allocation

An allowance is the tradable equivalent of one metric ton of CO_2e. The number of allowances to be distributed for each compliance period will be determined by the declining emissions cap. Allowances can either be given away freely to entities that must come under compliance, or they can be auctioned and distributed to the winning bidders. Both methods of distribution provide allowance value to the complying entities.

When allowances are auctioned, *revenue* is generated. This revenue, as described by the non-statutory Economic and Allocation Advisory Committee (EAAC), can then be distributed to the complying entities, the public treasury, or to California households and communities. It can also be used to lower the implementation costs of AB 32. Further descriptions of specific auction formats, pros, and cons can be found in the EAAC's report to ARB, *Allocating Emissions Allowances Under a California Cap-and-Trade Program*.[13]

Allowances may be given away freely to complying entities in an effort to limit *emissions leakage*. Emissions leakage is an increase in GHG emissions out-of-state as a direct result of California's climate policy. In short, introducing an environmental regulation in Jurisdiction A could increase the costs of production and goods movement. If Jurisdiction B participates in the same market without the same environmental regulation and associated compliance costs, demand for goods from Jurisdiction A may decrease and production may increase in Jurisdiction B, reducing GHG emissions in Jurisdiction A and increasing emissions in Jurisdiction B. This increase in emissions in Jurisdiction B is referred to as *leakage*. The extent to which leakage may occur will depend largely on the presence or absence of a regional or national cap-and-trade program and on the complying sector in question. Again, further detail on leakage is provided in the EAAC's report.[ii]

In addition, allowance allocation has implications on wealth transfer and fairness. According to the Congressional Budget Office (CBO), regardless of how allowances are distributed—whether by auction, free allocation, of some combination of the two—

[ii] The "Proposed Regulation to Implement the California Cap-and-Trade Program" proposes the issuance of free allowances to trade-exposed industries as a means of addressing leakage.

most of the cost of meeting a cap on CO_2 emissions would be borne by consumers in the form of higher prices.[14] The CBO states that the price increases would be regressive in that poor households "would bear a larger burden relative to their income than wealthier households would." Selling allowances at auction and distributing the revenue as an equal lump-sum payment to all households would offset regressive effects of the cap. Allocating allowances for free to producers would be "likely to increase profits and ultimately benefit shareholders, although the government would regain part of the allowance value through taxes on higher profits." In such a case, wealth would transfer from energy consumers to producers.[iii]

Offsets

Offsets are compliance instruments approved by ARB that represent a reduction, avoidance, or sequestration of CO_2e. Offsets, often cheaper than on-site emissions reductions, are cost containment measures that allow complying entities the option of purchasing off-site reductions to meet their compliance targets, in lieu of reducing emissions on-site. Offset projects could include forest and urban forest projects (carbon sequestration), methane reduction, and destruction of ozone depleting substances. All offset protocols are subject to Air Resources Board approval.

As mandated by AB 32, offsets must be real, quantifiable, verifiable, enforceable, and additional:

- *Real*: reduction or removal of emissions genuinely took place;
- *Quantifiable*: reductions are real and accurately counted;
- *Permanent*: emission reductions or removals are not re-emitted into the atmosphere;
- *Verifiable*: reductions are subject to third party verification before credits can be issued to ensure that reductions have occurred within program criteria;
- *Enforceable*: offsets can be investigated and actions for non-compliance can be taken.

Offsets that do not meet the above criteria would fail to meet the ultimate program goal of reducing GHG emissions and would reap fewer health co-benefits.

Banking

Banking is the holding of a compliance instrument (such as an allowance or offset credit) from one compliance period for the sale or use in a future compliance period. Under the proposed regulation, the compliance periods are three years long allowing for facilities to accommodate for variations in their production. Banking allowances for future use is a cost containment measure within the cap-and-trade program that allows for greater flexibility in deciding when compliance instruments are used.[13]

Each of the cap-and-trade program design elements listed above will work together to help shape GHG emission prices. This price is intended to more truly reflect negative externalities associated with greenhouse gas emissions (such as climate change) and provide a price incentive for switching to clean energy technologies in order to achieve the GHG emissions target cap in a cost-effective manner.

[iii] The "Proposed Regulation to Implement the California Cap-and-Trade Program" proposes that IOUs return the revenue from the auction of allowances to the benefit of ratepayers.

Establishing a price on CO_2 emissions sends a signal to the marketplace and is essential to achieving the ultimate program goal: a reduction in GHG emissions to 1990 emission levels. Pricing CO_2 to drive emissions reductions can also lead to a wide variety of indirect impacts—including changes in air quality, increases in energy costs, energy efficiency improvements to counteract these, and changes in employment by job sector. These indirect impacts can positively and negatively impact health; or impacts may vary from one community to the next or may vary by income level. The goal of the health impact assessment is to inform the final cap-and-trade regulations by:

- Assessing the relative magnitude, direction, and distribution of potential health impacts;
- Highlighting potential heath co-benefits associated with the program;
- Recommending mitigation strategies to alleviate possible negative health impacts; and
- Protecting communities that may not share in positive impacts of the program (e.g. possible reductions in air pollution).

2. HEALTH IMPACT ASSESSMENT OF A CAP-AND-TRADE PROGRAM

2.1 HIA Practice Standards

Health Impact Assessment (HIA) is "a means of assessing the health impacts of policies, plans, and projects in diverse economic sectors using quantitative, qualitative and participatory techniques."[15] HIA is used to evaluate the potential health impacts of a project or policy, with the intent to provide recommendations to increase positive health co-benefits and to mitigate negative health impacts. Health impact assessment provides a structured framework for the consideration of health impacts, and a venue for public participation in the planning process. HIA has often been used to evaluate projects and policies that have substantial health effects but would otherwise be considered peripheral to the traditional public health arena.[16]

HIAs can vary substantially based on the timeframe of the assessment, resources available, and the project being assessed. However, the practice of HIA aims to uniformly support healthy public decision-making, as described in *A Guide for Health Impact Assessment:*

- Identifying harms and benefits before decisions are made;
- Identifying strategies for decisions to protect and promote health;
- Supporting inclusive and democratic decision-making;
- Protecting social justice and equity;
- Planning public health and service delivery; and
- Catalyzing social and institutional learning.[1]

Further information about HIA is available in the CDPH *Guide for Health Impact Assessment*[iv], and the *Practice Standards for Health Impact Assessment*, developed by the North American HIA Practice Standards Working Group in 2009 (available at www.sfphes.org, www.humanimpact.org, and www.habitatcorp.com).[17]

A Guide for Health Impact Assessment describes the 5 core stages of an HIA:

1. **Screening:** deciding whether or not an HIA would be valuable and feasible.
2. **Scoping:** determining health issues for analysis, the temporal and spatial boundaries for analysis, and research methods to be employed.
3. **Assessment:** using data, expertise, qualitative and quantitative research methods, and/or spatial analyses to assess the magnitude and likelihood of potential health impacts, identifying their significance, and identifying appropriate mitigations and/or design alternatives.
4. **Reporting:** synthesizing the assessment findings and communicating the results, in written reports, fact sheets, comment letters, and public testimony.
5. **Monitoring:** tracking the final decision and its impact on health risk and health outcomes.

The core objectives and the stages of HIA discussed above have provided the foundation for this assessment of a cap-and-trade program.

[iv] The *Guide* is available at: http://www.cdph.ca.gov/pubsforms/Guidelines/Documents/HIA%20Guide%20FINAL%2010-19-10.pdf.

2.2 Cap-and-Trade HIA Stakeholder Process

2.2.1 Screening

The health impact assessment of cap-and-trade regulation in California began with the *Screening* stage in the Fall of 2009 as part of the Climate Action Team Public Health Workgroup (CAT PHWG). The CAT Public Health Workgroup was created to "provide a forum for communication, coordination, and education across agencies and with stakeholders."[18] Public meetings were co-hosted by the California Department of Public Health and the California Air Resources Board.

At a September 14, 2009 public meeting of the CAT Public Health Workgroup, a proposed public health analysis for cap-and-trade regulation was discussed. The assessment would be based on the CDPH framework in the draft document, *A Guide for Health Impact Assessment*, and provide a mechanism to consider a broad range of impacts based upon existing public documentation and analyses of the cap-and-trade program. The final results of the assessment were expected to inform the cap-and-trade rulemaking process set for Fall of 2010.[19]

A public health-related assessment of cap-and-trade was deemed to be both relevant and useful in order to:

- Identify potential health effects;
- Identify the distribution of these effects in order to assess potential inequities; and
- Inform the regulatory structure for cap-and-trade to maximize co-benefits and minimize potential negative health impacts.

It was determined that staff from ARB and CDPH would co-lead the HIA of cap-and-trade, using expertise and resources from both agencies to perform the assessment. The purpose of the HIA was not to "provide exhaustive documentation of all potential health impacts of a cap-and-trade rule, nor to quantify the majority of potential impacts…the purpose is to highlight aspects of the cap-and-trade program most likely to influence public health."[20]

2.2.2 Stakeholder Scoping of Potential Health Effects

Subsequent CAT PHWG meetings focused on clarifying the objectives and process of HIA, while discussing relevant health pathways to be assessed as part of an HIA of cap-and-trade. Initial deliberations by stakeholders in December 2009 concluded that the baseline cap-and-trade program design for the assessment would be based on the preliminary draft regulation released by ARB November 24, 2009 (as final regulations were not available at the time).[20] [21] Public discussions identified allowance allocation strategies, revenue use, trading restrictions, and the use of offsets as program features that could impact health. The consideration of these design elements was expected to be largely qualitative due to limited data and time.[20]

Climate Action Team PHWG meetings on January 27 and February 8, 2010 were used to further detail health pathways of interest, engage and elicit stakeholder feedback and written comments, and then revise the pathways to more fully capture stakeholder concerns. In turn, stakeholder feedback began to elucidate *health determinants* of concern.

Health determinants are defined by the World Health Organization as the everyday context of people's lives that impacts their health, such as the social and economic environment, the physical environment, and an individual person's characteristics and behaviors. This can include

income and employment; water quality, air quality, safe houses, and transportation access; social support networks; health care access; genetics; and personal behaviors such as smoking, diet, and personal mechanisms for coping with stress.[22]

Stakeholders identified the following health determinants that are most likely to affect health and be impacted by cap-and-trade regulation:

- Air pollution emissions;
- Consumer economic impacts;
- Employment;
- Ecological impacts from offsets; and
- Transparency and meaningful stakeholder engagement.

Based on stakeholder feedback and internal staff deliberations, the health determinants were reviewed within the context of cap-and-trade regulation. Cap-and-trade program design elements that would likely have the greatest impact on the health determinants noted above were referred to by stakeholders as "policy levers" and included:

- Distribution mechanism for emission allowances (auction vs. free allocation);
- Use and distribution of revenue proceeds;
- Use of offsets / types of offsets allowed; and
- Provisions to maximize co-benefits.[23]

Other stakeholder and staff discussions included the temporal and geographic scope of the assessment, the range of health outcomes to be assessed either qualitatively or quantitatively (e.g., respiratory disease, cardiovascular disease, etc.), and the consideration of sector-based emission differences from stationary sources that must comply with the cap-and-trade program. The preliminary framework for the cap-and-trade HIA, based on stakeholder feedback, is shown in abbreviated form[v] in Table 1.[23] ARB and CDPH staff narrowed this scope of issues into final health pathways that were of greatest concern and that could be assessed given staff resources and time available. Final health pathways are discussed in more detail in Section 2.3.

Table 1. Draft of stakeholder-identified scope of issues to be considered for an HIA of the cap-and-trade regulatory framework in California

Policy levers of interest	Health determinants potentially impacted	Scope of analysis	Capped sectors
• Allowance allocation strategy • Allowance revenue recipients • Revenue distribution and use • Offset limits • Provisions to maximize co-benefits	• Air pollution emissions • Consumer economic impacts • Employment & income • Ecological impacts • Social factors (such as transparency and engagement)	• Statewide • Regional • Local • Analysis to assess two points in time: 2010 and 2020 • Case studies of community(s) highly impacted by stationary sources of pollution	• Industrial facilities that emit >25,000 MT CO_2e • Electricity delivers / generators • Transportation fuel deliverers • Natural gas and gas deliverers

[v] Full documentation is available at: http://www.arb.ca.gov/cc/AB32publichealth/meetings/012710/hia_framework.pdf.

2.2.3 Scope of CDPH and CARB Assessments

Following the final scoping phase meeting of the CAT Public Health Workgroup in February 2010, CDPH secured funding from the Health Impact Project, a collaboration funding effort of the Robert Wood Johnson Foundation and The Pew Charitable Trusts, to undertake an HIA of the cap-and-trade regulatory framework. The HIA process was formally divided into two parts to more efficiently utilize existing resources and agency expertise. ARB would focus on evaluating co-pollutant emissions, while CDPH would conduct a HIA to investigate the health impacts associated with economic changes, revenue distribution, and the use of offsets. The ARB co-pollutant emission analysis can be found at: http://www.arb.ca.gov/regact/2010/capandtrade10/capv6appp.pdf. This document only addresses the portion of the HIA led by CDPH.

Staff from ARB and CDPH collaborated to finalize health impact pathways for analysis. A HIA Working Group consisting of university health researchers, HIA practitioners, health and environmental non-profits, and industry representatives was convened in late March to formally finalize the scoping phase and begin the assessment phase of the HIA led by CDPH. Many of the stakeholders involved with the CAT PHWG, as well as ARB and CDPH staff, also participated in the HIA Working group. The HIA Working Group provided content-expert feedback, technical assistance, and peer reviews as the HIA proceeded through the final assessment, reporting, and monitoring stages. Based on feedback from the HIA Working Group, the final scope for the assessment stage of the HIA was developed and is discussed in detail below.

2.3 Final Scope for the CDPH Health Impact Assessment

2.3.1 Analytic Scope of Health Impact Pathways

The health pathways with the greatest health relevancy that could be qualitatively and/or quantitatively assessed within the given timeframe were finalized at a May 24, 2010 meeting of the HIA Phase 2 Working Group (the portion of the assessment led by CDPH). These pathways were chosen based on iterative discussions at previous public meetings that considered the best available scientific evidence, public comment, and staff deliberation. The pathways were centered on stakeholder-identified 'policy levers'—those cap-and-trade program design elements that were deemed by stakeholders to most likely impact health. Policy levers to be considered in the assessment included:

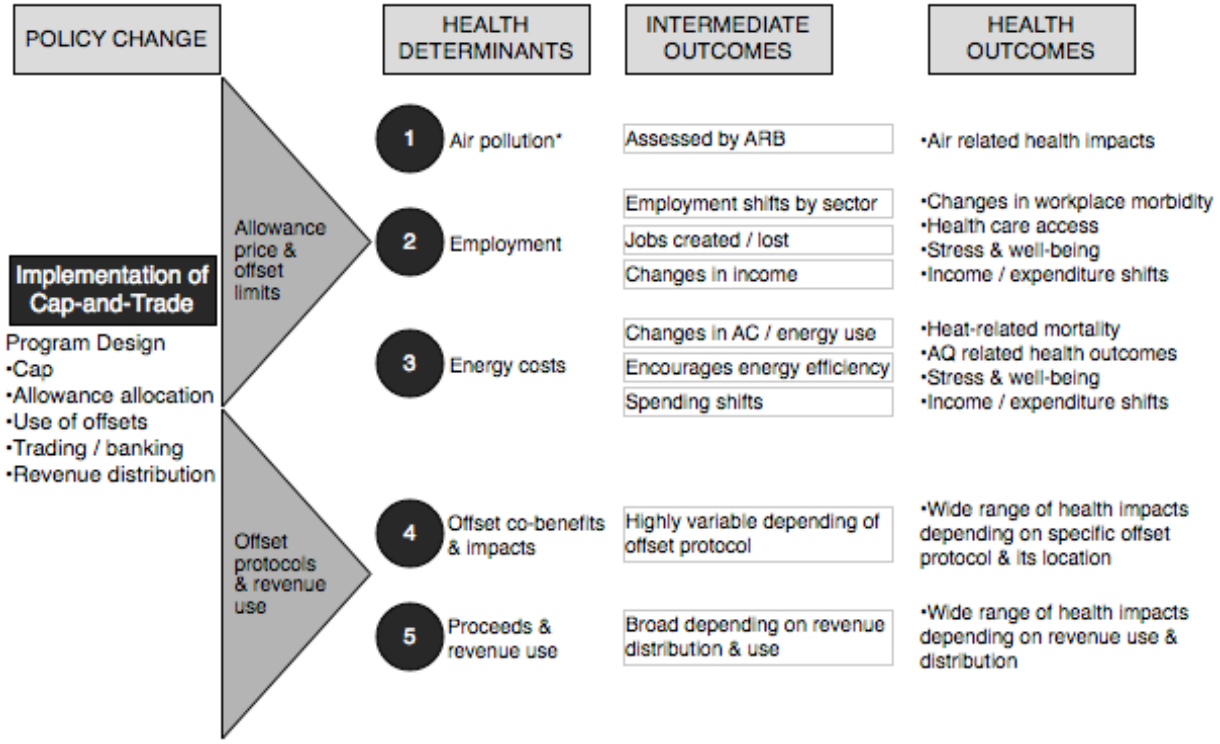
- Allowance allocation;
- Use of offsets and specific offset protocols;
- Allowance revenue proceeds and distribution; and
- Unlimited use of banking/trading restrictions.

These policy levers would work in concert with the final emissions cap to mediate a price for CO_2 emissions and impact the five core stakeholder-identified health determinants:

1. Air pollution (assessed by ARB);
2. Employment changes and changes in income;
3. Changes in household energy costs;
4. Offset program co-benefits and impacts; and
5. Co-benefits associated with allowance revenue distribution.

The publicly accessible *Updated Economic Analysis of California's Climate Change Scoping Plan* provides the economic baseline for the HIA and the modeling results for changes in stakeholder-identified health determinants.[24] The final health impact pathways, including intermediate outcomes and stakeholder-identified health outcomes, are shown in Figure 1. Establishing emissions caps on transportation fuels—though recognized by stakeholders as a major potential health determinant—was deemed to be out of the scope of this health impact assessment due to limited time and staff resources, and because transportation sector caps would be unlikely to begin until the second phase of a cap-and-trade program.

Figure 1. Stakeholder-identified health impact pathways associated with a cap-and-trade program in California



** Health determinant #1 and subsequent health pathways are the foundation of the health assessment led by ARB. Health Determinants #2-5 are the basis of the Phase 2 HIA*

As previously discussed, the emissions cap is arguably the most significant program feature of any cap-and-trade system, and will substantially impact allowance prices over the course of the program. This declining cap and change in allowance prices, in turn, will drive reductions in CO_2 emissions and associated pollutants, and will contribute to both employment and consumer economic shifts—identified by stakeholders as potentially significant sources of health impacts. As a cap-and-trade program progresses, the allowance price will be shaped by the availability and types of offsets, the use of trading and/or banking restrictions, the method of allowance allocation, linkage with other emissions markets, the effectiveness of complementary policies, and the extent to which leakage occurs.[13] Further details on the factors influencing allowance price are available in the EAAC's final report.

2.3.2 General Parameters and Limitations of the Scope of the HIA

The core analysis of economic health determinants—including employment, income, and residential energy costs—is at the State level, and include impacts by income, job sector, gender, age, and/or race whenever possible. Local economic and health data were deemed too scarce to provide a reliable community-level analysis of these health determinants, and assessing impacts on socioeconomic health determinants by region, county, or city were thus out of the scope of this assessment. However, it is recognized that there are substantial community concerns over localized impacts (as discussed below in Section 2.3.3). Community case studies in Section 5 provide insight into the health needs and inequitable distribution of health outcomes in communities that are highly impacted by stationary emissions sources and other existing environmental health risks. The case studies highlight the diversity of health issues facing California's most vulnerable communities and are used to inform potential uses for allowance revenue to protect public health.

Offset co-benefits and impacts can occur at the State, regional, or community-level depending on the specific offset type and its location. Most offset impacts are expected to accrue at the local level, but predicting where these offset projects will be implemented is impossible at this stage of regulation development. However, efforts were be made to provide an overview of health impacts that may result from 1) the use of offsets as a cost-containment measure and 2) specific offset protocols.

Similarly, health impacts stemming from allowance revenue use will vary greatly based on the final regulatory framework, the mechanisms, recipients, and timing of revenue distribution, and priorities for revenue use. We highlight approaches to distribution of proceeds that are likely to maximize health benefits, particularly for vulnerable and impacted communities.

2.3.3 Limitations of a Local Assessment

Community concern exists regarding the distribution of impacts on local communities throughout California. The cap is implemented at the State level, but as individual firms comply with the statewide cap in a manner that best fits their needs, local community impacts will vary. An uneven distribution of economic, environmental, and associated health benefits is thus likely to occur. Some communities, environmental justice advocates, and researchers have expressed concern that localized increases in air pollution are also possible, though less likely. This concern is examined in the "Co-Pollutant Emissions Assessment" conducted by ARB, available at: http://www.arb.ca.gov/regact/2010/capandtrade10/capv6appp.pdf.

This concern stems from the potential for variable reductions in co-pollutant emissions and the development of small geographic areas with relatively high concentrations of particulate pollution within the larger pollution control region.[25] It has been pointed out that:

> "While a GHG cap-and-trade system would lead to overall reductions in statewide co-pollutant emissions, its impact on co-pollutant emissions in specific locations would vary. Given this variation, under some circumstances it is possible that a GHG cap-and-trade system could lead to an increase in ambient co-pollutant concentrations in particular isolated locations."[26]

There is the potential for some GHG emission reductions to lead to local increases in co-pollutants even in light of net decreases in GHG emissions at the State level:

> "It is also the case that some means of reducing GHG emissions can actually increase co-

> pollutant emissions. Moreover, even though they may, on net, achieve statewide reductions in co-pollutant emissions, some measures that reduce GHG emissions may increase co-pollutant emissions in particular locations."[26]

Economic impacts—aggregated at the State level for this analysis—will also vary from one community to the next. This assessment is limited in its ability to geographically pinpoint local economic and air quality impacts and subsequent health effects. However, efforts have been made to understand the distribution of impacts by race, income level, and other demographic indicators whenever possible.

3. ASSESSMENT OF HEALTH IMPACTS OF A CAP-AND-TRADE REGULATION IN CALIFORNIA

3.1 Introduction to Assessment

In the sections that follow, the impacts of cap-and-trade regulation on health determinants and health outcomes will be assessed, including:

- The socioeconomic impacts on health potentially associated with employment, income, and household energy costs;
- The potential health impacts associated with proposed offset protocols;
- Community case studies to highlight the health needs of communities typical of those in which industries impacted by the cap-and-trade regulation are found.

3.2 Economic Modeling Results from Cal/EPA, Air Resources Board

The *Climate Change Scoping Plan* is California's guiding document for the implementation of AB 32 and the reduction of GHG emissions to 1990 levels by 2020, and contains many complementary measures as well as a cap-and-trade program. ARB's economic analysis assessed the impact of implementing the Scoping Plan on California's economy over the next decade. ARB's *Updated Economic Analysis of California's AB 32 Climate Change Scoping Plan* (released March 24, 2010) considered the modifying effect of the global economic downturn and recent federal energy policies. Sensitivity analyses were used to assess the economic impact if complementary policies did not achieve their expected emission reductions goals. The outcomes of the analysis are focused solely on California, and the analysis does not consider the avoided costs of inaction.

3.2.1 Overview of the Updated Economic Analysis of AB 32 and Cap-and-Trade

The Air Resources Board's economic assessment of the AB 32 Scoping Plan evaluated a cap-and-trade program and all complementary measures. A brief summary of the ARB's methodology will be provided here, as will a description of the various cases assessed, and the final results from the economic analysis. The ARB economic analysis provides the foundation for the HIA of potential health effects related to projected economic changes. A highly detailed description of ARB's methods can be found in the *Updated Economic Analysis of California's AB 32 Climate Change Scoping Plan* on ARB's website.[vi] A more recent economic analysis was conducted of the proposed cap-and-trade regulation and included in the staff report released on October 29, 2010, but is not considered in the assessment here.[vii]

Other academics, consultants, and other government agencies have also developed economic models to assess the macroeconomic impacts of implementing the AB 32 Scoping Plan or a national cap-and-trade program. A public hearing on April 21, 2010 allowed ARB staff, economic

[vi] ARB's *Updated Economic Analysis* is available here: http://www.arb.ca.gov/cc/scopingplan/economics-sp/economics-sp.htm

[vii] This new analysis was completed too late to be considered in the HIA, so as previously mentioned, the evaluation here focuses on the March assessment of implementation of the Scoping Plan.

experts, and stakeholders to discuss the various models and elicit feedback and comments in a public forum.[27] The model used by ARB was determined to be fair, and its final results similar to most findings from other economic models. While all models are limited in their ability to predict the future, ARB's efforts were found to fall "within the parameters of good model practice."[28] ARB's analysis is used here to assess the impact of implementing AB 32 on economic health determinants.

ARB's economic analysis relied on the Energy 2020 model and the Environmental Dynamic Revenue Assessment Model (E-DRAM). Using both models, the economic analysis gives a more complete assessment of emissions reductions, changes in fuel costs, and shifts in allowance price, as well as projections for the statewide economy, income, and employment. The models were used to compare various scenarios for the implementation of the AB 32 Scoping Plan to a business as usual (BAU) Reference Case in which AB 32 was not implemented. Thus, the economic model consists of:

A) *Reference Case*: a business as usual baseline scenario in which the Scoping Plan is not implemented; and
B) *Policy Case*: a scenario in which the entire AB 32 Scoping Plan (inclusive of a cap-and-trade program) is implemented.

The difference between the Policy Case and the baseline Reference Case is, in essence, the economic impact of implementing the Scoping Plan and a cap-and-trade program in California. This economic impact is the basis for assessing the program's potential health effects. And as noted earlier, net changes in economic health determinants results from the implementation of a cap-and-trade program and complementary measures.

The Reference Case scenario establishes the baseline for which to compare the macroeconomic impact of implementing the Scoping Plan. In the *Updated Economic Analysis*, the business as usual Reference Case includes energy efficiency policies from the Scoping Plan that have been adopted at the Federal level since the Scoping Plan was finalized, such as the Pavley I Standards and policies in the 2007 Energy Independence and Security Act (EISA). Emissions reduction policies that are considered in the BAU Reference Case are shown in Table 2. In the Reference Case projected business as usual emissions for 2020 are 525 million metric tons CO_2e. A more detailed description of this baseline scenario can be found in the *Updated Economic Analysis* from ARB.[24]

Table 2. Description of the Reference Case policies assumed in assessing business as usual economic growth in the absence of AB 32 implementation

	Reference Case policies in the BAU scenario
Transportation	Reaching the Pavley I standards
Renewable fuels	Reaching required level of biofuels
Renewable portfolio standard (RPS)	20% of all electricity by 2020
Metal halide lamp fixtures	Increase to 80% of market (from 15% commercial and 60% industrial)
Other measures	Boiler and furnace efficiency; walk-in cooler efficiency; electric motor supply efficiency; energy efficient lighting

As discussed earlier, the complementary measures contained in the Scoping Plan are essential in reaching the emissions reduction goals, and work in concert with the cap-and-trade program to achieve these reductions in a cost-effective manner. If complementary measures do not achieve target energy efficiency objectives, the cap-and-trade program would be forced to achieve a greater proportion of total GHG reductions to meet AB 32 emission goals. Complementary measures in the Scoping Plan that are included in the Policy Case modeled by ARB are shown in Table 3.

Table 3. Description of complementary measures included in the Policy Case

	Complementary measures in the Policy Case
Transportation	Advanced Clean Car Standards
Low carbon fuel standard (LCFS)	10% reduction in carbon intensity
Renewable portfolio standard (RPS)	Increased to 33% from 20%
Energy efficiency	Reduce electricity sales by 24,000 GWh and natural gas sales by 800M therms by 2020 (efficiency improvements assumed to come from all sectors)
Combined heat and power (CHP)	Assumed increase 30,000 GWh by 2020
VMT reductions	Assumed reductions of 5% by 2020
Heavy duty vehicle efficiency	Increase freight end-use efficiency
Ship electrification at ports	Reduced on-board engine use at ports

The complementary measures and the cap-and-trade regulatory structure are the two core components of the Policy Case. Case 1 and Case 2, as assessed in ARB's *Updated Economic Analysis*, assume that the cap-and-trade program is implemented and that the goals of the complementary measures are achieved at 100% effectiveness. Case 1 and Case 2 differ only in whether offsets are allowed (Table 4). In Case 1, the cap-and-trade program allows unlimited banking, offsets can be used as compliance instruments for 49% of program reductions[viii], and 100% auction of allowances is assumed. In Case 2, the cap-and-trade program allows unlimited banking and 100% auction is assumed, but offsets are not allowed.

[viii] 49% of *program reductions* translate to 4% of a facility's *emissions* that can be covered by offsets (http://www.arb.ca.gov/cc/capandtrade/meetings/022510/pres.pdf). That said, referring to the use of offsets at 4% and 49% is meant to convey the same limit. In this document, 49% will be used to remain consistent with past stakeholder discussions.

Table 4. Description of the Case 1 and Case 2 scenarios, including the cap-and-trade program design

POLICY CASE SCENARIOS	Case 1	Case 2
Complementary measures	Included at 100% implementation	
Geographical boundary	California only	
Pollutants	CO_2, CH_4, N_20, SF_6, PFC, HF	
Covered sectors	• 2012-2014: narrow scope (electricity production and industrial sources >25,000mt CO_2e/yr) • 2015-2020: narrow scope sectors + transportation fuels, and fuels used by commercial, residential, and small industrial sources	
Banking	Unlimited	
Trading	Unlimited	
Allowance allocation	100% auction	
Offsets	Limited to 49% of program reductions	No offsets

In addition, three sensitivity analyses (Cases 3, 4, and 5) were examined to determine the impact on the state economy if the complementary measures were not achieved at 100%. Though this health impact assessment will focus on the modeling results for Case 1 and Case 2, the sensitivity analyses are useful for understanding the importance of reductions achieved by the complementary measures. In all sensitivity analyses, offsets are allowed within the cap-and-trade program, as in Case 1. A summary of the sensitivity analyses are shown in Table 5, and more details are available in the *Updated Economic Analysis*.

Table 5. General modeling terms for three sensitivity analyses (for all Cases, cap-and-trade program implemented with the use of offsets)

SENSITIVITY ANALYSES	Reductions	Specific modeling terms
Case 3	Reduced transportation measures	• VMT reduction excluded • LCFS and Pavley II reduced to 50%
Case 4	Reduced electricity / natural gas measures	• Energy efficiency and CHP reduced 50% • 33% RPS excluded (therefore a 20% RPS)
Case 5	Reduction in transportation & electricity / natural gas measures (Case 3 + Case 4)	• VMT reduction excluded • LCFS and Pavley II reduced to 50% • 33% RPS excluded (therefore a 20% RPS) • Energy efficiency and CHP reduced 50%

Results of summary economic indicators from the *Updated Economic Analysis* are shown in Table 6, including the gross state product, indicators of income, and labor demand. Case 1 shows minor changes in all economic categories when compared to the reference case. Case 2 also indicates small economic impacts, with slightly greater decreases in gross state product and labor demand in comparison to Case 1. Impacts vary across the three sensitivity analyses, though all trend towards minor negative impacts. As the cap-and-trade program changes with

regards to offset limits, and as the effectiveness of complementary measures varies, projected 2020 allowance prices also vary (Table 7). In addition, emissions reductions from capped sectors are larger in Cases 3, 4, and 5. This is because the cap-and-trade program carries a greater burden of emission reductions when complementary policies do not meet emission reduction objectives. This increased reliance on cap-and-trade also explains the increase in allowance prices in Cases 3, 4, and 5 in comparison to Case 1. The implication is that the complementary policies are very important in achieving emission reductions in an economically efficient manner, and bolster the cost-effectiveness of the cap-and-trade program.

Table 6. Summary economic modeling results for the California economy under the implementation of cap-and-trade and complementary measures (source: ARB's Updated Economic Analysis)

SUMMARY ECONOMIC INDICATORS	2020 Baseline Reference Case				Sensitivity Analyses		
			Case 1	Case 2	Case 3	Case 4	Case 5
Gross State Product ($ Billions)	2,502	Percent change from Reference Case in 2020	-0.2%	-0.9%	-1.0%	-0.8%	-1.4%
Personal Income ($ Billions)*	2,027		0.1%	-0.4%	-0.8%	-0.4%	-1.2%
Income Per Capita ($ Thousands)	46.06		0.1%	-0.1%	-0.5%	-0.1%	-0.6%
Labor Demand (Millions)	18.41		0.1%	-1.2%	-0.8%	-1.0%	-1.7%
	Annual Average Growth (2007 to 2020)						
Gross State Product	2.4%		2.4%	2.3%	2.3%	2.3%	2.3%
Personal Income	2.4%		2.4%	2.4%	2.3%	2.4%	2.3%
Income Per Capita	1.2%		1.2%	1.2%	1.2%	1.2%	1.2%
Labor Demand	0.9%		0.9%	0.8%	0.9%	0.8%	0.8%

* Personal income = a measure of income received by all persons from all sources.
** Income per capita = is a measure of total state production by population.

Table 7. Allowance price and emissions reductions in policy scenarios for which California emissions targets are achieved (source: ARB's Updated Economic Analysis)

ALLOWANCE PRICE PROJECTIONS & EMISSIONS ABATEMENT	Case 1	Case 2	Case 3	Case 4	Case 5
Allowance price 2020	$21	$106	$40	$87	$102
Total CO_2e abatement (MMT) 2012-2020	510	509.5	478.2	485.6	460.2
From complementary policies	*319.2*	*319.2*	*234.1*	*202.3*	*136.8*
From reduced economic growth	*4.1*	*20.3*	*23.9*	*18.0*	*32.3*
From capped sources/C&T	*99.9*	*170.0*	*118.0*	*166.7*	*180.1*
From C&T offsets	*86.8*	*0.0*	*102.2*	*98.6*	*111.0*

Under the five analysis cases, allowance prices in 2020 could range from $21-106. With cap-and-trade program offsets varying from none to 49% of program reductions, and under the assumption that all complementary policies are achieved at 100% effectiveness, labor demand can be expected to fall within a range of +0.1 to -1.2% compared to business as usual, with income per capita plus or minus 0.1% for Case 1 and Case 2 compared to business as usual scenarios. In all cases, these changes from the business as usual scenarios represent very small changes in the overall growth in economic activity and employment expected to occur by 2020.

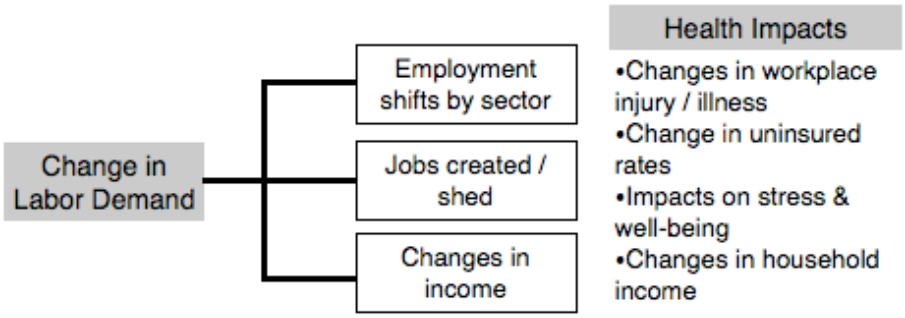
Employment, income, and household fuel costs were identified by stakeholders as important health determinants that may be impacted by cap-and-trade. In the following section, the impact of each of these health determinants on health outcomes will be reviewed. A limitation of the analysis is that it is not feasible to completely isolate the impacts of cap-and-trade from those of the complementary measures because they work in concert with each other.

3.2.2 Employment & Income

Health Rationale

The health impacts associated with steady employment and income are very broad. Employment is a key determinant of income; income and income inequities are among the most significant and all-encompassing health determinants. Employment also impacts health insurance status (workers and family members, household budgets (and related issues such as food security and housing quality), and risk of occupational injury and illness (Figure 2). Working conditions are variable among job sectors and occupations, with varying exposure to chemicals, risks from falling, noise, musculo-skeletal injury, or other common workplace health hazards.[29]

Figure 2. Employment and health pathways



Health risks are greater in regions where unemployment is widespread. Job security and one's workplace satisfaction can positively impact psychological well-being and overall health, while higher rates of unemployment cause more stress, illness, and premature death.[30] The threat of unemployment can also impact health: mental health impacts such as anxiety and depression can begin when people first feel their jobs are threatened.[31] Work-related stress can impact risks for cardiovascular disease and common psychological disorders.[32] The health impacts of unemployment are not just limited to the unemployed. If those responsible for a household's meal preparation must devote more time to paid employment in response to another household member's unemployment, household food security can diminish.[33]

Health risks from unemployment are not distributed equally: nationally, Hispanic and African

American populations and the least educated are more likely to be unemployed (Table 8 and Table 9). In addition, youth ages 16-24 years are more likely to be unemployed compared to those 25 years of age and over.

Table 8. Annual unemployment rate by race for individuals 16 years of age and older

Year	White (%)	Asian (%)	Hispanic or Latino (%)	Black or African American (%)	Average for all races (%)
2005	4.4	4.0	6.0	10.0	5.1
2006	4.0	3.0	5.2	8.9	4.6
2007	4.1	3.2	5.6	8.3	4.6
2009	8.5	7.3	12.1	14.8	9.3

Source: Bureau of Labor Statistics, Public Data Query; unemployment rate by race, not seasonally adjusted.

Table 9. Unemployment rate and median earning by educational attainment in 2009

Educational attainment	Median weekly earnings ($)	Unemployment rate (%)
Doctoral degree	1,532	2.5
Professional degree	1,529	2.3
Master's degree	1,257	3.9
Bachelor's degree	1,025	5.2
Associate degree	761	6.8
Some college, no degree	699	8.6
High school graduate	626	9.7
Less than a high school diploma	454	14.6

Source: Bureau of Labor Statistics, Public Data Query; unemployment rate by race, not seasonally adjusted.

Changes in employment have the potential to impact uninsurance rates. In 2008 and 2009, years marked by substantial job losses in California, the number of non-elderly Californians covered by employment-based health insurance dropped nearly 6%. This reduction includes workers that lost their jobs as well as family members covered by their insurance plans. While some who lost employment-based coverage were able to obtain public or other insurance, overall, uninsurance rates rose.[34] Disparities in health insurance coverage exist across specific segments of the population. A recent analysis in California found that unmarried women between the ages of 50-64—an age at which health complications are often accelerating—have twice the uninsurance rate as their married peers. And Latina women 50-64 have three times the uninsurance rates as their white peers. Underinsurance and uninsurance are associated with adverse health outcomes related to delays in getting needed health care or neglect of routine health screenings.[35]

Employment and household income are closely linked, and income is one of the strongest and most persistent predictors of health and disease.[36] Research consistently indicates that people with low-incomes have consistently greater health risks than those with higher incomes, including higher incidence of low birth weight babies, injuries, diabetes, hypertension, heart disease, and cancer.[37] Reduced healthcare access may limit the ability for low-income families

to care for their chronic health conditions: both adults and children in low-income households are more likely to be without health insurance and access to care.[38] Large health disparities exist between income groups, and the relationship follows a gradient: an individual's chance of premature mortality is reduced with each incremental rise in income.[32] People who live in low-income communities have significantly lower life expectancies than those in higher income neighborhoods; for example, life expectancy for residents in West Oakland is 10 years shorter than residents of the wealthier Berkeley Hills.[39]

Conversely, higher earnings predict better health, improved nutrition, and longer lives. Individuals and families with stable, comfortable incomes have jobs that are more likely to provide health insurance or can afford to pay for healthcare; often have access to better schools; may learn more healthy behaviors; live in neighborhoods with better access to healthy foods, lower rates of crime, more access to safe parks and recreational facilities; and have more time for leisure activities and a stress-reducing lifestyle.[32] Income *inequality* is in and of itself a contributor to poorer health. An individual earning a lower income than the majority of other individuals in her community is more likely to die prematurely, report depressive symptoms, and have poor self-reported health.[40] [41] [42]

Employment & Income Findings from the Updated Economic Analysis

Overall, the rate of employment growth to 2020 is expected to remain essentially unchanged when comparing the implementation of complementary measures and a cap-and-trade program to the business as usual scenario.[ix] Employment will, however, vary on a sector by sector basis (Table 10). Compared to the reference case, implementation of all complementary programs and a cap-and-trade system with 49% offsets may result in 6,000 fewer jobs being created by 2020 (<0.1% change), and shifting of jobs between industries with job growth and those with slower job growth. Total job shifts in Case 1 represent 90,000 jobs. In Case 2, where offsets are not permitted, 200,000 fewer jobs are created by 2020 (a decrease of 1.4%) compared to the business as usual scenario. The largest differences in under Case 2 would occur in construction, manufacturing, and retail trade.

[ix] It should be noted that the economic changes the modeling reflects also accounts for changes in migration into and out of California, so that reduced labor demand compared to BAU does not necessarily indicate that many Californians would have had jobs but do not.

Table 10. Projected change in employment by sector compared to reference case (source: ARB's Updated Economic Analysis)

	Reference Case	Case 1		Case 2	
Sector	**Thousands of jobs**	**Thousands of jobs**	**% change from reference case**	**Thousands of jobs**	**% change from reference case**
Agriculture, forestry & fishing	448.7	453.4	1.0%	441.4	-1.6%
Mining	25.9	22.2	-14.2%	23.3	-10.0%
Construction	928.6	920.1	-0.9%	893.6	-3.8%
Utilities	67.1	61.4	-8.5%	47.4	-29.3%
Energy-intensive manufacturing	857.6	849.5	-0.9%	835.4	-2.6%
Other Manufacturing	1,189.4	1,176.2	-1.1%	1,166.8	-1.9%
Wholesale trade	791.4	791.1	0.0%	789.3	-0.3%
Retail trade	1,901.3	1,895.2	-0.3%	1,831.1	-3.7%
Transportation & warehousing	503.4	500.1	-0.7%	484.1	-3.8%
Information	448.4	450.7	0.5%	451.6	0.7%
Finance, insurance, & real estate	1,025.6	1,036.5	1.1%	1,022.3	-0.3%
Services	6,728.5	6,753.4	0.4%	6,713.9	-0.2%
TOTAL	*14,916.0*	*14,910.0*	*0.0%*	*14,700.0*	*-1.4%*

Changes in household income will vary by income level (Table 11).[x] When compared to the baseline Reference Case, which reflects an average growth in per capita income of 0.9% per year through 2020, implementation of all complementary measures at 100% effectiveness and a cap-and-trade program are expected to induce very minor increases in income. These increases are small and consistent across most income levels in Case 1 (ranging from 0.1-0.3%); though slightly negative for those earning over $200k (-0.2%). In Case 2, changes in household income are positive for most income groups, ranging from 0.2-1.1%. Very small negative change is seen only for those earning over $200k (-0.8%). Results are more mixed when considering cases in which the sensitivity analyses in which complementary measures do not achieve 100% effectiveness, but still very small in comparison to the business as usual case (data not shown, full details are available from ARB's *Updated Economic Analysis*).

[x] Income levels by tax bracket level are shown in Table 12.

Table 11. Change in household income by income level in California following implementation of AB 32 under two different scenarios (source: ARB's Updated Economic Analysis)

	Reference Case	Case 1	Case 2
Household income by CA tax bracket	**Thousands of 2007 $**	**Change from reference case**	**Change from reference case**
0% Marginal CA PIT*	24.4	0.3%	1.1%
1% Marginal CA PIT	11.3	0.1%	0.2%
2% Marginal CA PIT	33.0	0.1%	0.4%
4% Marginal CA PIT	58.3	0.1%	0.5%
6% Marginal CA PIT	85.0	0.1%	0.6%
8% Marginal CA PIT	118.8	0.2%	0.7%
9.3% Marginal CA PIT (under $200k)	197.4	0.1%	0.4%
9.3% Marginal CA PIT (over $200k)	1,256.2	-0.2%	-0.8%

* PIT = personal income tax

Table 12. Income range by tax bracket for single and joint file income tax returns (source: State of California, Franchise Tax Board)

Tax bracket	Taxable income (single)	Taxable income (joint file)
1.0%	$0 - 6,827	$0-13,654
2.0%	$6,827-16,185	$13,654-32,370
4.0%	$16,185-25,544	$32,370-51,088
6.0%	$25,544-35,360	$51,088-70,920
8.0%	$35,460-44,814	$70,920-89,628
9.3%	$44,814 and over	$89,628 and over

Most of the employment differences reflected in the modeling relate to changes in the rate of growth of different sectors rather than in actual contraction. Under the Case 1 scenario, growth in employment would remain relatively stable through 2020 compared to business as usual, resulting in few health impacts with regards to employment loss. However, as different sectors experience slightly slower or faster employment growth relative business as usual, some job instability may occur, disrupting access to employer-based insurance and steady income. As previously discussed, job insecurity can increase stress and negatively impact the health of all household members. Overall, employment shifts in Case 1 are minor and readily mitigable.

Under the Case 2 scenario, job growth by 2020 is expected to be 1.4% lower compared to business as usual, amounting to roughly 200,000 fewer jobs being created by 2020. Though additional jobs may be created in other industries that may experience labor gains that are not captured in the economic analysis (such as jobs in green technology or emerging energy technologies), these differences in the rate of economic growth could have more substantial health impacts than Case 1.

From December 2007 to December 2009, the California economy shed 1.2 million jobs.[43] In that same period, 1.4 million people lost their employment-based health insurance (this figure

accounts for coverage of spouses, children, and individuals on COBRA; but it does not account for individuals that may have subsequently enrolled in a public insurance program or bought private insurance).[34] However, recent national health care mandates will increase coverage beginning in 2014. According to an analysis from UCLA, 63% of those currently uninsured in California will be eligible for expanded Medi-Cal coverage or insurance subsidies, while 22% remain ineligible because of citizenship status, and 15% are ineligible because of income.[44] Thus, increases in uninsurance should be muted if all eligible recipients are enrolled.

Income is one of the most consistent and well-documented health determinants. For both Case 1 and Case 2, changes in income are positive across most income levels (at the income levels over $200,000 there is a slight decrease). For Case 2, all income levels see positive increases in household income compared to the reference case, with the exception of those earning over $200k (small decrease of 0.8%). For both Case 1 and Case 2, health impacts associated with changes in income are expected to be negligible. However, efforts to capitalize on a shifting job market—by implementing jobs training programs or creating incentives for growth in emerging clean technology industries—could create positive work and income-related health benefits, particularly when programs are targeted to less educated, low-income populations that are most challenged in a shifting employment market and would benefit the most from small increases in employment, income, and associated health gains.

Occupational health and safety is also an important health determinant, and can contribute to variations in workplace-related morbidity and mortality rates between job sectors. Variations in workplace injury and illness are shown in Table 13.

Table 13. Incidence rates of job-related injury and illness in California across job sectors in 2008 (source: Bureau of Labor Statistics, U.S. Department of Labor)

Industry	Annual employment (thousands)	Incidence rate	Rate for cases with day(s) away from work	Total cases
Agriculture, forestry & fishing	357.2	4.5	3.0	12,700
Mining	24.8	1.7	1.2	5,000
Utilities	58.8	6.6	4.0	2,400
Construction	854.2	4.8	3.1	33,400
Energy Intensive manufacturing	1,442.4	3.8	2.4	50,000
Other manufacturing				
Wholesale trade	720.4	3.4	2.2	22,700
Retail trade	1,685.3	4.6	2.9	59,400
Transportation & warehousing	437.1	6.1	4.4	23,600
Information	461.3	2.0	1.1	7,400
Finance, insurance, & real estate	878.0	2.2	1.0	15,400
Services	8,533.2	4.7	2.3	207,200
All sectors	*15,452.7*	*4.4*	*2.4*	*502,200*

Energy Intensive Manufacturing and *Other Manufacturing* are modeled by ARB as distinct subgroups. For simplicity, incidence rates here are shown for all *Manufacturing*.

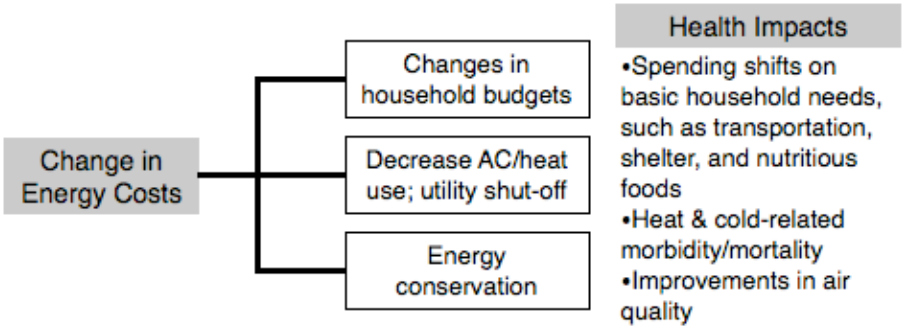
Incidence rates represent the number of illnesses and injuries per 100 full-time workers. Across all industries, workplace-related injuries and illnesses occur at the rate of 4.4 incidents per 100 full-time employees (FTE) per year. Growth in job sectors with high injury/illness rates may result in small increases in job-related morbidity incidents. And labor shrinkage in such sectors may result in fewer cases of work-related injury and illness. Assuming that sector-specific morbidity rates remain static, Case 1 and Case 2 would both result in negligible reductions in job-related injuries and illnesses. Since 2006, however, most industries in California have seen small decreases in the rate of job-related injury and illness—overall rates have decreased 6% since 2006 (according to data from Bureau of labor Statistics; data not shown). If declines were to continue, the difference in the total number of job-related injuries and illnesses due to employment shifts will be even more negligible.

3.2.3 Household Energy Costs

Health Rationale

Basic household costs—including residential and other energy costs—are important health determinants because they influence household access to goods and services required for healthy living, such as nutritious food, quality housing, healthcare, venues for physical activity, and transportation (Figure 3). Residential energy costs impact the proportion of income spent on household utilities. Families trying to save money by limiting air conditioner use during a heat wave may increase the risk of heat-related morbidity—especially amongst children and the elderly. Yet, increases in energy costs can also have a beneficial effect, providing price signals to spur energy conservation and reduce energy consumption, ultimately improving air quality and reducing GHG emissions. Changes in the cost of fuels in the industrial, commercial, and transportation sectors will also potentially impact health, but the focus here is on impacts associated with changes in household fuel costs. An assessment of residential fuel costs was deemed most relevant to health for the first phase of the cap-and-trade program and feasible given time and resource constraints. Other fuel costs are not addressed here.

Figure 3. Health effects associated with residential energy costs



As energy costs rise, low-income households will spend an increasingly disproportionate amount of their income on residential fuel costs—increasing their risk for utility shut-off and forcing tough budget decisions that may shift funds away from other basic needs, such as nutritious foods, shelter, education, and transportation. A recent survey in California found that 49% of low-income households surveyed worried about paying their energy bill, and 56% had cut back

on basic household necessities. Thirty-seven percent of low-income households surveyed have reported skipping payment on their utility bill altogether at some point.[45]

Low-income and vulnerable households straining to meet household utility costs are less able to afford in-home air conditioning, a basic adaptation tool for heat waves in urban areas and one that is likely to become increasingly important as global temperatures rise. A study of heat waves in four American cities found that African Americans were half as likely to have AC access, and that deaths among blacks were more closely associated with elevated temperatures.[46] And heat waves are most likely to negatively impact vulnerable populations—including young children, adults over 65 years of age, the disabled, and the poor. In California, these health effects vary by geography. An assessment of heat waves in California found that the negative health impacts were often most pronounced in regions with relatively modest temperatures, suggesting that a population's existing adaptive capacity—including access to air conditioning and heat preparedness plans—plays a large role in health risks.[4]

Additionally, coping is a concern for low-income households that rely on in-home electric medical devices (such as home ventilators and medication nebulizers). Electricity disruptions to individuals relying on such devices can be life-threatening. An assessment of the 2003 New York City blackout found that many of these individuals were forced to hospital emergency rooms to access power.[47] A survey of low-income households by The California Public Utilities Commission found that 5% of all households had an individual with an energy operated medical device.[45]

Higher energy costs can also spur reductions in energy use or investments in energy efficiency, reducing CO_2 emissions and improving air quality. Improvements in air quality would have positive health impacts. However, low-income households have a limited ability to invest in home energy efficiency upgrades. So while overall health effects from rising energy costs could be positive, low-income Californians are most likely to be negatively effected by increases in residential energy costs.

Household Energy Costs: Findings from the Updated Economic Analysis
Fuel prices will increase—and world oil prices are expected to double by 2020—regardless of the implementation of AB 32 (Table 14). Increases in the market price of fuels will increase residential fuel prices as well, with the steepest increase in oil (Table 15).

Table 14. Forecasted fuel prices by year under a business as usual scenario (source: ARB's Updated Economic Analysis)

Fuel prices by year	2006	2012	2015	2020
World oil price (2007 US$ / barrel)	60.70	94.84	108.52	112.05
Natural gas wellhead price (2007 US$ / mmBtu)	6.91	6.75	6.90	7.43
Coal price (2007 US$ / ton)	25.29	27.69	27.77	27.38

Table 15. Forecast fuel residential fuel prices in California by year under business as usual scenario (source: ARB's Updated Economic Analysis)

Residential fuel prices by year (2007 $ / mmBtu)	2006	2012	2015	2020
Electricity	40.10	40.80	41.20	42.10
Natural Gas	13.50	13.00	13.40	14.00
Oil	17.90	21.00	22.30	24.30
LPG	24.90	28.00	29.20	31.30

Under the Case 1 and Case 2 policy scenarios, most residential fuel prices are expected to increase, with the largest increases in gas (Table 16). For Case 1, in which all complementary measures are achieved at 100% effectiveness and offsets are limited to 49% of program reductions in capped sectors, fuel price increases range from 0-11% depending on the fuel type, with residential electricity prices remaining static compared to business as usual scenarios. All residential fuel types increase in price in Case 2, in which offsets are not allowed and costs of compliance would be higher for entities covered under the cap-and-trade program. Under the Case 2 policy scenario, residential electricity prices would increase 4%, and residential gas prices would increase 50% compared to business as usual. Energy costs depend on both on price and how much energy is used. Implementing the Scoping Plan will result in decreases in total fuel use in California. Table 17 shows the changes in expenditures in the residential sector, including decreases in aggregate fuel expenditures for Case 1. These figures represent aggregate Statewide totals, and not impacts on use and expenditures by income level.

Table 16. Change in fuel prices compared to business as usual for Case 1 and Case 2 policy scenarios (source: ARB's Updated Economic Analysis)

Utility Prices	Case 1		Case 2	
Residential fuels (2007 $ / mmBtu)	Change from reference case (%)	Price in 2020	Change from reference case (%)	Price in 2020
Electric	0	$42.10	4	$43.80
Gas	11	$15.50	50	$21.00
Oil	7	$26.00	36	$33.00
LPG	3	$32.20	15	$36.00

Table 17. Change in aggregate expenditures for the residential sector for Case 1 and Case 2 policy scenarios (source: ARB's Updated Economic Analysis)

(2007M$/Yr)	Case 1	Case 2
Change in Device, Process, and Operating Expenditures	$1,539	$2,486
Change in Fuel Expenditures	($2,269)	($1,001)
Aggregate Change in Expenditures	($730)	$1,485

Residential Fuel Costs and Health Projections

Low-income households are the most vulnerable to fluctuations in energy costs. Nationally, households spend increasingly more on fuel expenditures as household income increases (Table 18). The lowest income quintile household spent $1,300 on residential fuel expenditures in 2008, compared to nearly $3,000 for the highest income quintile households. However, as a percentage of total income, the lowest income quintile households spend the most on household fuel expenditures (Table 19). While the lowest income quintile households spend nearly 13% of their total income on residential fuel expenditures, household fuels cost the second lowest income quintile household 6% of their income. The highest income quintile households spend 2% of their total income on residential fuel costs.

*Table 18. Annual consumer unit fuel expenditures by income quintile by fuel type in 2008 in the U.S. (source: Bureau of Labor Statistics, Consumer Expenditure Survey)**

		Household Fuel Expenditures (2008 US$)			
Income quintile	**Mean pre-tax Income**	**Electricity expenditure**	**Natural gas expenditure**	**Fuel oil & other fuel expenditures**	**Total fuel expenditures**
1st Quintile	$10,263	$910	$310	$97	$1,317
2nd Quintile	$27,442	$1,172	$425	$162	$1,759
3rd Quintile	$47,196	$1,324	$505	$175	$2,004
4th Quintile	$74,090	$1,517	$603	$242	$2,362
5th Quintile	$158,652	$1,843	$812	$282	$2,937

* A *consumer unit* consists of all members of a household or person/persons that share joint expenditure decisions. Consumer unit is the official term for the Consumer Expenditure Survey, but is often used interchangeably with *household* and *family* for convenience.

Table 19. Annual consumer unit fuel expenditures by income quintile as a percent of pre-tax income in 2008 in the U.S. (source: Bureau of Labor Statistics)

		Fuel Expenditures as a Percent of Pre-tax Income (%)			
Income quintile	**Mean pre-tax Income**	**Electricity expenditures**	**Natural gas expenditures**	**Fuel oil & other fuel expenditures**	**Total fuel expenditures**
1st Quintile	$10,263	8.9%	3.0%	0.9%	12.8%
2nd Quintile	$27,442	4.3%	1.5%	0.6%	6.4%
3rd Quintile	$47,196	2.8%	1.1%	0.4%	4.2%
4th Quintile	$74,090	2.0%	0.8%	0.3%	3.2%
5th Quintile	$158,652	1.2%	0.5%	0.2%	1.9%

For low-income households, total household expenditures often exceed reported household income.[xi] When comparing household utility expenditures to total household expenditures, the gap between low and high-income households is substantial, but decreased in comparison to

[xi] Total expenditures often exceed total reported income, especially for low-income households, because of non-response to questions of income, incomplete reporting of income sources, spending from savings during periods of unemployment, and debt spending. More detail is available from the Bureau of Labor Statistics (http://www.bls.gov/cex/csxfaqs.htm#q20).

measures of energy expenditure per reported income (Table 20). By this measure, the lowest income household spends two-fold the proportion of all household spending on residential fuel expenditures in comparison to the highest income household.

Table 20. Annual consumer unit fuel expenditures by income quintile as a percent of all household expenditures in 2008 in the U.S. (source: Bureau of Labor Statistics)

		Fuel Expenditures as a Percent of all Household Expenditures (%)			
Income quintile	**All household expenditures**	**Electricity expenditures**	**Natural gas expenditures**	**Fuel oil & other fuel expenditures**	**Total fuel expenditures**
1st Quintile	$22,304	4.1%	1.4%	0.4%	5.9%
2nd Quintile	$31,751	3.7%	1.3%	0.5%	5.5%
3rd Quintile	$42,658	3.1%	1.2%	0.4%	4.7%
4th Quintile	$58,631	2.6%	1.0%	0.4%	4.0%
5th Quintile	$97,003	1.9%	0.8%	0.3%	3.0%

If residential fuel costs rise, low-income families may be forced to spend a disproportionate portion of their income on basic energy costs. Low-income families have the least ability to invest in basic energy-saving investments, such as appliance upgrades, home-conditioning measures, and installation of energy-efficient lighting. While many households have the capital to finance these basic upgrades and lower total residential energy use, low-income households often do not, exacerbating household energy burdens. In face of rising residential fuel prices, low-income California families are most at-risk to suffer from adverse related health effects—including poorer nutrition, increased household stress, or utility shut-off and heat-related illness and mortality.

As the climate warms and heat waves become more common and more prolonged, heat adaptation at the household and community level will be necessary to minimize the negative health impacts. Ensuring that low-income families have access to household energy efficiency upgrades and affordable energy will prevent heat-related morbidity and mortality, including strategies to expand the use of discounted utility programs for impacted households.

3.3 Summary of Economic Determinants & Health Impacts at the State Level

This analysis only examines average economic impacts at the State level, and thus assesses broad health impacts. The general conclusions are likely to pertain to any final rule with regard to overall direction and type of health effect related to economic impacts, but the specifics may not be the same depending on the specifics of the final rule and the ways in which allowance value and any resulting revenue are used.

In summary, health impacts of predicted impacts of cap-and-trade on economic determinants—including income, employment, and household fuel costs—are expected to be negligible to minor under the Case 1 scenario in which 4% of emission can occur through offsets, and minor to moderate under the Case 2 scenario in which no offsets are allowed. The health impacts include:

- Minor health impacts are likely due to relatively small changes in the rate of growth in employment in different sectors and related labor demand shifts and employment transitions. Net changes in the rate of employment growth are unlikely to create positive or negative health impacts in Case 1. Slightly greater changes in the rate of employment growth in Case 2 could have slightly larger impacts on health. Low-income households, youth, the least educated, and communities of color are historically at the greatest risk to be adversely impacted by unemployment and shifts in labor market demands.
- Potential for small positive health impacts due to decrease in occupational injuries as jobs shift to safer industries and from reduced job growth.
- Minor negative health impacts may occur from small increases in household energy costs for low-income households.
- Possible small positive health effects if higher energy costs are associated with aggregate reductions in residential energy use and associated improvements in air quality.

It should be noted that the assessment of economic health determinants is based on a State level analysis. An assessment limited to statewide risk exposures and health effects across the entire population may hide variations in exposure, and limit the perceived impact on health. However, if certain populations are disproportionately impacted (for example, because of income, geography, or job-sector), then changes in risk exposure and health effects could be greater for these subgroups, but not the State as a whole. And, of course, individual health outcomes can be highly significant, even when the population-wide impact of risk exposure and health effects is small.

Disproportionate impacts on vulnerable communities and in smaller geographical areas cannot be ruled out, with concomitant health impacts. This community-to-community variation in air quality, energy costs, labor demand, unemployment, and other impacts cannot be accurately projected because of data limitations. Understanding baseline health, environmental, and economic status in the diverse California communities that are already impacted by capped sectors or are likely to be impacted by the cap-and-trade regulation may help identify and mitigate any potential negative health impacts and optimize health co-benefits.

A more detailed summary of potential health effects is included below.

3.3.1 Employment and Health Effects

Case 1—Minor Effect

- Overall, net changes in the rate of employment growth are unlikely to create substantial positive or negative health impacts in Case 1. Some minor health effects may occur due to labor demand shifts and transitions between job sectors. Mitigation efforts should be used to alleviate the stress of short-term labor demand shifts and economic transition.
- Low-income households and other populations with higher unemployment rates (e.g. black and Hispanic communities) —hampered by limited savings and often lower educational attainment—will have the greatest challenges adapting to changing patterns of job growth and mitigation efforts should be focused here.
- Small reductions in occupational injury and illness are expected. Workplace morbidity and health risks in emerging job sectors (such as green jobs or clean energy jobs) should be evaluated and interventions developed on an as-needed basis.

Case 2—Moderate Effect

- Net changes in the rate of employment growth and shifts between job sectors could have a small negative impact on public health associated with higher health uninsurance rates, increased stress, and impacts on household budgets and income. Mitigation efforts should focus on increasing health care access for the unemployed in coordination with recent national healthcare legislation, and alleviating negative impacts of unemployment.
- The least educated, youth, and communities of color are historically the most likely to be impacted by unemployment. Mitigation measures should address these and other disproportionately impacted subpopulations as needed.
- Decreases in workplace-related morbidity may occur and could have a positive health effect, but may be at the expense of reduced job growth. Overall, job-related health outcomes in Case 2 may be moderate and would merit efforts to lessen health impacts.

3.3.4 Income and Health Effects

Case 1— Negligible Effect

- Net changes in income are expected to be very small, mostly positive, and flat across most income levels. No net health impacts are expected, and no mitigation measures are needed.

Case 2— Negligible Effect

- Net changes in income are expected to be very small and mostly positive. No net health impacts are expected, and no mitigation is needed.

3.3.5 Residential Energy Costs and Health Effects

Case 1—Minor Effect for low-income households; positive impacts on energy efficiency and air quality

- Net changes in residential energy costs are, on average, very small. At the aggregate level, total statewide expenditures may decrease. Low-income households, already strained by tight household budgets, have the least ability to invest in home efficiency measures and adapt to changes in basic household costs, possibly leading to negative health effects. Even small changes in residential energy costs may force low-income households to neglect household expenditures, including nutritious foods, education, and basic home improvements, or potentially threaten utility shut-off. Mitigations are recommended for this subpopulation, and the health effects are readily reversible.
- Decreased net residential energy use in response to changes in energy costs could result in improved air quality, resulting in net positive health impacts. Small positive health effects are expected.

Case 2*—Moderate effect for low-income households; positive impacts for energy efficiency and air quality*

- Reductions in residential fuel costs would not completely offset higher expenditures. Both negative impacts on low-income households and positive impacts on air quality and energy efficiency are expected to be greater in Case 2 than in Case 1. Mitigation is necessary for low-income households to reduce adverse health impacts associated with higher household energy costs.

4. SCOPING OF OFFSET PROTOCOL HEALTH PATHWAYS

4.1 Overview of Emission Offsets Health Impacts

Offsets are cost containment instruments that allow capped entities to meet their target emission reductions by purchasing emission reduction credits in the form of offset projects. Offset projects occur outside of the capped industries and the emissions reductions they create must be certified as real, quantifiable, permanent, verifiable, and enforceable. Offsets help contain program costs and increase the flexibility complying entities have in meeting their emission reduction goals. The *Preliminary Draft Regulation* released by ARB would allow for offsets to account for 49% of total emission reductions by 2020. This is the same offset limit assessed in Case 1 of the *Updated Economic Analysis*.[21]

Emission offsets can impact health through three pathways. First, allowing emission offsets reduces the emission reductions that must be made on-site by stationary facilities. On-site emission reductions will have air quality co-benefits, positively impacting acute and chronic diseases related to air pollution. To the extent that air pollution reductions from offsets are diminished in comparison to on-site emission reductions, the use of offsets may diminish positive air pollution co-benefits. Second, the use of offsets, as seen in the statewide assessment of economic health determinants in Section 3, also helps lower program costs, positively impacting economic health determinants.

Third, the offset projects themselves may have health impacts, depending on specific project protocols. Impacts may stem from factors such as changes in air quality, mitigations of heat island effects in urban areas, or changes in employment, among many other health effects. These impacts are likely to be broad and wide-ranging, and may be unknown or highly uncertain depending on the specific offset project.

A quantitative assessment of emission impacts associated with the use of offsets is out of the scope of this document and is considered in the ARB Co-Pollutant Emissions Assessment. The focus here will be a *high-level* overview of potential health impacts that may arise as a result of the offset protocols themselves. The scoping of health pathways presented below is based on offset protocols from Climate Action Reserve (CAR) and the best current knowledge of related health impacts, as collected from literature reviews published in peer reviewed journals and government reports on health. The offset protocols considered here include ozone depleting substances, manure management digesters, urban forest and forest. Only offset protocols up for Board approval in 2010 are considered here.

4.2 U.S. Ozone Depleting Substances (ODS) Offset Protocol

4.2.1 Regulatory Context

Ozone depleting substances (ODS) are chemicals that, when released into the atmosphere, destroy stratospheric ozone, and are large contributors to global warming. ODS were traditionally used in applications such as refrigerants, foam blowing agents, solvents and fire suppressants.[48]

Stratospheric ozone (also known as the ozone layer) is located approximately 10 to 30 miles above the earth's surface. It forms a natural layer that protects life on earth from the sun's harmful ultraviolet (UV) rays.[49] Over time, the release of man-made substances such as chlorofluorocarbons (CFCs), halons, methyl bromide and hydrochloroflourocarbons (HCFCs) has contributed to the depletion of the ozone layer worldwide.[50]

Because of the potential for damage to the environment and to people from depletion of stratospheric ozone, the Montreal Protocol on Substances that Deplete the Ozone Layer was adopted internationally in 1987. Its intention was to phase out ODS production worldwide, with the goal of having the ozone layer recover by 2050. It has undergone six revisions since its inception. Both the Montreal Protocol and the Clean Air Act (CAA) govern ODS production in the United States; however, there remains a gap in the legislation which the Ozone Depleting Substances Offsets Protocol (ODS Protocol) aims to address. Under both the Montreal Protocol and the CAA, the destruction of existing stocks of ODS is not required. This means that ODS stock can be left to leak into the atmosphere or can be reused indefinitely. Reuse of ODS stock can be particularly problematic, as it is often placed in older equipment with high leakage rates. The ODS protocol aims to target this problem area by focusing on the destruction of two sources of ODS stock: refrigerants and foams.[48]

The ODS protocol describes the projects that would qualify under the new program:

- *Refrigerants: a project may collect eligible ODS refrigerant from industrial, commercial or residential equipment, systems, and appliances or stockpiles, and destroy it at a qualifying destruction facility.*
- *Foams: a project may extract eligible ODS blowing agent from appliance foams and destroy the concentrated ODS foam blowing agent at a qualifying destruction facility; or, a project may destroy intact foam sourced from building insulation at a qualified destruction facility*.[48]

4.2.2 ODS Reduction and Health

In this section the potential health effects that may occur as a result of the ODS protocol are reviewed. A summary of the effects is shown in Figure 4. It should be noted that although there is a large body of evidence tying respiratory health problems to ground-level ozone exposure, these effects are not explored below, as the protocol relates only to substances that affect stratospheric ozone levels and not ground-level ozone.

Exposure to UV radiation

Stratospheric ozone naturally protects life on earth from UV rays, which are known to have damaging health effects. Malignant melanoma is the most lethal of these effects, killing approximately 8,700 people in the United States each year.[51] Squamous and basal cell carcinomas (also known as non-melanoma skin cancer (NMSC)) are also thought to be partially caused by exposure to UV rays, as is eye damage: cataracts, squamous cell cancer of the cornea, and other damage to the cornea.[52] [53] Over-exposure to sunlight has also been found to suppress immune response, making people more susceptible to infectious disease and skin tumors.[50] [54] These health effects are well-established, and are strongly tied to UV radiation exposure. In terms of positive health effects, increased exposure to UV rays increases the skin's natural synthesis of Vitamin D, a vitamin that has been shown to be important in bone health and more recently in the prevention of diseases such as multiple sclerosis, type 1 diabetes, and several

cancers.[55] Decreased exposure to UV radiation could increase risks for diseases related to low Vitamin D levels.

The extent to which the thickness of the stratospheric ozone layer has contributed to the burden of these diseases is uncertain, and predicting the health implications of replenishing stratospheric ozone is challenging. One study has attempted to calculate the increase in the number of new skin cancer cases (melanoma and NMSC) and deaths from skin cancer based on different ODS protocols/policies. It demonstrates that the number of excess skin cancers in the U.S. would be dramatically reduced with increased stringency of the control policy, and with the possibility of eventually returning to baseline levels (i.e., 1979-1980 levels) under the Montreal adjusted protocol.[50] Although the study does not estimate the effect of the destruction of ODS stocks *per se*, the study is nonetheless useful in providing support for a reduction in disease burden attributable to restoring the ozone layer.

The aim of the ODS proposal is to contribute to replenishing the ozone layer (or, at minimum, curtailing further damage). If the proposal is successful and there is a decrease in UV radiation exposure in California, there are likely to be associated health benefits in the diseases listed above, although the extent and distribution of these effects within the population is unknown.

Greenhouse gas reduction

The substances released by ODS stocks are major contributors to global warming. The chemicals that are particularly effective at trapping heat in the earth's atmosphere include CFCs and HCFCs. Both of these substances are released by ODS stocks. Since the reduction of GHGs are common to all of the offsets protocols, the impacts on health are outlined in the protocols summary section.

Changes in agricultural and ecological systems

The replenishment of the ozone layer may also result in indirect changes to human health, via changes in agricultural and ecological systems on which humans are dependent.

Agricultural and ecological systems are reliant on sunlight for many natural processes, the main one being photosynthesis. However, overexposure to sunlight can also have negative impacts on these systems. For example, increasing UV exposure has been shown to decrease the immunity of vegetation to pest infestation. Presumably, this would increase the use of pesticide application, which could have detrimental human health impacts (although the evidence on the impacts of some pesticides on human health is inconclusive). And agricultural and ecological systems change could increase bacterioplankton stress in water, leading to changes in the fish and amphibian populations in aquatic ecosystems, and disrupt nutrient cycles.[56 57 58 59] Efforts to halt increases in UV exposure could mitigate potential negative ecological impacts associated with increased UV exposure.

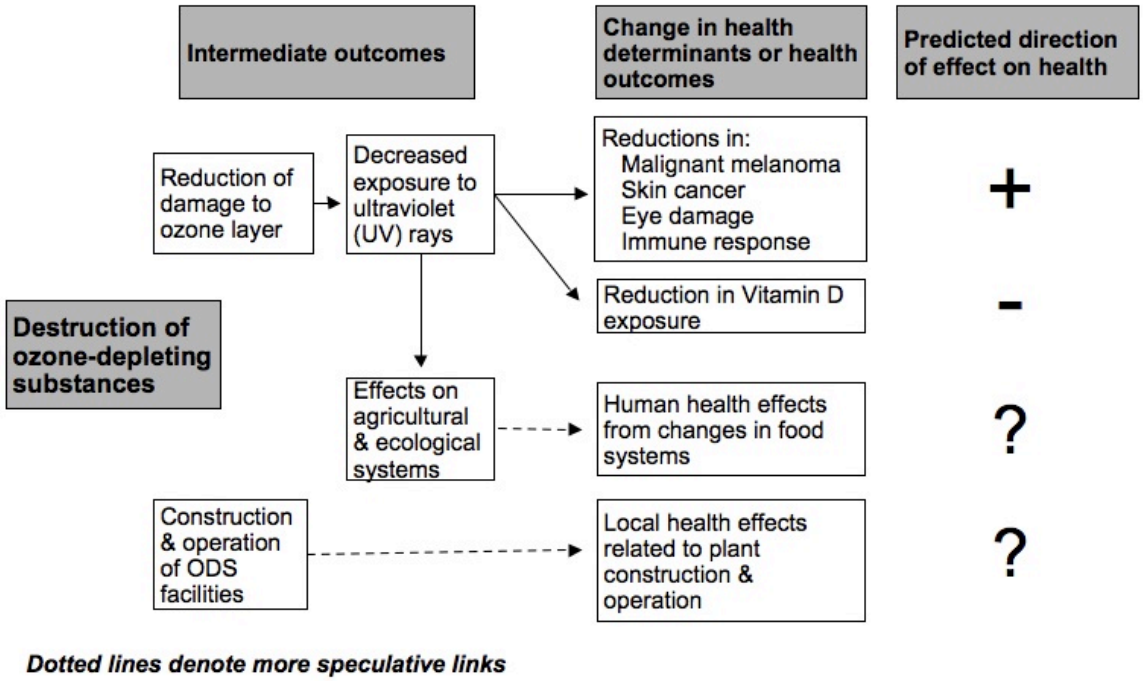
The ODS Protocol has the potential to affect these health pathways depending on levels of UV exposure; however, it is not possible to predict the exact nature, direction, or extent of potential health impacts.

Construction and operation of ODS facilities

Job creation may occur as a result of the construction and operation of ODS destruction facilities; however, construction near populated areas may also result in issues related to noise,

dust or air quality disturbance, and other health effects that stem from social changes in the surrounding communities. These impacts could be substantial on a project by project basis, but are beyond the scope of this document.

Figure 4. Summary of potential health impacts from the Ozone-Depleting Substances Offsets Protocol



4.2.3 Conclusions for ODS Protocols

If the ODS Protocol meets its goal of contributing to the replenishment of the ozone layer, it is likely to result in a number of positive health impacts and few potential negative health consequences. The positive health benefits would likely extend beyond the borders of the state of California, and are likely to affect most populations.

The following recommendation is intended to maximize the likelihood of potential benefits and minimize potential harms associated with the ODS protocol.

- If new ODS destruction facilities are built in California, their siting should take into consideration potential effects on human health that may stem from issues such as job creation and the equity of changes to social or biophysical environments. Environmental and health impact assessments of the proposed facilities may be useful once planning for the facilities is underway.

4.3 Livestock Manure Management Digesters Offset Protocol

4.3.1 Regulatory Context

Manure management digesters (MMD) (also referred to as livestock digesters) are systems that harness manure to produce biogas. In a process known as anaerobic methane digestion, the manure is placed into covered containers or vessels, which anaerobically convert the volatile organic manure solids into biogas. The biogas produced can be used to generate electricity that can power on-site operations and equipment. The electricity can also be sold to an electrical grid system. Some estimates suggest that California has the potential to produce over 200 megawatts of renewable energy with the use of MMD, enough energy for upwards of 60,000 homes.[60]

One of the primary outcomes of using MMD is a reduction in methane emissions. Methane is produced naturally when organic waste decomposes. Methane is a potent greenhouse gas, absorbing 21 times more heat per molecule than carbon dioxide, meaning that it has stronger warming effects. It is estimated that manure from the 1.7 million dairy cows in California emit 450,000 tons of methane each year.[61] This accounted for 2.2% of California's GHG emissions in 2004.[62] Therefore the use of MMD could have a significant impact on reducing California's GHG emissions.

In addition, the use of MMD may reduce air pollutants such as hydrogen sulfide (H_2S), volatile organic compounds (VOCs), and particulate matter (PM); however, the process of combusting biogas also increases levels of nitrous oxides (NOx), a primary contributor to smog formation.

The Manure Management Digesters Offsets Protocol (MMD protocol) applies to projects that install a biogas control system for the purpose of capturing and destroying methane gas that is produced from anaerobic manure treatment and/or storage facilities on livestock operations. The captured biogas may be destroyed on-site, transported for off-site use, or used to power vehicles. Digesters that integrate waste from multiple livestock operations are also eligible under this protocol.

4.3.2 Manure Management Digesters and Health

The potential health effects that may occur as a result of the MMD protocol are discussed below. A summary of the effects is shown in Figure 5. The MMD protocol, as outlined above, has the potential to result in decreases in greenhouse gases, a change in air pollutants, improvements in ground and surface water, and reduced nuisance odors.

Greenhouse gas reduction

The use of MMD has the potential to affect GHG levels through three routes: a decrease in methane emissions, a change in carbon dioxide emissions, and displacement of fossil fuel use. The reduction of methane is the primary impact of the MMD protocol. Using methane digesters will result in a reduction of methane emissions due to anaerobic decomposition of manure in waste treatment and storage. The use of the biogas control systems may themselves result in carbon dioxide emissions; however, these are considered biogenic emissions (as opposed to anthropogenic) and are not included in the GHG reduction calculation, per the Intergovernmental Panel on Climate Change's (IPCC) guidelines for captured landfill gas.[63] Finally, the use of the biogas-generated electricity produced from this process is likely to

displace some of the need for other fossil fuels, thus reducing GHG emission levels; however, transportation of manure to central MMD facilities could contribute to fossil fuel use. Since the reduction of GHGs are common to all of the offsets protocols, the impacts on health are outlined in the summary section for offset protocols.

Change in air pollutants

The implementation of the MMD protocol may result in reductions in ambient levels of volatile organic compounds (VOCs), particulate matter (PM) and hydrogen sulfide (H_2S) through the use of biogas control systems. These substances have been linked to a range of health effects:

- VOCs can cause eye, nose and throat irritation, headaches, visual impairment, and dizziness;
- PM can cause respiratory symptoms, decreased lung function, aggravated asthma, chronic bronchitis, irregular heartbeat and heart attacks; and
- Hydrogen sulfide may cause nausea and headaches.

The effect of these substances on human health is modulated by a number of factors. Modifying factors include the concentration of the substances in the air, duration of the exposure, the age and overall respiratory health of the human receptors, and other factors. In general, the population groups most vulnerable to health effects as a result of exposure include children, elderly and those with previous respiratory and cardiovascular disease. Any reduction in these substances that results from increased MMD use would incrementally lessen the risk of respiratory and cardiovascular illness for affected populations.

However, this benefit may be offset by an increase in nitrous oxides associated with MMD use. Exposure to nitrous oxide has been associated with a stronger response to inhaled allergens, increased respiratory infection and wheezing. Nitrous oxides are also precursors to photochemical smog, a major source of ozone, and its production therefore also contributes to the health effects observed with ground-level ozone—airway irritation, coughing, wheezing, inflammation, aggravation of asthma, increased susceptibility to respiratory disease, and permanent lung damage.[64 65] Children, the elderly, and anyone with existing respiratory illness are most susceptible to these health effects.[64 66]

It is not currently possible to estimate the amount of these air-polluting substances that would be eliminated or created as a result of the livestock protocol; this will depend on the amount of manure removed and processed using biogas control systems, the type of biogas control systems deployed and the controls that are placed on the MDD facilities. Any decrease in air pollutants can be assumed to be beneficial for human health; however, the extent of the impact and the population groups that would be most strongly impacted are unknown.

Reduced contamination of ground and surface water

Ground and surface water near farms can sometimes be contaminated by biological pathogens that spread to the water supply from manure runoff, and water quality can suffer from the delivery of excess nutrients.[61] In tests, methane digesters[xii] have been shown to improve water quality by reducing the quantity of pathogens by 95% or greater, and by reducing biological oxygen demand, a positive water quality indicator.[60] Because a reduction in water quality poses

[xii] Applies to thermophillic (heated) digesters.

a potential hazard for human health, a reduction in opportunities for water pollution represents a potential health benefit.

The MMD protocol as outlined by Climate Action Reserve also highlights environmental contamination issues that could result from MMD if not properly maintained and operated. Threats to ground and surface water could result from "catastrophic digester failures; leakage from pipework and tanks; and lack of containment in waste storage areas…Further, application of improperly treated digestate and/or improper application timing or rates of digestate to agricultural land may lead to increased nitrogen oxide emissions, soil contamination, and/or nutrient leaching, thus negating or reducing benefits of the project overall."[63]

MMD projects thus have the potential to positively or adversely impact human health through changes in water quality. Overall, properly implemented and monitored, the benefits are likely to outweigh the hazards; however, it is not yet possible to quantify the extent of these effects.

Reduced nuisance odor

Odors produced from the aerobic and anaerobic fermentation of manure can sometimes lead to annoyance among neighbors of farming operations, particularly concentrated animal feeding operations (CAFOs).[67] The odors are composed of many compounds, including volatile organic compounds (VOCs), ammonia (NH_3), and hydrogen sulfide (H_2S). In some cases, neighbors of CAFOs have complained of more severe health symptoms, including decreases in quality of life and poor mental health and reduced immune function.[68] [69] The health effects of odors are difficult to study and the actual health effects remain poorly understood; however, odors from manure can at minimum cause annoyance.

The MMD protocol is expected to lead to a reduction in odor emissions resulting from decreased levels of methane and volatile organic compounds emissions. Overall, this should result in decreased odor and potentially decreased annoyance levels in affected households. However, it is not possible at this time to determine the potential magnitude of the impact. It is expected that the effects will last the life of the MDD and will result in a positive impact on human health.

4.3.3 Conclusions for MMD Protocols

Overall, the MMD protocol is likely to result in a net benefit to human health. Potential positive benefits include reduced exposure to respiratory irritants such as VOCs and PM; reductions in surface water contamination; improvements in odor related to farming operations; and decreases in global health effects experienced as a consequence of reduced GHG emissions. The only anticipated net negative impact could stem from increases in nitrous oxides, a known respiratory irritant.

The following recommendations are intended to maximize the likelihood of potential benefits and minimize potential harms associated with the MMD protocol.

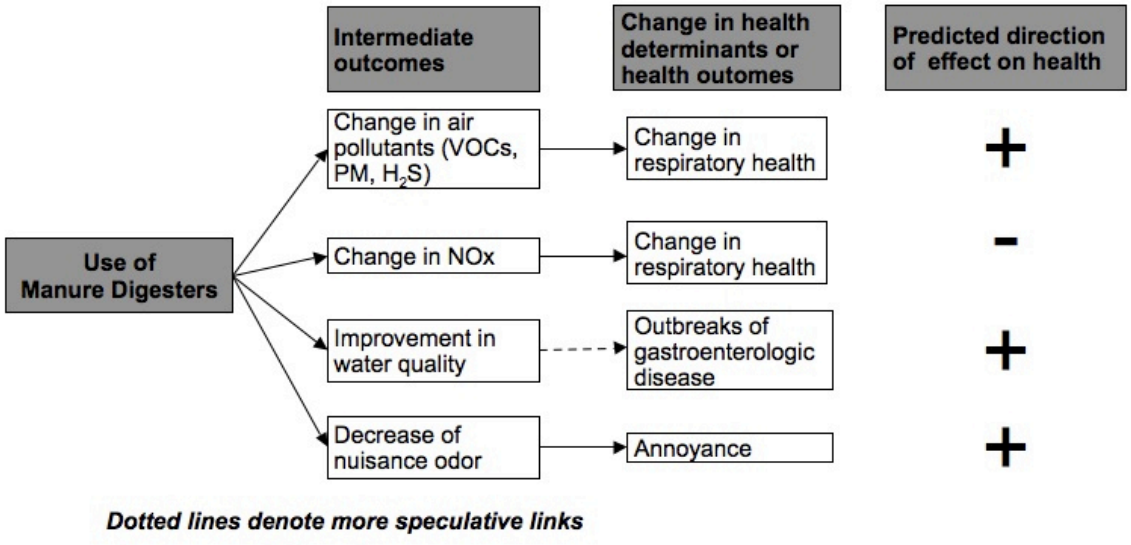
- Overall, an increased exposure of nitrous oxide is seen as detrimental to the health of Californians and any measures that could be undertaken to reduce nitrous oxide production from MMDs should be implemented.

- MMD technology is expensive, which may present a barrier to its implementation, especially in smaller farming operations. To the extent that program benefits outweigh

potential negative impacts, measures could be considered to increase access to the technology to improve the equitable distribution of benefits across the California population.

- There are a number of manure-related issues that may also have health implications not addressed through the use of MMD, such as steroid/antibiotic load in the manure and the proper application or disposal of manure. Additional attention to these issues will help improve human health outcomes related to farming operations.

Figure 5. Summary of potential health impacts from the Manure Management Digesters Offsets Protocol



4.4 Urban Forest Project Protocol

4.4.1 Regulatory Context

Urban forest is the process of planting and maintaining trees in an urban environment. The main purpose of the urban forest offset protocol is to sequester carbon and reduce air pollutants.

Forests play a significant role in reducing atmospheric carbon dioxide. The main mechanism is through carbon sequestration, a process that removes CO_2 from the air and transforms it into carbon that is stored in the tree's biomass (i.e., trunk, leaves, branches and roots). Urban forests can also indirectly impact emissions levels. First, forests can moderate temperatures of nearby buildings, potentially causing a decrease in air conditioning or heating use and reducing emissions involved with the consumption of electricity, natural gas and fuel oil.[70] Second, the biomass from fallen trees can also be harvested and used as feedstock for power plants, displacing GHG emissions that would have been generated through the use of fossil fuel sources.[71]

The Urban Forest Project Protocol (Urban Forest protocol) describes the projects that would qualify under the new program. GHG tree projects that account for the net storage of CO_2 through tree plantings can be reported. The program includes:

> *A planned set of tree planting and maintenance activities that permanently increase carbon storage and that take into consideration GHG emissions associated with planting and maintenance of project trees.*

More specifically, the Urban Forest protocol focuses on urban forest projects undertaken in three different settings: 1) in municipalities, 2) on educational campuses and 3) by utilities.

4.4.2 Urban Forest and Health

In this section the potential health effects that may occur as a result of the Urban Forest protocol are reviewed. A summary of the effects is shown in Figure 6.

Greenhouse gas reduction

The balance of evidence indicates that trees offset GHGs by absorbing carbon dioxide, one of the primary greenhouse gases. Since the reduction of GHGs is common to all four offset protocols, the impacts on health are discussed in the summary section for all offset protocols.

Changes in air quality

The Urban Forest protocol is likely to improve air quality. Trees are able to filter out a number of air pollutants, including particulate matter, nitrous oxides (NOx) and ground-level ozone that are known to contribute to poor air quality and have been linked to a variety of respiratory and cardiovascular health problems, including asthma, chronic bronchitis, headaches and heart attacks.[72] [73] These effects are experienced by populations proximate to the pollution sources, and certain vulnerable populations—including children, the elderly, low-income populations and those living in urban environments—are disproportionately affected.[74] By improving air quality in urban areas, urban forest in California has the potential to improve respiratory and cardiovascular health among Californians. Benefits such as decreasing ozone levels have been observed in other areas of the US in which urban forests have been planted.[75]

Some trees have been observed to reduce air quality by emitting biogenic volatile organic compounds (BVOCs). Different types of trees have different abilities to filter out pollutants or to emit BVOCs; for example, ash, alder and birch have relatively beneficial effects on air quality, while willows, poplars and oaks can potentially have negative health impacts during hot weather.[76] Therefore, the types of trees planted in urban forests will have an effect on the degree of health effects experienced. Overall, the benefits of tree planting on air quality generally outweigh potential negative effects from BVOC emissions.[77]

The pollen from trees is a main cause of allergies, and can lead to rhinitis, conjunctivitis, asthma, and dermatitis. Many trees planted in urban areas are known allergenic species. Increasingly, evidence suggests that exposure to pollution and vehicle emissions in urban areas increases the risk for pollen-induced allergies. Selection of trees that produce less allergenic pollens will prevent potential adverse health impacts of urban forest that could be associated with increased allergic response.[78]

Heat island effects

Heat islands are parts of the metropolitan environment that are warmer than surrounding areas. They are formed when natural land cover is replaced by pavement, buildings, and other impervious surfaces and man-made structures, particularly in areas that lack adequate tree canopy. Heat islands may increase ambient temperatures 1.8 to 5.4°F and as much as 22°F at night.[79] Heat islands may pose health risks in areas that experience high temperatures by increasing the likelihood of heat-related effects such as heat exhaustion, heat stroke, cramps, or dehydration. The elderly and children are often among those most strongly affected by high temperatures; additional vulnerable groups include the socially isolated, outdoor workers, the poor, the chronically ill and the medically underserved.[80]

An assessment of in 4 metropolitan areas in California (the Los Angeles, Sacramento, San Diego, and San Francisco metropolitan areas) found that the proportion of households living below the poverty line was consistently higher in communities with diminished tree canopy coverage and increased levels of impervious surfaces. Similarly, the percent of people of color was also higher in neighborhoods with low tree canopy coverage and higher levels of impervious surfaces.[81] This suggests a higher risk for heat exposure in low-income communities of color in these California metropolitan areas—the same populations in California that have been shown to have diminished air conditioner access.[80]

The Urban Forest protocol would likely help to reduce the heat island effect. Trees planted in urban centers can reduce the impact of heat islands by replacing impervious surfaces that store heat with greened areas that absorb heat, and by providing shade. However, it is not possible to estimate the extent of the resultant health effects without extensive additional detail about the projects.

Economic and energy efficiency benefits

It has been found that up to 25% of a household's energy consumption can be saved by planting trees next to buildings.[82] Not only does this reduce reliance on fossil-fuel derived fuel sources, it can also reduce heating and electricity bills. This could alleviate financial stress on low-income or fixed income populations if urban forest projects are undertaken in these neighborhoods. As noted above, income and residential fuel costs have strong ties to health outcomes.[83] People already living within tight spending limits (paying more than 30% of income on house and related expenses) may particularly benefit from lower utility bills associated with properly planted trees.

Businesses may also benefit financially from having trees planted outside their establishments. Some research has indicated that consumers find businesses with trees outside more desirable and are willing to pay a higher price for products.[84] These benefits could also have positive financial benefits for the municipality.[85]

Reduced household and business energy consumption also reduces fossil fuel combustion, thus providing a second pathway through which urban forest may improve air quality.

Noise reduction

Noise in urban environments has become a health topic of concern worldwide. Urban noise (caused by traffic and other local sources) has been shown to increase levels of annoyance and stress, contribute to sleep disturbance, and over the long-term can increase the risk for

cardiovascular disease.[86 87] Excessive noise exposure can also contribute to cognitive impairment.[88 89]

The urban forests planted under the protocol may reduce urban noise levels. Several studies have indicated that urban plantings may decrease sound. One estimate suggests that 7db noise reduction is achieved for every 100 feet of forest, while another found that wide belts of trees and soft ground resulted in a 50% reduction in loudness.[90 91] This reduction may reduce levels of annoyance or irritation in certain population groups; however, the extent of health benefits cannot be estimated at this point.

Landslides, water quality, and fire risk

Forest vegetation, especially tree roots, can help stabilize hillsides and prevent landslides.[92] These benefits take effect very shortly after tree planting. By increasing forest cover in hilly urban areas common to California, the threat of landslides and the consequent potential for human injury and displacement may be reduced.

Urban forest can also improve water quality. Trees and other plantings reduce urban water run-off and increase ground infiltration, reducing sediment loads and harmful urban pollutants (such as metals, pesticides, organic pollutants, etc.) in urban streams. Their leaves improve ecological function when transported to urban streams and help reduce urban pollutants to less toxic forms.[93]

However, urban forests may increase the risk of fire in inhabited areas by increasing fuel loads. The type of tree planting used may have an impact on the risk of fire spread. Some types of trees are particularly flammable, such as pine and eucalyptus, while others are more resistant if fire breaks out.[94] Protocol mechanisms to reduce fire risk may limit health any potential health risks. Additional investigation into the fire hazard associated with different tree types and combinations will help minimize public risk.

Road safety

Trees planted in a strategic manner in urban areas have been shown to improve road safety and reduce vehicular and pedestrian morbidity. When trees are planted street side they give the impression of narrowing streets and encourage slower driving, while also providing a safety buffer between vehicles and pedestrians.[76]

Social benefits and mental health

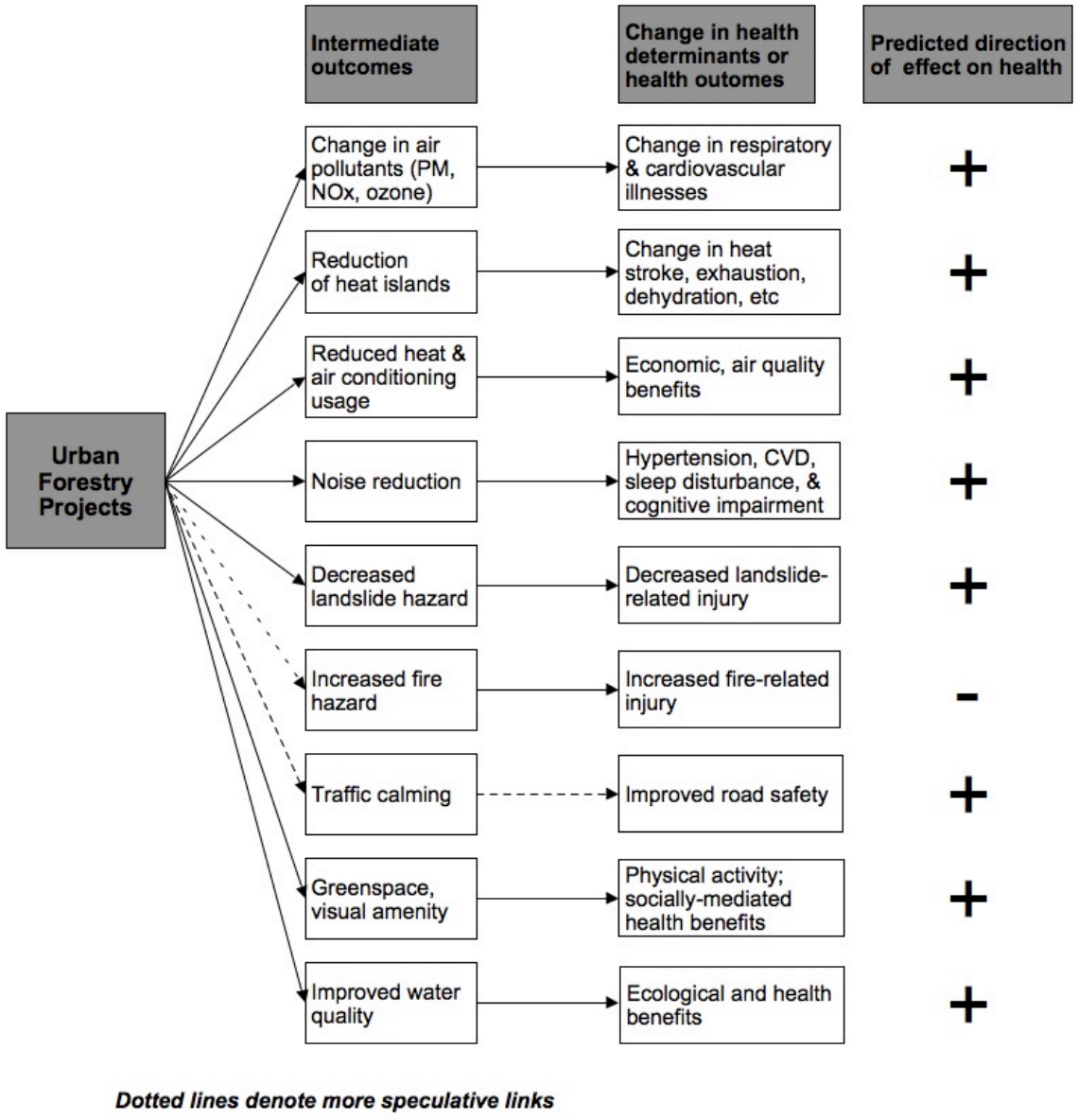
The urban forest protocol may also have wider social benefits in a number of realms that are difficult to measure but that have been documented in health-related literature. Planting trees in urban areas has been shown to have positive impacts on physical activity levels, mental health, sense of well-being, and social cohesion.[95] It has also been shown to reduce reported crime levels and increase feelings of safety.[85] These impacts can lead to altered physical health including changes in mood, self-esteem and blood pressure.[96] Wider benefits of community empowerment have been observed when community members are able to partake in tree planting planning and operations.[85]

There is a significant body of literature connecting green space with improved health outcomes. Views of green space can have dramatic impacts on people: improved worker productivity, reduced domestic violence, and shorter healing times.[97 98 99] Views of green space from home

are also linked to a greater sense of well-being and neighborhood satisfaction.[100] [101] And allowing children with attention deficit disorder (ADD) have access to green spaces has been found to relieve their symptoms and improve their ability to concentrate.[102]

The social benefits of urban tree planting and green space will accrue to the population groups that are able to access the increased greening as a personal or community resource.

Figure 6. Summary of potential health impacts of the Urban Forest Protocol



4.4.3 Conclusions for Urban Forest Protocols

Overall, the Urban Forest protocol will result in a net benefit to human health. Potential positive benefits include decreases in global health effects experienced as a consequence of

GHG emissions, reduced exposure to respiratory irritants such as NOx, ozone and PM, reduction in health impacts experienced from high city temperatures, and socially-mediated health benefits resulting from the provision of green space and visual amenity. The potential negative health impacts identified are allergenicity and an increased risk of fire; however, this may be reduced by selection of appropriate tree species, placement, care and maintenance.

It is not possible to quantify the health benefits that may be realized as a result of the urban forest protocol. However, there are approaches to urban forest projects that may improve the likelihood that human health co-benefits are fully realized. The following recommendations are intended to maximize the likelihood of potential benefits and minimize potential harms associated with the Urban Forest protocol.

- The location of urban forest plantings should be planned to:
    - Break up large impervious surfaces that reflect heat and cause heat islands;
    - Target California communities with diminished tree canopy coverage, especially amongst low-income and communities of color that are historically more susceptible to heat waves and live in areas with fewer trees;
    - Provide vegetative cover for unstable hillsides that may be prone to landslides;
    - Provide shade for buildings to improve cooling and reduce electricity bills; and
    - Shield population groups from unwanted noise sources (e.g. highways) and support traffic-calming measures.

- The types of trees planted should maximize the ability to filter air pollutants and minimize fire hazard and allergenicity.

- Planting of urban forests should benefit all population groups, and in particular target disadvantaged populations and neighborhoods that have inadequate tree canopy and lack green space.

4.5 Forest Project Offset Protocol

4.5.1 Regulatory Context

Forests are an important part of the ecosystem and a major contributor to the management of greenhouse gases. And forests play a significant role in reducing atmospheric carbon dioxide. The main mechanism is through carbon sequestration, a process that removes CO_2 from the air and transforms it into carbon that is stored in the tree's biomass (i.e. trunk, leaves, branches and roots). Carbon can also be stored in plants that grow on the forest floor and in the forest soils.[103]

Tree disturbance—which occurs from events such as forest fires, tree harvesting, pest infestation (like Pine Beetle) or disease—results in the release of CO_2 back into the atmosphere. The quantity and rate of CO_2 released depend on the nature of the disturbance.

Therefore, forests can either be a source of atmospheric CO_2 or a "sink", removing CO_2 from the atmosphere. Proper management of forests can play a significant role in addressing CO_2 contribution to climate change.[103]

The Forest Projects Offset Protocol (Forest protocol) outlines forest management and conservation practices that would be considered eligible under the cap-and-trade offsets program. Projects that would qualify under the new program include:

- Reforestation*: involves restoring tree cover on both private and public lands.*

- Improved Forest Management*: involves management activities that maintain or increase carbon stocks on private or public forested land by:*
    - *Increasing the overall age of the forest by increasing rotation ages;*
    - *Increasing the forest productivity by thinning diseased and suppressed trees;*
    - *Managing competing brush and short-lived forest species; and*
    - *Increasing the stocking of trees on understocked areas.*

- Avoided Conversion*: involves preventing the conversion of private forest land to a non-forest land use by dedicating the land to continuous forest cover. This may involve tree planting and harvesting.*

All projects must comply with sustainable harvesting practices and natural forest management. Sustainable harvest practice uses a variety of methods to ensure that harvest levels are sustainable over time and natural forest management ensures that a diversity of native species are utilized and maintained.

4.5.2 Forest and Health

In this section we discuss the potential health effects that may occur as a result of the Forest protocol. A summary of the effects is shown in Figure 7.

GHG emissions and air quality

As described in the Urban Forest protocol, forests have the ability to absorb carbon dioxide (thus reducing GHG levels) and to filter out air pollutants that can cause respiratory or cardiovascular problems.

Landslides, erosion, and fires

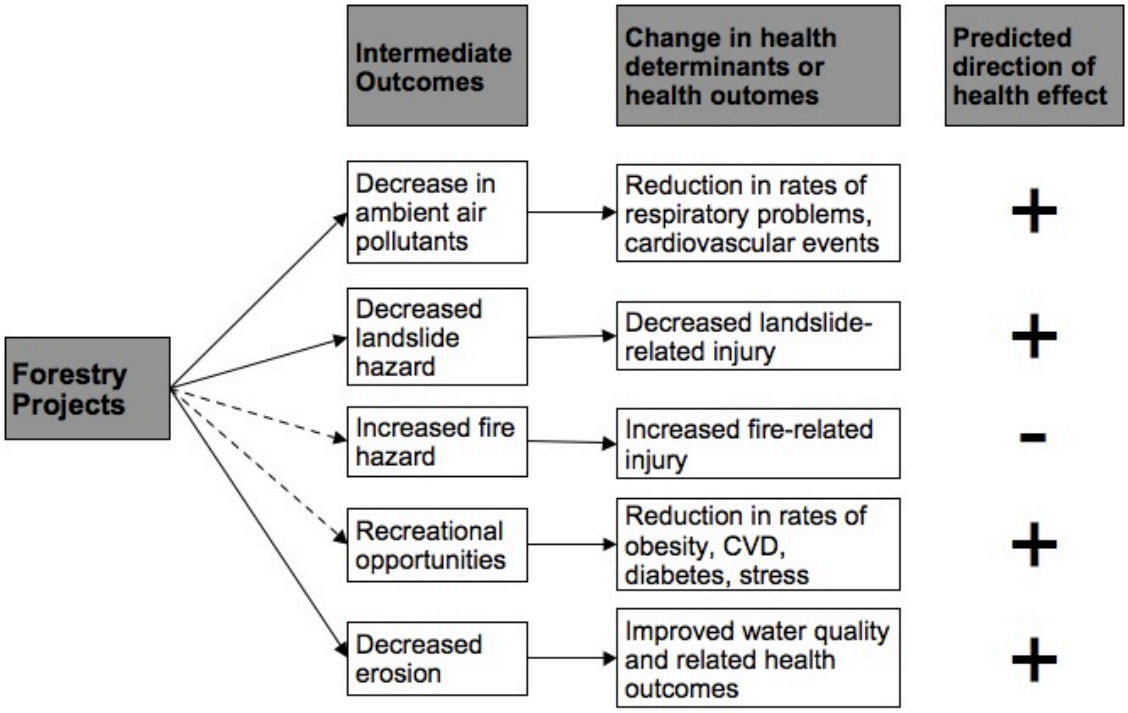
Also as discussed in the Urban Forest protocol, forests help stabilize hillsides and prevent landslides and erosion.[92] Preserving or increasing forest cover in hilly areas of California, the threat of landslides and the consequent potential for human injury and displacement may be reduced. Preventing erosion can have long-term positive effects on water quality. However, forests and increased fuel loads also bring a risk of fire. Forest management practices that proactively address the potential for fire will simultaneously address the associated health risks.

Recreation

The Forest protocol allows for projects on both public and private lands. The stipulation for public lands means that newly forested lands or maintained lands may provide for recreational areas for the general population. These recreational uses may result in increased rates, types, or accessibility of opportunities for physical activity. Recreational physical activity has many known health benefits including reduced rates of obesity, cardiovascular disease, diabetes, cancer and stress.[104]

The extent to which the Forest protocol will impact physical activity levels is unknown as the relationship between forests and physical activity levels is not well studied. However, if forests are maintained and created in a manner that is conducive to physical activity (e.g. incorporation of trail systems; easy accessibility to population centers) an increase in physical activity could result, with a positive impact on population. Attention to transit access to forests would allow those without private vehicles to access these resources

Figure 7. Summary of potential health impacts from the Forest Project Offsets Protocol



Dotted lines denote more speculative links

4.5.3 Conclusions for Forest Protocols

Overall, the Forest protocol may result in a net benefit to human health, with effects on a local and a global level. Potential positive benefits include decreases in global health effects experienced as a consequence of GHG emissions, improved air quality, improved water quality, and reduced landslide risk. However, forests do pose a fire hazard that must also be considered—in terms of injury and air pollution. Properly maintained forest stock should prevent increases in fire risk.

The following recommendation is intended to maximize the likelihood of potential benefits and minimize potential harms associated with the Forest protocol:

- Forest projects should consider providing incentives for the preservation of forests on publically accessible lands. Maximum benefits would accrue from recreation limited to human powered activities (as opposed to motorized activities) such as walking, hiking or biking trails.

4.6 Summary of All Offset Protocols

4.6.1 Cross-Cutting Issues

In addition to the protocol-specific effects described above, there are several issues that are common to the four offset protocols that may also affect the types or nature of health effects experienced. These include:

- Greenhouse gas emissions: The main intention of the cap-and-trade proposal is to reduce the emission of greenhouse gases. While this reduction will have significant benefits for the environment, there are human health benefits from the reduction of GHGs.

  As discussed earlier in Section 1.2, significant attention has been given to the effects of GHGs and climate change on human health.[105] Health effects pathways have focused on four main routes: extreme weather events; effects on ecosystems; sea-level rise; and environmental degradation. Each of these environmental effects has been shown to have varying health effects across the world including: deaths or illness resulting from floods, storms, cyclones and bushfires and their resulting impacts on food yields; food poisoning resulting from increased microbial proliferation; changes in infectious disease patterns; reduced crop, livestock and fishery yields causing impaired nutrition, health or survival; and loss of livelihoods or displacement from environmental degradation leading to poor mental health, infectious disease and physical risk outcomes. The extent and direction of impact is dependent on many factors including geographic location and vulnerability of populations.[105]

  In addition, a direct link has been shown between CO_2 emissions and health outcomes. Localized CO_2 emissions, in isolation, can contribute to increases in ozone and particulate matter, leading to small increases in mortality each year in California.[106]

  It is not possible to estimate the extent of health impacts due to GHG reductions from the four offset proposals.

- Verifying emissions reductions from offsets: As discussed in Section 1.4, emission reductions from offsets must be real, quantifiable, permanent, verifiable, and enforceable. If the regulation of offsets fails to meet these standards, the offset protocols will not meet broader program goals to reduce GHG emissions.

- Jobs and economic effects: All four protocols will result in new projects that are likely to provide jobs, and indirectly impact human health through this route.

  As discussed earlier, employment is an important determinant of health, both through impacts on income and on mental well-being and social connectivity. The provision of jobs that results from these protocols is likely to result in improved health outcomes for people who are employed by projects enabled by the offset rules. The extent to which job creation will occur as a result of these protocols is unknown and therefore the health impacts are unquantifiable. The impact will depend on factors such as the number of jobs created, the type of work (shift/full-time/part-time), and the work hazards faced by employees. However, all four offset protocols considered here do have the ability to impact health through this route. Job

creation can be used to maximize potential health benefits and minimize harms by targeting low-income groups and providing steady, stable and fairly-paid jobs.

- Equity and fairness: The offset protocols will all result in changes to physical and social environments that will not be evenly dispersed geographically or across the California population. Offset projects can be designed and located to improve conditions in low-income areas, while not exacerbating environmental stressors among those populations.

- Geographic distribution of health effects. Last, it is important to note that all of the offsets protocols can include projects both in California and outside California. California-based projects will reap positive co-benefits for Californians and potential positive health impacts that could be associated with implementing these protocols (e.g., job creation, improvement of the local environment, etc.).

4.6.2 Summary of Health Effects

All four of the offset protocols analyzed above are intended to reduce greenhouse gases, improve environmental conditions, and benefit human populations. As described in the four protocol analyses, a variety of human health effects can be anticipated as a result. Table 21 summarizes the most likely health effects that may occur from each of the protocols. An overall rating of the net benefit from each protocol is also provided.

Overall, urban forest is the offset protocol with the greatest number of health co-benefits. Urban forest, widely employed, has the potential to reshape California communities in a health promoting manner. Reductions in air pollution would benefit those living with asthma, improved pedestrian safety and green play areas would boost physical activity, and trees' cooling effect would pacify heat spells in urban areas.

Ozone depleting substances and methane digesters would likely have a net positive effect on health. Concerns have been raised regarding methane digesters and increases in nitrous oxide; but overall impacts are most likely positive. The forest protocol has the fewest immediate positive health effects. The recommendations discussed at the end of each section will be revisited in the conclusion of this report.

Table 21. Core anticipated health effects from offset protocols

Protocol	Likely positive health effects	Likely negative health effects	Overall health effect
Ozone Depleting Substances	• Reduced rates of diseases related to ultraviolet light exposure: melanoma, eye damage, immune function • Possible job creation	• Possible reduction in vitamin D exposure	Positive
Methane Digesters	• Decreased odor-related annoyance • Improved local air quality • Reduced water contamination • Possible job creation	• Possible increase in nitrous oxide exposure	Positive
Urban Forest	• Improved air quality and reduced rates of respiratory and cardiovascular health problems • Temperature moderation • Noise reduction • Visual amenity • Decreased risk of landslides • Improved water quality • Possible job creation	• Possible increased risk of human injury and respiratory illness due to fires • Possible increase in allergen exposure	Very positive impacts
Forest	• Improved air quality and reduced rates of respiratory and cardiovascular health problems • Decreased risk of landslides and resulting human injury • Decreased erosion maintains water quality • Possible job creation	• Increased risk of human injury and respiratory illness due to wild fires if not properly managed	Small positive impacts in the near-term; likely longer-term benefits

5. COMMUNITY HEALTH VULNERABILITIES, INVESTMENT OPPORTUNITIES, & IMPLICATIONS FOR REVENUE USE

5.1 Overview of Community Health Vulnerabilities

The implementation of AB 32 presents both opportunity and uncertainty for many of California's communities. Assembly Bill 32 and a cap-and-trade program can drive reductions in emissions, improve environmental quality, generate investments in California communities, and spur growth in clean technology and green jobs. However, there is concern that a cap-and-trade program could lead to emissions hot-spots in some communities, and that the program's benefits may not be distributed equitably, increasing existing health inequities in communities that are already highly impacted by environmental hazards.

In California, well-documented environmental inequities in low-income communities of color already exist.[107] [108] [109] [110] Environmental burdens, when coupled with other health determinants —such as low educational attainment rates, poverty, and limited neighborhood resources— decrease community resiliency and contribute to inequities in health outcomes in these vulnerable communities. If environmental or economic burdens were to result from a cap-and-trade program in California, these would likely exacerbate existing conditions for the State's most vulnerable communities.

California's Global Warming Solutions Act of 2006 specifies that the implementation of the bill must not disproportionately impact California's most vulnerable communities; it states that the ARB shall:

- "ensure that activities undertaken to comply with the regulations do not disproportionately impact low-income communities" {CHSC §38562(b)(2)};
- "ensure that the greenhouse gas emission reduction rules, regulations, programs, mechanisms, and incentives under its jurisdiction, where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California and provide an opportunity for small businesses, schools, affordable housing associations, and other community institutions to participate in and benefit from statewide efforts to reduce greenhouse gas emissions" {CHSC §38565}; and
- "consider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution" {CHSC §38570 (b)(1)}.[10]

Any potential environmental and economic impacts from the cap-and-trade program will vary from one community to the next, and there is limited ability to predict these local impacts because of scarce local level data and an inadequate ability to accurately predict or model local impacts related to cap-and-trade. However, as discussed earlier in Section 2.3.3, there is community concern regarding the potential for emissions "hot spots", variable and potentially inequitable reductions in co-pollutants, and adverse local and household economic impacts. To assess community vulnerabilities associated with this uncertainty, CDPH:

1) Surveys the variety of existing environmental conditions and health concerns in two California communities which are highly impacted by stationary emissions;
2) Surveys the broad environmental and health risks in the Central Valley;
3) Identifies the potential for the implementation of a cap-and-trade program to impact health; and

4) Recommends a series of steps that can be taken to monitor impacts going forward.

The Wilmington-Harbor City-San Pedro neighborhoods in Los Angeles County and the City of Richmond in Contra Costa County are both communities with a well-documented history of industrial pollution and health inequities, and have rich local health data available. The third case study focuses on the San Joaquin Valley region, because adequate local level health data for smaller communities are not available.

The community case studies are neither detailed nor comprehensive needs assessments. They provide an overview of existing health status, needs, and social, environmental, and economic health determinants and risks in vulnerable communities to help inform potential strategies to ensure that, as required by law, those in the most disadvantaged communities benefit from the implementation of cap-and-trade and other GHG emission reduction strategies.

5.1.1 Environmental Health Risks and Vulnerable Communities

Low-income communities and communities of color in California are disproportionately impacted by environmental exposures and have a greater susceptibility to the negative health impacts of environmental risks because of existing health and socioeconomic vulnerabilities.[111] Such communities are often called "environmental justice communities". Environmental justice is defined by the U.S. Environmental Protection Agency (EPA) as:

> "The fair treatment and meaningful involvement of all people regardless of race, color, national origin, culture, education, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair Treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal environmental programs and policies."[112]

A core goal of environmental justice is to eliminate and reduce environmental health inequities—the excessive health burden that some communities experience as a result of disproportionate environmental risks. These environmental health inequities are exacerbated by chronic stressors such as poverty, racial segregation, high crime, and lower quality schools and housing.[113] Thus, it is crucial to address both social vulnerabilities and environmental health risks when considering public health in the most vulnerable communities.[114]

The U.S. EPA describes the four properties of a vulnerable community as:

- Susceptibility of individuals;
- Differential exposures to health risks;
- Differential preparedness to withstand the environmental stressor; and
- Differential ability to recover from the effects of the stressor.[115]

Because of discrepancies in susceptibility, exposure, preparedness, and responsiveness, underlying vulnerability can increase the health effects resulting from exposure to environmental health risks in environmental justice communities. Improving upon these four traits can reduce a community's vulnerability and increase their resiliency to health risks, improving health outcomes.[111]

Additionally, a neighborhood's physical and social environment profoundly impacts the community's health and shapes their vulnerability profile. Healthy neighborhoods have access to unpolluted air and clean water, reliable public transit, nutritious foods, parks and other recreational areas, and high quality housing. These resources, as detailed below, are essential for promoting public health and improving community resiliency.

Air pollution, environmental contaminants, and health

Many major sources of air pollution—such as freeways, power plants, oil refineries, seaports, airports, and chemical manufacturers—are often located in and adjacent to low-income and minority communities. As a result, hazardous particulate matter, mercury, sulfur dioxide, nitrogen oxides, and other toxic air contaminants are often disproportionately high in low-income communities of color.[116] [117] Breathing polluted air leads to asthma and respiratory illnesses, cardiovascular disease, cancer, impaired neurological development, low birth weights, and miscarriages.[118] And other environmental contaminants have been linked to the development of conditions such as diabetes and obesity: persistent organic pollutants can induce genes which affect insulin production and exposure to environmental estrogens around the time of birth may affect the risk of obesity later in life.[119] [120] These problems can be exacerbated by poverty, poor quality housing, and insufficient health care access in these communities.

Access to neighborhood resources

A community's access to everyday amenities can promote public health. A "complete" neighborhood—characterized by a mix of residential and commercial uses with easy access to reliable transit, a variety of food, retail, and service options, and parks and public spaces—provides residents with resources necessary to pursue healthy and active lives. Complete neighborhoods encourage active transportation as a form of regular exercise and offer broad health benefits.[121] [122] [123] Simple physical activity, including walking as a method of transportation, is associated with reductions in premature mortality and the prevention of chronic diseases such as diabetes and hypertension, and improvements in mental well-being.[124] [125] [126]

Accessible public transit can reduce air pollution and encourage more physically active forms of transportation. Americans who use public transit have been found to be more physically active, spending a median of 19 minutes each day walking to and from transit.[127] A U.S. study found that each additional hour spent in a car each day was associated with a 6% increase in the likelihood of obesity, and that each additional hour walked each day is associated with a 4.8% reduction in the likelihood of obesity.[124] For low-income residents who do not own automobiles, accessible and affordable mass transit is necessary for most daily activities such as getting to work, taking children to school or childcare, buying daily necessities, and obtaining timely medical care.

Residential proximity to grocery stores improves access to and the consumption of healthy food.[122] [128] But many low-income neighborhoods lack full service grocery stores. Smaller retail food stores charge about 10% more for products than supermarkets and usually offer more processed foods and limited or no fresh produce. In the absence of a full-service supermarket, low-income residents have little choice but to buy less expensive but more accessible calorie-dense foods at fast food restaurants or corner stores.[129] These cheap, nutrient-poor foods increase the risk obesity in low-income populations.[130] Diet-related disease is one of the top

causes of preventable deaths among Americans, and the burden of obesity falls disproportionately on low-income populations. [131] [132] Access to at least one large neighborhood supermarket may improve the nutritional health of low-income communities.

According to the Centers for Disease Control, access to safe local parks and public spaces for physical activity results in 25% more people exercising three or more days a week.[133] Inadequate physical activity is a risk factor for obesity, heart disease, cancer, diabetes, osteoporosis, and depression. Parks provide reprieve from everyday stressors, and can improve health by reducing stress, alleviating depression, and improving one's ability to focus.[134] And children with neurobehavioral disorders function better following activities in green settings.[135] In contrast, people dissatisfied with their available green spaces have 2.4 times higher risk for mental health issues.[136] Trees and vegetation also mitigate air pollution and decrease the heat island effect in urban areas.[137]

5.1.2 Assessment of Community Health Vulnerabilities

The community case studies that follow assess key social and environmental determinants that shape a community's health, as well as health outcomes (Table 22). The indicators utilized are not exhaustive, but include health determinants that impact a wide range of health outcomes and outcomes that are representative of community health status. Comparisons to the county and State health data are made where feasible to assess health inequities and highlight local and county health needs.

Table 22. Selected community health indicators

Community health outcomes	Community characteristics & neighborhood resources	Indicators of environmental quality
• Leading causes of mortality • Prevalence of obesity / overweight, diabetes, heart disease, high cholesterol & blood pressure, smoking, asthma • Rate of low birth weight* • Rates of physical activity • Percent of persons without health insurance	• Availability of parks and recreational spaces • Density of fast food restaurants • Perceptions of neighborhood safety • Number of hospitals • Poverty	• Number of toxic release inventory (TRI) facilities, hazardous sites, major greenhouse gas emitting facilities, and leaking underground storage tanks (LUSTs) • Pounds of pesticides released • Location of sensitive receptors near hazardous land uses[§] • Number and percent of population living near busy roadways • Air quality

* A low birth weight infant is defined as an infant born weighing less than 5.5 pounds or 2,500 grams, regardless of gestational age.
[§] Sensitive receptors are defined as children and senior citizens.

5.1.3 Methods for Community Assessment

Data were obtained from a variety of publicly available sources, and directly from the Los Angeles County Department of Public Health for the Wilmington-Harbor City-San Pedro-Port of Los Angeles communities (WHCSPP). Appendix A provides a detailed list of all data sources used in the WHCSPP and Richmond case studies. Generally, data can be grouped into demographic and spatial data from the U.S. Census, environmental information from California state agencies and the U.S. Environmental Protection Agency, and health data from the State and county departments of public health. Health outcomes were included at the city or neighborhood level

whenever available. Because community-level health outcome data are often limited, some estimates are statistically unstable and are so noted when appropriate.

The Wilmington-Harbor City-San Pedro neighborhoods are incorporated communities within the City of Los Angeles. This analysis utilizes the Community Plan Area designations for Wilmington, Harbor City, San Pedro, and the Port of Los Angeles.[138] Many hazardous sites fall within Wilmington. Harbor City and San Pedro were included in the analysis because of their close proximity to the same environmental hazards and to allow for a larger sample size of community health outcomes and more stable health outcome estimates. This area includes census tracts 294000 through 297999 and zip codes 90744, 90710, 90732, and 90731.

The City of Richmond is defined as those block groups that have their centroids in the city boundaries defined in the US Census TIGER/Line place designations. In addition, "best fit" zip codes for Richmond and include 94530, 94801, 94803, 94804, 94805, and 94806. For a list of census tracts and block groups used to define Richmond, please refer to Appendix A.

The analysis was conducted using ArcGIS software, version 9.3.1, from Environmental Systems Research Institute (ESRI) (http://www.esri.com). Locations of environmental hazards, sensitive receptors, and neighborhood resources are geo-coded from their addresses of record using Batchgeo (http://www.batchgeo.com/). Locations of hazards, sensitive receptors, and neighborhood resources are included and enumerated if they fell within city, community, or county designations.

Areal interpolation of demographic data from the 2000 U.S. Census was utilized to define impact areas. Generally, areal interpolation is weighted by area, using geography data and the counts of the data to be interpolated. The intersection zone included within the buffers is assigned a fraction of its respective source zone's count corresponding to the proportion of the source zone's area occupied by the intersection zone. Area weighted interpolation assumes that there is no internal variations in count density.[139] Areal interpolation was utilized to determine the number and percentages of people residing close to a major roadway and percentages of people living within a defined distance to neighborhood resources.

5.2 The Wilmington-Harbor City-San Pedro (WHCSP) Community

Wilmington and the surrounding communities of San Pedro and Harbor City are highly industrialized neighborhoods in the South Bay region of Los Angeles County. The Wilmington-Harbor City-San Pedro area (WHCSP) has historically been an environmental justice community faced with high levels of air pollution—the area is adjacent to a major port, home to several large industries, and bisected by major roadways and interstates. Wilmington is also home to six refineries that accounted for over 607,000 pounds of toxic chemical releases in 2008 alone.[140] The physical parameters of this area are shown below (Map 1).

The WHCSP area, like LA County as a whole, is a diverse community. The area is linguistically and ethnically diverse, with residents of all income levels. When compared to LA County, many demographic metrics are similar, but a higher percentage of WHCSP residents are Hispanic or Latino, are economically less well off, and have less than a high school education (Table 23).

Map 1. Los Angeles County and the WHCSP community

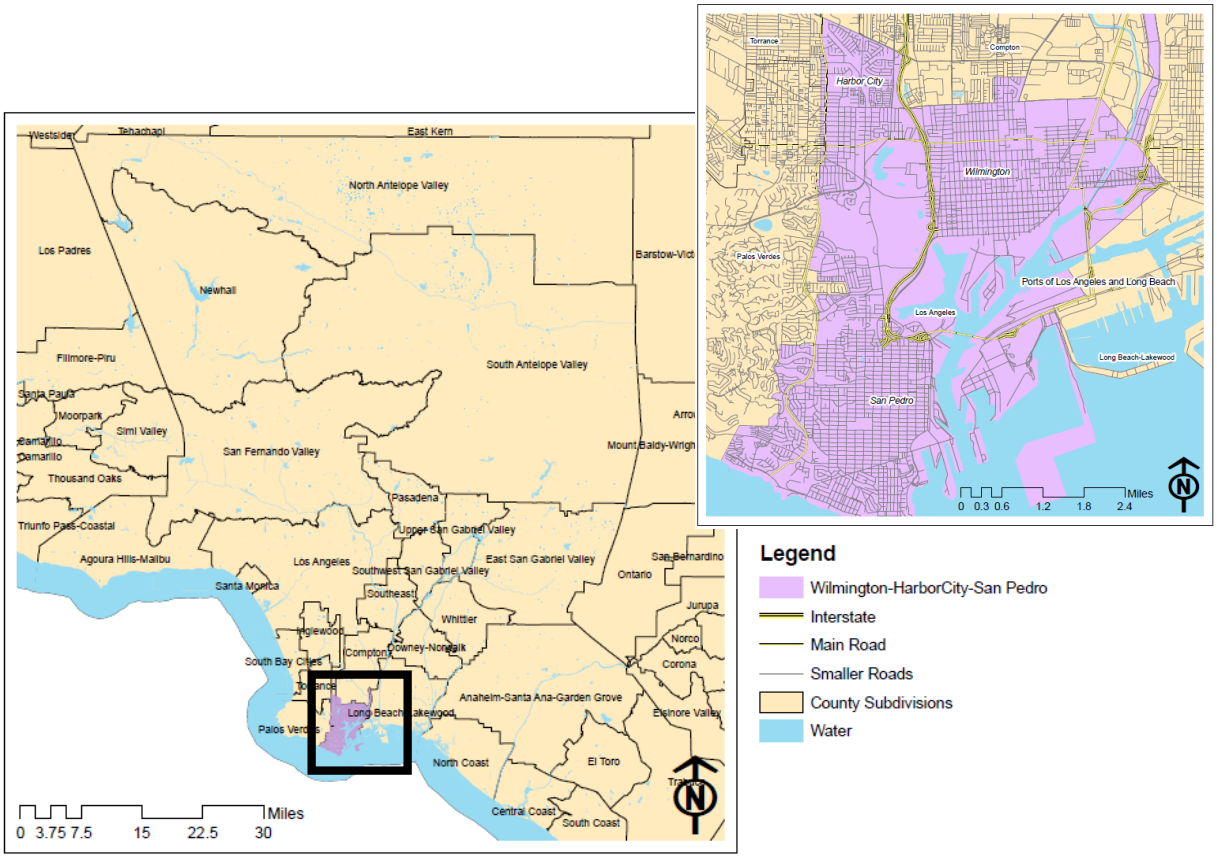


Table 23. Demographic characteristics of WHCSP compared to Los Angeles County (source: US Census 2000)

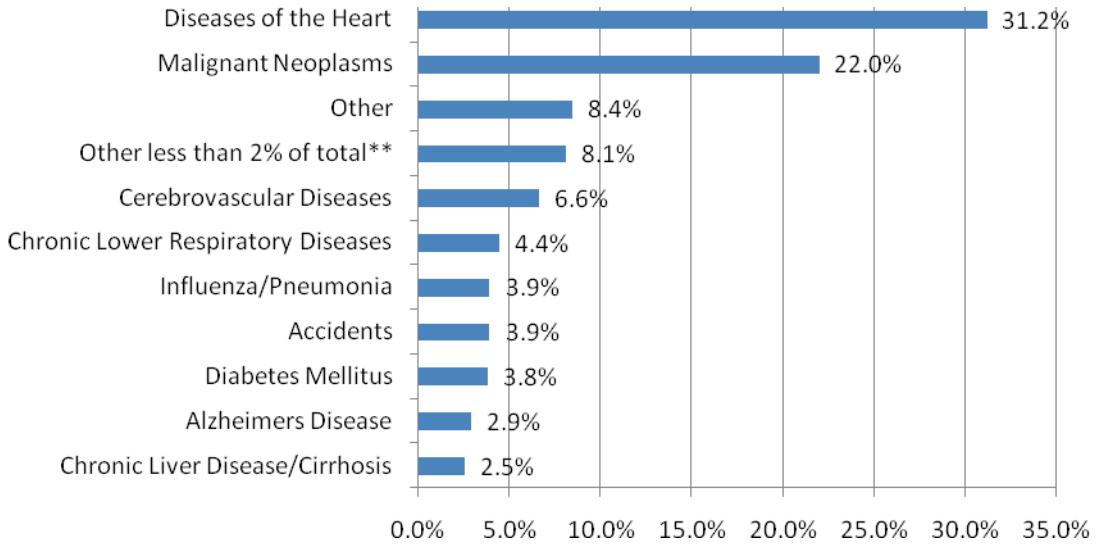
	WHCSP	LA county	California
Linguistically isolated households[xiii]	15%	15%	10%
Hispanic or Latino population	56%	45%	32%
People of color[xiv]	71%	69%	53%
Households with public assistance income	7%	6%	4.9%
Families at or below 200% of poverty	53%	49%	47%
Median household income	$39,105	$42,189	$47,493
Population 65 years old and older	9%	10%	11%
Population 5 years old and younger	10%	9%	9%
Population in rental housing	58%	50%	42%
Population 25+ years old with less than high school education	35%	31%	23%

[xiii] A household is linguistically isolated if no one in the household aged 14 or over speaks English very well.
[xiv] People of color defined as people who identify as a non-White race and/or of Hispanic or Latino origin.

5.2.1 Community Health Outcomes

Like many California communities, heart disease is the leading cause of all-cause mortality and premature death in the WHCSP area, accounting for nearly a third of all deaths (Figure 8). Heart disease is a larger proportion of all-cause mortality in WHCSP in comparison to LA County[xv] (Table 24).[141 142] Cancer is the second leading cause of mortality; and homicide is the second leading cause of premature mortality[xvi] in the Harbor Health District[xvii] and LA County in 2006 (Table 25). Heart disease and cancer have many underlying causes, including diet, exercise, pollution, and stress.[143] Exposure to violence or the threat of violence increases stress, and decreases one's willingness to go outside to play, exercise, or socialize—all health promoting activities.[144] Collectively, these impacts can contribute to increased rates of obesity, diabetes, and heart disease.

Figure 8. Distribution of mortality due to all causes stratified by underlying cause in WHCSP, 2007 (source: LA County DPH)*



*Counts of less than 5 observations are suppressed.
**"Other less than 2% of total" are causes of death that individually made up less than 2% of total mortality and include homicide, hypertension, nephritis/nephrotic syndrome, nephrosis, Parkinson Disease, suicide, congenital malformations, and perinatal conditions.

[xv] Comparisons to county level data are made in order to highlight health disparities communities may face. However, entire counties may experience less healthy social and physical environments that can contribute to poor health outcomes. The comparisons highlight potential health priorities whenever the communities fare much worse than the county, and can highlight health priorities for a county as a whole.
[xvi] Premature mortality is death before the age of 75.
[xvii] The WHCSP is located within the Harbor Health District, a service planning area for the County of Los Angeles Department of Public Health.

Table 24. Leading causes of all-cause mortality in WHCSP (2007) and LA County (2006) (source: LA County DPH)

Rank	WHCSP		LA County	
1	Heart disease	31.2%	Heart disease	25.0%
2	Cancer	22.0%	Cancer	23.0%
3	Cerebrovascular diseases	6.6%	Cerebrovascular diseases	6.0%
4	Chronic lower respiratory diseases	4.4%	Chronic lower respiratory diseases	4.5%
5	Accidents	3.9%	Pneumonia/ influenza	3.7%
	Influenza	3.9%		

Table 25. Leading causes of premature death in Harbor Health District and LA County, 2006 (source: LA County DPH)

Rank	Harbor Health District	LA County
1	Heart disease	Heart disease
2	Homicide	Homicide
3	Motor vehicle crash	Motor vehicle crash
4	Suicide	Liver disease
5	Liver disease	Suicide

Adult obesity prevalence is high in the WHCSP community and nearly twice the target rates established by Healthy People 2010 (Table 26). Obesity and overweight are risk factors for diabetes and heart disease. Similarly, many residents suffer from high cholesterol and high blood pressure, and 15% remain uninsured. These rates are compared to the Center for Disease Control's Healthy People 2010 Targets when applicable.[145] Currently, physical activity measures in WHCSP and LA County are the only health indicators to meet and exceed CDC Healthy People 2010 targets.

Los Angeles County ranked 54th out of 58 counties in low birth weight percentage statewide.[146] Neither WHCSP nor LA County meets the low birth weight target of 5% (Target 16-10a) set by Healthy People 2010. Exposures to air pollution during pregnancy have been shown to have detrimental effects on preterm birth, fetal growth and development, and birth weight; and risk for low birth weight may be compounded by excess social and environmental stress in environmental justice communities such as WHCSP.[147] [148] [149]

Table 26. Health risks and outcomes and CDC Healthy People 2010 goals (source: LA County DPH, CDPH, and CDC)

Health outcome indicator	WHCSP prevalence	LA County prevalence	CDC Healthy People 2010 target	Healthy People 2010 target met
Physical activity guidelines met among adults	61%	53%	Target 22-3: 30%	✓
Obesity among adults	29%	22%	Target 19-2: 15%	X
Overweight among adults	40%	36%	NC	NC
Diabetes among adults	10%	9%	NC	NC
Heart disease among adults	8%	8%	NC	NC
High cholesterol among adults	30%	29%	Target 12-14: 17%	X
High blood pressure among adults	24%	24%	Target 12-9: 16%	X
Cigarette smoking among adults	14%	14%	Target 27-1a: 12%	X
Asthma among children	6%	8%	NC	NC
Low birth weight infants	6%	7%	Target 16-10a: 5%	X
Health insurance coverage among adults*	85%	81%	Target 1-1: 100%	X
Health insurance coverage among children*	95%	93%	Target 1-1: 100%	X

NC = no comparable target for health outcome indicator measured
* Harbor Health District numbers taken from the 2007 LA County Healthy Survey
X = non-attainment of Health People 2010 Target

5.2.2 Characteristics of Social Vulnerability and Access to Neighborhood Resources

Residents in the WHCSP area may be more vulnerable to a variety of health outcomes due to poorer economic standing, social isolation, and fewer educational opportunities. Residents of WHCSP have a higher likelihood of not completing high school, and families within WHCSP are more often at or below 200% of the federal poverty level (Table 23). Additionally, the majority of WHCSP's residents are people of color—56% identify as Hispanic or Latino—and may experience the additional stress and social isolation associated with discrimination. In WHCSP and LA County, 15% of households are linguistically isolated.

Linguistic isolation imposes language and cultural barriers that can negatively impact one's ability to respond and adapt to environmental health risks.[150] People with limited or no English proficiency may be less able to secure consistent work, face a higher risk for unemployment and poverty, and be more vulnerable to negative health outcomes. Linguistic isolation may also serve as a barrier to social participation and civic engagement.

Civic engagement is an important indicator for people's ability to advocate for themselves within defined institutions and to organize as a community. Civic engagement can augment one's sense of control over life; this increased sense of control positively impacts cardiovascular health.[151] Voter turnout is a direct measurement of participation in government. In WHCSP,

65% of registered voters cast ballots in the 2000 general election, fewer than in LA County and California (Table 27).

Table 27. Voter turnout for the 2000 general election

	WHCSCP	LA County	California
Percent voter turn out	65%	68%	71%

Source: data compiled from CA Secretary of State and/or various county governments and was subsequently reworked into the "Statewide Database" maintained by Berkeley Law, Center for Research http://swdb.berkeley.edu/about.html.

Public health is also impacted by diverse neighborhood characteristics—such as park space, healthy food access, and a community's perception of safety. As discussed earlier, the built environment and other neighborhood characteristics can greatly affect physical activity, mental health and social interactions, nutrition, and subsequent health outcomes such as obesity and diabetes.[152] [153] [154] Proximity to parks can impact physical activity patterns, and access to healthy foods can improve community nutrition and health.[155] [156] Currently, 34% of WHCSP residents live within a quarter mile of a park or recreational area. As shown in Table 28, WHCSP contains 747 acres of parks and recreational areas—or about five acres per 1,000 residents. The City of Los Angeles, in comparison, has nearly two-fold park acreage for every 1,000 people.

Table 28. Distribution of parklands in WHCSP, LA City, and LA County (source: US census/TIGER Line)

	WHCSP	LA City	LA County
Park and rec acreage*	747	20,298	705,797
Percent of land	4.9%	11.8%	27.2%
Acres per 1,000 residents	4.7	8.2	74.1

*Park and recreational areas is defined as MTFCC K2180-90 and K2561 (parks, beaches, golf courses, and recreational facilities). Areal interpolation of 2000 Census Block Group data was used to determine the number of people living within a quarter mile of a park or recreational area.

WHCSP has a higher density of fast food restaurants compared to LA County as a whole (table 29), and 46% of residents in the Harbor Health District reported eating at fast food restaurants at least once a week compared to 40% of LA County residents.[157] The presence of many fast food restaurants has been associated with poor health outcomes, including increased rates of obesity, diabetes, and poor cardiovascular health.[158] [159] [160]

Table 29. Density of fast food restaurants in WHCSP and LA County

	WHCSP	LA County
Total	76	5,714
Fast food restaurant density (restaurants per 1,000 acres)	4.9	2.2

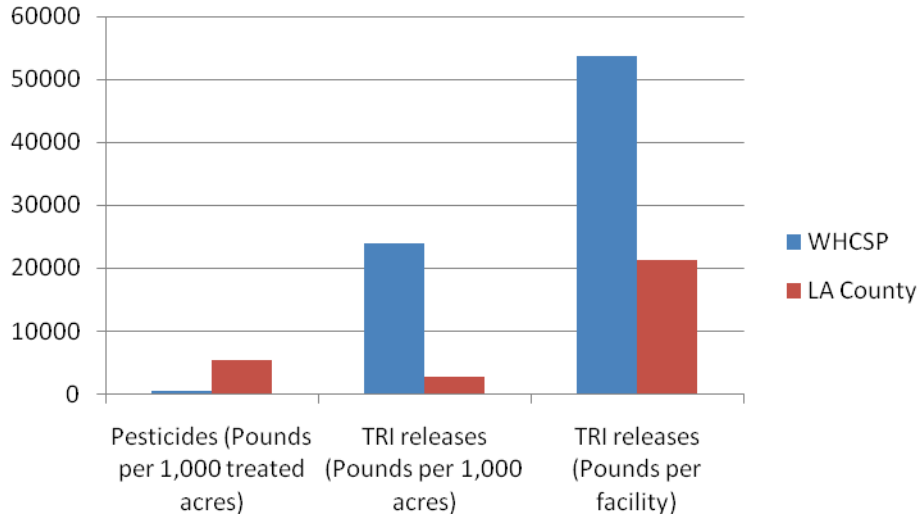
Source: CA DPH Network for a Healthy California GIS Map Viewer and 2000 Decennial Census, American FactFinder.
Fast food restaurant is defined as an eating outlet categorized as fast food chain, pizza chain, or subs/ deli/ sandwich chain.

In addition, negative perceptions of neighborhood safety increase stress, hinder access to neighborhood amenities such as parks, and may limit access to physical activity. In the Harbor Health District of LA County, over 80% of respondents report positive perceptions of neighborhood safety—rates similar to LA County. The vast majority of respondents describe their community as safe and physical activity levels are higher relative to LA County, but mental health and physical well-being may be negatively impacted for those with neighborhood safety concerns.[161] [162]

5.2.3 Environmental Health Risks in WHCSP

The WHCSP is a residential community with a variety of environmental burdens, including busy roadways, one of the largest port complexes in the world, and many industrial land uses. Approximately 31% of the Wilmington-Harbor City Community Planning Area is used for industrial purposes, equaling to 2,044 total net acres.[163] WHCSP had more pounds of toxic releases per 1,000 acres and per facility than LA County in 2008 (Figure 9), and contains more toxic release facilities, hazardous sites, and leaking underground storage tanks (LUSTs) per 1,000 acres than LA County as a whole.[xviii] And though WHCSP is only 1.7% of the LA County's population and less than 1% of its total land area, WHCSP houses over 4% of the county's hazardous sites and toxic release inventory facilities (Table 30).

Figure 9. Pesticides and Toxic Releases in WHCSP and LA County



Source: data from CA Department of Pesticide Regulation Pesticide Use Reporting and US EPA Toxic Release Inventory. Pesticide usage includes all reported uses of any pesticides in 2008. In 2008, there were 14 TRI facilities in WHCSP and 334 in LA County.

[xviii] Toxic release facilities include manufacturing, metal and coal mining, electric utilities, commercial hazardous waste treatment, petroleum terminals, chemical distributors, and solvent recovery services. Hazardous site is defined as a federal superfund site, state response site, voluntary cleanup site, school cleanup site, correct active site, operating hazardous waste facility, post-closure hazardous waste facility, and non-operating hazardous waste facility. Refer to the California Department of Toxic Substances Control's website for more information (http://www.envirostor.dtsc.ca.gov/public/).

Table 30. Environmental Hazards in the WHCSP area and LA County

Environmental hazards	WHCSP	LA County	Percent of all County sites located in WHCSP
Hazardous sites	43	933	4.6%
Toxic release inventory facilities	14	334	4.2%
Leaking underground storage tanks	36	2,111	1.7%

Source: EPA Toxic Release Inventory, CA Department of Toxic Substances Control Envirostor, CA State Water Resources Control Board GeoTracker

WHCSP also suffers from racial disparities in environmental burdens. According to research conducted on major greenhouse gas-emitting facilities in California, eight of the top ten as ranked by the Pollution Disparity Index[xix] are located in LA County.[164] Wilmington contains three of the top ten facilities as ranked by a health impact index[xx] (Table 31).

Table 31. The top 10% of California's greenhouse gas-emitting facilities by health impacts index

Rank	Facility name	City	Health impacts index
1	ExxonMobil Torrance Refinery	Torrance	54.4
2	***Tesoro Wilmington Refinery****	***Wilmington***	***50.0***
3	***BP Carson Refinery****	***Carson***	***46.3***
4	Chevron El Segundo Refinery	El Segundo	41.2
5	***ConocoPhillips Wilmington Refinery****	***Wilmington***	***30.3***
6	Shell Martinez Refinery	Martinez	27.1
7	Valero Benicia Refinery	Benicia	19.1
8	Mountainview Power Plant	San Bernardino	17.5
9	Chevron Richmond Refinery	Richmond	17.3
10	California Portland Cement Company Colton Plant	Colton	14.1
11	Paramount Refinery	Paramount	13.8
12	***Valero Wilmington Refinery****	***Wilmington***	***13.0***
13	Cemex Victorville/White Mountain Quarry	Apple Valley	12.5
14	Tesoro Golden Eagle Refinery	Martinez	12.1
15	Etiwanda Generating Station	Rancho Cucamonga	11.1

Source: Table reproduced from "Minding the Climate Gap" (2010): http://college.usc.edu/pere/documents/mindingthegap.pdf.
* Facilities either located in WHCSCP or within 2.5 miles of WHCSP.

[xix] The Pollution Disparity Index measures the relative co-pollutant burden on communities of color. If the pollution disparity index is added up across all facilities in the state, the result is equal to the statewide difference in average PM10 emissions burden between people of color and non-Hispanic whites. See the "Minding the Climate Gap" for details: http://college.usc.edu/pere/documents/mindingthegap.pdf.

[xx] Health impacts index calculations quantify each facility's NOx and PM2.5 emission impacts on premature mortality in the region. For more information on how the health impacts index was calculated, refer to the "Minding the Climate Gap" report, and the NRDC's "Boosting the Benefits: Improving Air Quality and Health by Reducing Global Warming Pollution in California".

The South Coast Air Quality Management District (SCAQMD) estimated the overall cancer risks from air pollution in the South Coast area to be 1,200 in a million and among the highest in the nation. The Ports of Los Angeles and Long Beach are large local sources of diesel emissions in the South Coast area.[165] Cancer risk increases in relation to port proximity; residents nearest the ports have a maximum lifetime cancer risk of up to 2,900 in a million. Wilmington had one of the highest cancer risks compared to the other study sites, and diesel particulate matter (PM) is a major contributor to air toxics risk and accounts for 84% of the total cancer risk.[166]

Sensitive receptors, including the elderly and children, are at greatest risk to pollution exposure. The ARB and SCAQMD recommend siting schools greater 500 feet from busy roadways. And the SCAQMD recognizes that safety buffers as much as 1,000 feet may be considered health protective for students and school employees.[167] [168] California Senate Bill 352 states the school district must determine if air quality at the site poses a significant health risk to pupils if a proposed school site boundary is within 500 feet of busy roadway.[169]

Over 25% of WHCSP residents live close to a busy roadway (Table 32). And several sensitive receptor sites are situated within 500 feet of an environmental hazard (Table 33). Individuals in these facilities face greater exposures to vehicular pollution and other environmental toxins.

Table 32. Proportion of population living within 1,000 feet of busy roadways (source: US Census& TIGER/Line)*

	WHCSP	LA County
Numbers	40,622	2,271,565
Percent of population	26%	24%

Estimates were made using areal interpolation.

* Busy roadway is defined as a primary or secondary road (MTFCC classification S1200 and S1100).

Table 33. Percent of sensitive receptors within 500 feet of hazardous land uses

	Major Roads		Port		Toxic Release Facility	
	WHCSP	LA County	WHCSP	LA County	WHCSP	LA County
Public schools	8%	10%	0%	0%	0%	<1%
Child care facilities	18%	16%	2%	*	0%	<1%
Senior residences	11%	14%	0%	0%	0%	0%

Source: CA Department of Education and CA Department of Social Services. Senior residences are categorized as Residential Care Facilities for the Elderly by the CA Department of Social Services. Public schools are active or merged schools, grades preschool—12th grade. Child care facilities are licensed facilities registered with the CA Department of Social Services.

Race and income characteristics are also associated with residential proximity to major roadways, and low-income communities of color are disproportionately exposed to air pollution from vehicular emissions.[170] A higher proportion of people of color live within 1,000 feet of a busy roadway in the WHCSP community as compared to LA County—28% in WHCSP compared to 20% in LA County.[xxi]

[xxi] Sources of data: 2000 US Census American FactFinder and US TIGER/Line. Person of color is defined as someone who identifies as Hispanic or Latino and/or Non-White. Estimates were made using areal interpolation.

5.2.4 Summary of Health Risks from Wilmington-Harbor City-San Pedro

Wilmington-Harbor City-San Pedro residents have high rates of obesity and diabetes compared to LA County and do not meet many of the CDC's Healthy People 2010 targets. The health challenges faced by the community are impacted by overlapping health risks and a variety of social and economic hardships. Together, these challenges may modify the community's ability to respond or adapt to environmental health risks.

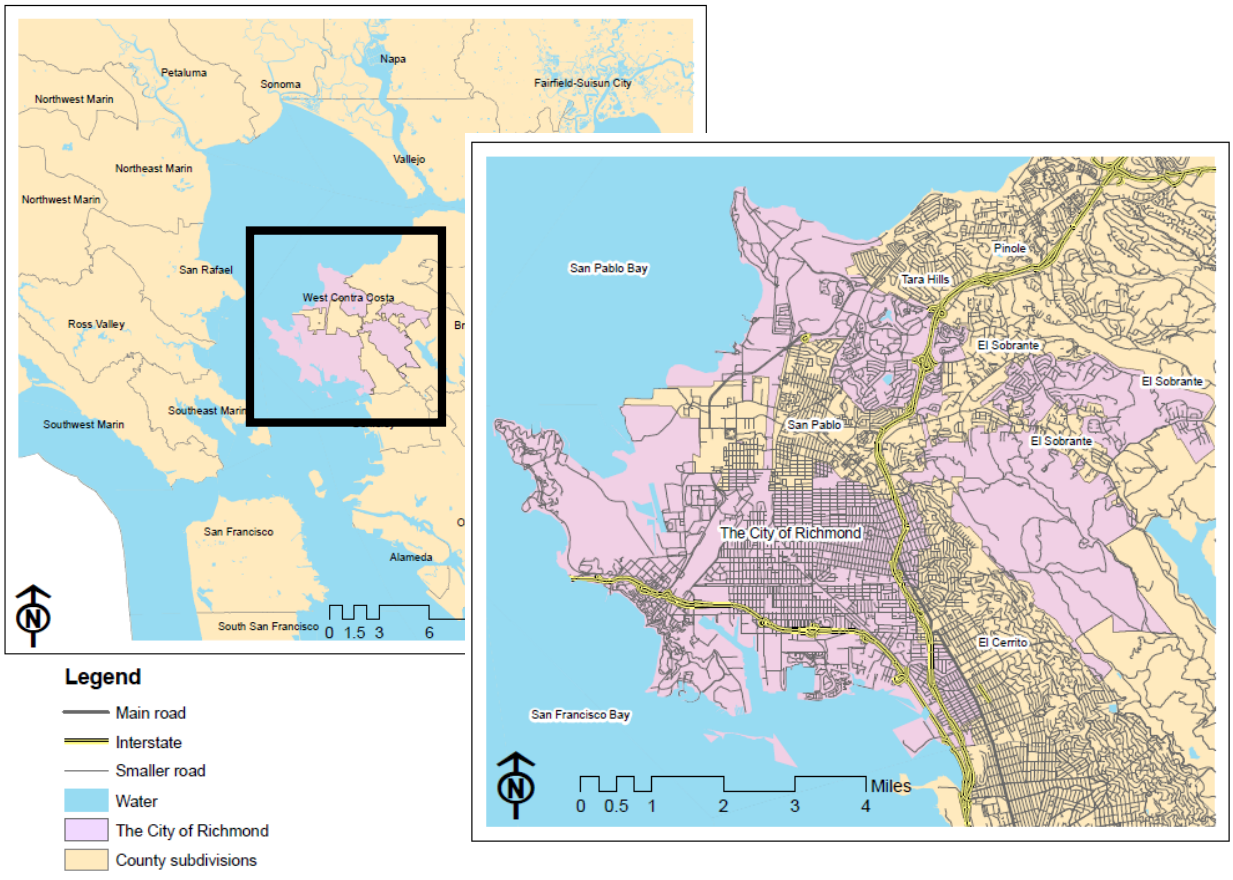
The WHCSP area currently faces a disproportionate burden of environmental health risks:

- WHCSP makes up less then 2% of LA County's population and land mass, yet it contains over 4% of LA County's TRI facilities and hazardous sites.
- A number of the State's most pollution-intensive industrial facilities and ports are located in Wilmington and negatively impact air quality, increasing risks for respiratory and cardiovascular disease.
- The WHCSP community is underserved by park and recreational spaces and over-served by fast food outlets, increasing community risks for cardiovascular disease, obesity, and diabetes.
- Persons of color in the WHCSP area are disproportionately exposed to pollution from vehicular sources.

5.3 The City of Richmond, California

The City of Richmond is an economically and racially diverse city in western Contra Costa County, northeast of San Francisco. Richmond neighborhoods have extensive shorelines and picturesque natural environments.[171] However, the city also struggles with many social and environmental challenges. Richmond is home to one of the largest GHG emitters in California, a high proportion of the county's toxic release facilities, a port facility, and two highly trafficked interstates. Richmond residents experience high rates of poverty and crime, and often have less than a high school education compared to their counterparts in other parts of the County. Richmond has many active community organizations and city officials who have raised concerns over Richmond's environmental burdens and have begun shaping policies to address these issues.

Map 2. The San Francisco Bay Area and the City of Richmond



Richmond is an urban environment with a higher population density than most of Contra Costa County, constituting 11% of the County's population and 5% of the County's land area (Table 34).[172]

Table 34. Population and density of Richmond, CA and Contra Costa County (source: US Census)

	Richmond	Contra Costa County
Population	106,157	948,816
Land acreage	21,382	457,821
People per acre	4.96	2.07

The City of Richmond is a racially diverse city with high rates of poverty and median household incomes far below the County average. Richmond has higher rates of linguistic isolation and more residents with less than a high school degree when compared to the County, but rates similar to California as a whole (Table 35).

Table 35. Demographic characteristics of Richmond compared to Contra Costa County and California (source: US Census 2000 and Berkeley School of Law Statewide Database)

	Richmond	Contra Costa County	California
Linguistically isolated households	9%	5%	10%
Voter turnout	73%	79%	71%
Hispanic or Latino population	26%	18%	32%
People of color population	76%	42%	53%
Households with public assistance income	6%	3%	5%
Families at or below 200% of poverty	48%	27%	47%
Median household income in 1999	$46,975	$63,675	$47,493
Population 65 years old and older	10%	11%	11%
Population 5 years old and younger	9%	8%	9%
Housing units renter occupied	47%	31%	43%
Population in rental housing	47%	29%	42%
Population 25+ years old with less than high school education	24%	13%	23%

Richmond, like many small and medium-sized cities in California, has limited health outcomes data. Health data concerning the prevalence of heart disease, diabetes, asthma, and adult obesity were not available for Richmond; and health behavior data such as rates of physical activity and food choices are not accessible at the city level. However, other data sources can provide a snapshot of community well-being. This assessment draws heavily from the National Citizen Survey—a survey developed to assess residents' opinions about community services provided by local governments, and tailored specifically to Richmond's needs. In addition, some local health data were available from Contra Costa Health Services and local community groups. Many questions pertaining to quality of life issues such as safety, environmental quality, social cohesion, and community involvement impact the health of the community and are reported here.

5.3.1 Community Health Outcomes

Similar to LA County and the Wilmington-Harbor City-San Pedro community, heart disease is the leading cause of death in Contra Costa County, accounting for 26% of all deaths.[173] Cancer is the second leading cause of death in the county, accounting for 24% of all deaths; and stroke is the third leading cause of death (Table 36). Richmond residents are at increased risk of dying from these causes compared to the County (Table 37), and the rates for both the City and the County are higher than CDC Healthy People 2010 Targets for all causes of death.[145]

Table 36. Leading causes of mortality in Contra Costa County, 2007 (source: Contra Costa Health Services)

Rank	Cause	Deaths	Percent of all deaths	Rate (incidents per 100,000 people)
1	Heart disease	5,280	26%	**179.9
2	Cancer	5,058	24%	*170.5
3	Stroke	1,686	8%	*57.8
4	Chronic lower respiratory disease	1,083	5%	37.7
5	Unintentional injuries	809	4%	**26.9

Rate is age-adjusted rates per 100,000 people
* Significantly higher rate compared to California
** Significantly lower rate compared to California.

Richmond and Contra Costa County meet the CDC Healthy People standards for diabetes-related deaths; but rates are higher in Richmond compared to Contra Costs County. Diabetes-related deaths are largely preventable, thus the differences may be due to limited access to health services, unhealthy behavioral choices, and increased environmental risks.[173]

At the county level, homicide is the second leading cause of death among residents aged 15-24 and 25-34 and the fourth leading cause of death among all African American residents. Half of all homicide deaths in the county occur among African Americans (129 people, or 55% of all homicides). Richmond residents are 4.5 times more likely to die from homicide than other County residents. Targets for Healthy People 2010 Objectives were not met for either the City or County (Target 15-32: 3 homicides per 100,000 people).

Table 37. Causes of death in Richmond compared to Contra Costa County, 2002-2004 (source: Contra Costa Health Services)

Cause of death	City Richmond			Contra Costa County		Are Healthy People 2010 Objectives met?	
	Deaths	Rate of cause-specific death	Proportion of cause-specific deaths in County	Deaths	Rate		
Heart disease	659	*265.2	12.5%	5,280	179.9	166 per 100,000	X
Cancer	537	*208.9	10.6%	5,058	170.5	159.9 per 100,000	X
Stroke	169	69.4	10.0%	1,683	57.8	48 per 100,000	X
Homicide	109	*35.7¥	46.8%	233	7.8¥	3 per 100,000	X
Diabetes	94	*37.0	16.1%	583	19.7	45 per 100,000	✓

Age adjusted rates per 100,000 residents
¥ Rate is crude rates per 100,000 residents.
* Statistically significant higher rate compared to the county overall.

From 2002-2004, Richmond had the greatest number of low birth weight infants in Contra Costa County, accounting for 14% of all low birth weight infants in the County (Table 38). Neither Richmond nor Contra Costa County meets the Healthy People 2010 Objective of 5%. Racial disparities in low birth weight persist—12% of all births among African American babies are low birth weight compared to an overall County rate of 6.5% for all races.

Over 41,000 children in the County are diagnosed with asthma, and African American children are at greater risk to be diagnosed and hospitalized for asthma. Asthma hospitalizations represent the most severe and, often times, uncontrolled cases: for every child that is hospitalized, many more are treated for asthma as a chronic illness. A greater proportion of Richmond's children are likely to be hospitalized due to asthma. Richmond residents account for 21% of all asthma hospitalizations in the County. Neither Richmond nor Contra Costa County meets CDC targets for asthma hospitalizations.

In Contra Costa, 27% of all fifth graders were overweight in 2005-2006. In the West Contra Costa Unified School District—the school district serving the City of Richmond—35% of 5th graders were overweight. Rates of overweight or obese 5th graders in Richmond and Contra Costa County do not meet the Healthy People 2010 objective of 5% (Target 19-3).

Table 38. Community health indicators in Richmond, CA and CDC Healthy People 2010 Targets (source: Contra Costa Health Services)

Health indicator	City of Richmond		Contra Costa County		Are Healthy People 2010 Objectives met?	
	Cases	Rate or prevalence	Cases	Rate or prevalence		
Low birth weight infants (2002-04)	368	7.3 ¥	2,604	6.5 ¥	5%	X
Asthma hospitalizations, age 10-14 (2002–04)	222	*30.5 Ω	1,052	17.0 Ω	12.5 per 10,000	X
Overweight 5th grade students (2005-06)**	826	*35.3% €	3,431	27.5% €	5%	X

¥ Rate is unadjusted crude rates per 100 live births.
Ω Rate is age-adjusted rates per 10,000 children
€ The percent of overweight 5th students in the district
* Significantly higher rate compared to the county.
** Richmond City is within the West Contra Costa Unified School District. Data for overweight students in Richmond is taken from the data of 5th graders attending the West Contra Unified School District.
X = non-attainment of Health People 2010 Target

Overall, Richmond residents fare worse than Contra Costa County residents on a number of health outcomes, and African Americans at both the County and City level suffer from higher rates of poor health outcomes:

- Mothers in Richmond are more likely to have low birth weight infants, and African American babies are at the highest risk County-wide;
- Richmond children are more likely to be overweight and more likely to be hospitalized for asthma; and
- Richmond residents are more likely to die from heart disease, cancer, homicide, and diabetes when compared to other Contra Costa County residents.

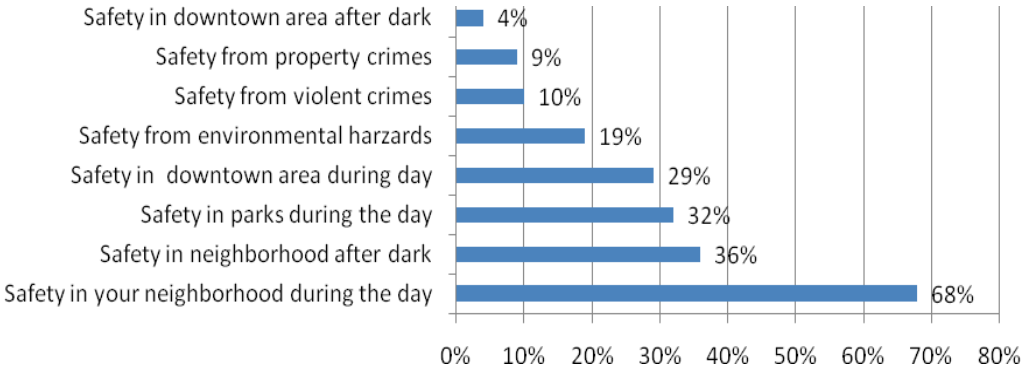
5.3.2 Characteristics of Social Vulnerability and Access to Neighborhood Resources

Numerous neighborhood characteristics may drive negative health outcomes among Richmond residents. Decreased perceptions of safety and increased crime rates may negatively influence residents' ability to go outside to socialize and exercise. Compromised park quality may hinder people's ability to use outdoor spaces, even though a large percent of the population has access to parks and other outdoor areas. And the availability of fast food outlets and grocery stores can influence nutritional choices, while financial constraints may make fast food a more popular option. Finally, limited health care access may strain residents' abilities to address health needs in a timely manner.

Perception of safety is a major concern for Richmond residents (Figure 10). And when compared to a 2007 survey, many residents feel that safety has become worse in the city.[174] Generally, many residents do not feel safe; and 64% of respondents considered the downtown area after dark to be "very unsafe" (only 4% considered the area "safe" or "somewhat safe"). Richmond fares worse for all perceived safety indicators when compared to all other jurisdictions across the County and other cities of similar size.

Over 25% of respondents reported that either they or someone in their household had been the victim of one or more crimes in the past year. However, only 73% of these crimes had been reported to the police. Residents experience more crime, but were less willing or able to report it. And perceptions of safety and crime may impact people's sense of community and neighborliness. Twenty-five percent of residents rate "sense of community" in Richmond as poor. Seventy-five percent of residents reported talking to or visiting with their neighbors at least once per month—less than the amount of contact reported in other communities.

Figure 10. Percent of residents that rate levels of safety as "very" or "somewhat" safe (source: National Citizen Survey, City of Richmond)



Over 75% of Richmond residents live within a quarter mile of a park, open space, or shoreline.[175] In all, Richmond is home to more than 50 parks totaling over 900 acres of parks and other recreational space (Table 39). Many Richmond residents are within walking distance of shoreline, but very few have water access. According to research by The West County Indicators

Project, 14% of Richmond residents live within a half-mile of undeveloped shoreline, but only 4% have easy shoreline access.[171]

Table 39. Access to parks and recreational areas in Richmond, CA and Contra Costa County (source: U.S. Census TIGER/Line)

	Richmond	Contra Costa County
Number of acres	904	14,769
Percent of land area	4.2%	3.2%
Acres per 1,000 people	8.5	15.6

Some residents have also expressed concern over the quality of open space in their community. Thirty-three percent of residents rate their city parks as being excellent or good quality, while 39% rate the parks as fair, and 13% rate them as being in poor quality.[174] Research by The Pacific Institute and the HEAL Collaborative found that many city parks were in disrepair or lacked key park features such as crosswalks, restrooms, and disability access. Moreover, racial disparities exist: neighborhoods with the worst park conditions have substantially larger proportion of residents of color compared to neighborhoods with nicer park amenities (86% compared to 69%).[171]

An analysis conducted by the City of Richmond found that 75% of Richmond residents have poor access to a produce market or full-service grocery store; and a majority of residents have better access to a fast food restaurant than a fresh produce market or full-service grocery store.[176] The City of Richmond's analysis also found that there are 6 times as many fast food restaurants and convenience stores in Richmond than super markets and farmer's markets. And residents in Richmond tend to have easier access to fast food restaurants compared to the County as a whole (Table 40).

Table 40. Fast food access in Richmond, CA and Contra Costa County (source: CDPH Healthy California GIS Map Viewer)

	Richmond	Contra Costa County
Total number	35	505
Fast food restaurants per 1,000 acres*	1.6	1.1
Percent of population within half mile of fast food restaurant	69%	53%

Areal interpolation was used to determine the percent of the population within a half mile of a fast food restaurant.
*Fast food restaurant is defined as an eating outlet categorized as fast food chain, pizza chain, or subs / deli / sandwich chain.

Richmond also faces a shortage of health care facilities, limiting residents' ability to access timely medical care. Richmond has only one hospital, and there are only two hospitals in all of west Contra Costa County (Table 41). The two existing facilities in west Contra Costa County serve more people per hospital bed compared to the County as a whole.

Table 41. Hospital service in Richmond and Contra Costa County (source: CA Statewide Health Planning and Development; US Census)

	Richmond	West Contra Costa	Contra Costa County
Number of hospitals	1	2	11
People per hospital*	106,157	118,004	86,256
People per hospital bed*	2,123	987	469

Source: CA Statewide Health Planning and Development, June 2009 and 2000 US Census Decennial Survey
*Assumes hospital service does not extend beyond planning boundaries.

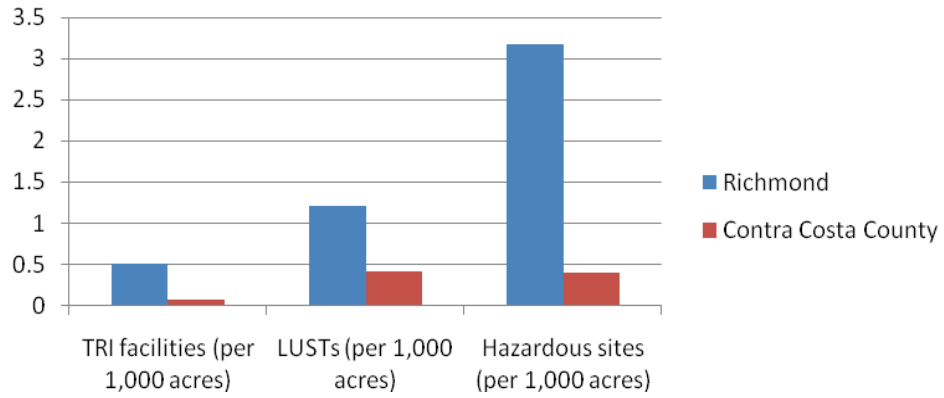
5.3.3 Environmental Health Risks in Richmond, CA

Richmond has a vibrant history of industry and production that is a source of both pride and environmental challenges. Today, over 20% of the land use in Richmond is devoted to industrial and port-related activities, equaling roughly 4,000 acres.[177] The city is home to the Chevron Refinery, the Port of Richmond and many port-related businesses, three railroads and numerous rail yards, multiple manufacturers, and a landfill.

Richmond faces a number of disproportionate environmental burdens compared to the county. Industrial land uses result in a greater numbers of TRI facilities, hazardous sites, and leaking underground storage tanks (LUSTs). Oil refineries expose residents to flaring events and the emission of air pollutants. And a larger percent of Richmond residents live in older homes and within close proximity to busy roads, increasing their exposure to air pollutants. When surveyed, over 30% of Richmond residents rated air quality and overall environmental quality as poor, and residents are less likely to feel safe from environmental hazards.[174]

Compared to the County, a disproportionate number of toxic release inventory (TRI) facilities, LUSTs, and hazardous sites are located in Richmond (Figure 11). There are more than seven times as many hazardous sites and over six times the number of TRI facilities per 1,000 acres in Richmond than in the County as a whole. And though Richmond is 11% of the county's population and 5% of its land area, it contains more than 36% of the hazardous sites and 29% of the TRI facilities in the County (Table 42).

Figure 11. Environmental hazards per 1,000 acres in Richmond, CA and Contra Costa County



Source: EPA Toxic Release Inventory, CA State Water Resources Control Board GeoTracker, and CA Department of Toxic Substances Control Envirostor. TRI facilities reported are facilities with > 0 pounds of release in 2008. LUSTs included open cases as of July 2010.

Table 42. Environmental hazards in Richmond, CA and Contra Costa County

	Sites in Richmond	Sites in Contra Costa County	Percent of all County sites located in Richmond
Hazardous sites	68	188	36.2%
TRI facilities	11	37	29.7%
LUSTs	26	192	13.5%

Source: EPA Toxic Release Inventory, CA Department of Toxic Substances Control Envirostor, CA State Water Resources Control Board GeoTracker.

Air quality in Richmond remains a long-standing public health concern. The city is identified as a "priority community" for air quality mitigation measures due to the area's high rates of toxic air contaminants and related diseases.[178]

In 2008, the Chevron refinery in Richmond emitted 4.7 million metric tons of carbon dioxide equivalents, making it the largest emitter of greenhouse gases in the state.[164] And the refinery had over 800,000 pounds of toxic releases in 2008, making it the largest TRI facility in the City of Richmond. Overall, four of the five top toxic release emitters in the County are located outside of Richmond. The largest toxic release emitter in Contra Costa County, the Shell Oil refinery in Martinez, emitted close to 900,000 pounds of toxic releases in 2008 alone.[179] Although there are more facilities in Richmond than in the County on a per area basis, many large emitters are located outside of the city.

Flaring at the Chevron Refinery is an important community health concern. Flares emit hydrocarbons, nitrogen oxides, and toxic chemicals such as benzene, toluene, xylenes, carbon-disulfide, mercury, carbon monoxide, particulate matter, and other air pollutants.[180] Releases of gaseous pollutants have been associated with respiratory problems, asthma attacks, and eye, skin, and nose irritations. Long-term exposures can lead to increased cancer risk, permanent respiratory conditions, and premature death. Seventy percent of the flare events between 2004 and 2007 had releases of more than double one of the Air District thresholds.[171]

Diesel exhaust—composed of many known toxic air contaminants—is a local concern. In the Bay Area, roughly 80% of all cancer risk from air pollution comes from diesel particulate matter.[181] Major sources of diesel pollution include the movement of trucks, trains and rail yards, and ships. West Contra Costa County includes the Port of Richmond, the Burlington Northern Santa Fe (BSNF) Richmond Rail Yard, warehouses and distribution centers, 15 miles of railway, and two Interstate highways. This infrastructure facilitates the movement of 5,000 ships into the Port of Richmond each year, 7,000 daily trucks trips on local highways, and 29 freight trains each day.[171] In total, over 90 tons of diesel pollution is released in west Contra Costa County every year from these sources. And mobile sources in Contra Costa County are responsible for over 90% of the additional cancer risk due to air pollution and more diesel exhaust.[182]

Housing age and proximity to major pollution sources may negatively impact some segments of the population in Richmond. The West County Indicators Project found that 50% of homes in Richmond, San Pablo, and North Richmond were built before 1960.[171] These older homes are more likely to expose their inhabitants to lead and higher levels of ambient air pollution.[183] [184] [185]

Richmond has a roughly proportional amount of sensitive receptor sites when compared to Contra Costa County (Table 43). Though mostly comparable to the County in terms of location to environmental hazards, a larger percentage of senior residences are located close to major roads compared to the County (Table 44). Sensitive receptors are generally not located near TRI facilities.

Table 43. Sensitive receptor sites located in Richmond, CA and Contra Costa County

	Richmond	Contra Costa County	Percent located in Richmond
Senior residences	26	435	6.0%
Public schools	33	318	10.4%
Child care facilities	39	330	11.8%

Source: CA Department of Education and CA Department of Social Services. Senior residences are categorized as Residential Care Facilities for the Elderly by the CA Department of Social Services. Public schools are active or merged schools, grades preschool—12th grade. Child care facilities are licensed facilities registered with the CA Department of Social Services.

Table 44. Percent of sensitive receptor sites located near environmental hazards

Sensitive receptor sites	Major Roads		TRI Facilities	
	Richmond	Contra Costa County	Richmond	Contra Costa County
Senior residences	23.1%	6.4%	0%	0%
Public schools	3.0%	3.1%	0%	0%
Child care facilities	7.7%	11.2%	0%	<1%

Source: CA Department of Education and CA Department of Social Services. Senior residences are categorized as Residential Care Facilities for the Elderly by the CA Department of Social Services. Public schools are active or merged schools, grades preschool—12th grade. Child care facilities are licensed facilities registered with the CA Department of Social Services.

But nearly one in five Richmond residents lives within close proximity to a major roadway; higher than the County average (Table 45). In Richmond, neither race nor income is strongly correlated with residential proximity to a major roadway, but more families live near a major roadway compared to the County average (Figures 12 and 13).

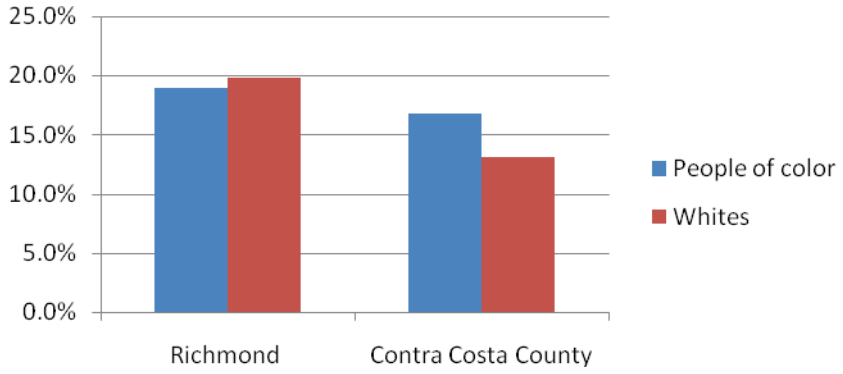
Table 45. Proportion of people living within 1,000 feet of a major roadway (source: US Census TIGER/Line)*

	Richmond	Contra Costa County
Number of people	20,320	139,246
Percent of population	19.1%	14.7%

Estimates were made using areal interpolation.

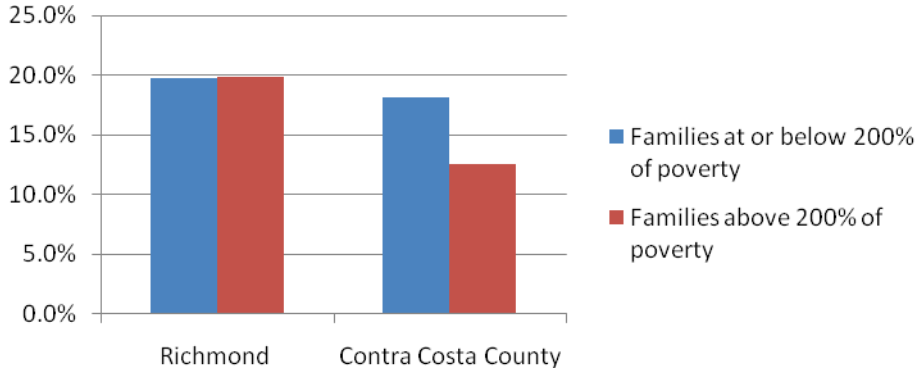
* Major roadway is defined as a primary or secondary road (MTFCC classification S1200 and S1100).

Figure 12. Percent of people by race living within a thousand feet of a major roadway (source: US Census)



Person of Color is defined as someone who identifies as Hispanic or Latino and/or Non-White. Estimates were made using areal interpolation.

Figure 13. Percent of families by poverty level living within a thousand feet of a major roadway (source: US Census)



Families with equal to or less than 200% of poverty are defined as a family of four persons making less than $44,999 annually. Poverty limit is based on the US Department of Health and Human Services 2009 Poverty Guidelines found at http://aspe.hhs.gov/poverty/09poverty.shtml. Estimates were made using areal interpolation.

5.3.4 Summary of Health Risks from Richmond, CA

Richmond residents—when compared to all residents of Contra Costa County—experience disproportionately high rates of child obesity and asthma hospitalization, higher rates of low birth weight, and an increased risk for heart disease, cancer, and stroke. These poor community health outcomes are compounded by local social and environmental concerns:

- High crime rates are a persistent issue in Richmond;
- Poor air quality—associated with heavy industrialization and diesel from mobile sources—has been a historically important issue in Richmond and is closely linked to poor respiratory outcomes and may be related to elevated rates of heart disease;
- Residents' exposure to poor air quality is unnecessarily elevated because of residential proximity to environmental hazards and an aging housing stock.

Social and economic conditions in Richmond complicate the environmental health burden that residents experience. High rates of poverty exacerbate community stress and likely hinder residents' ability to access timely health care. And poor perceptions of community safety may limit residents' ability to partake in health promoting activities, and further contribute to community stress, negatively modifying disease risk profiles for many residents.

5.4 San Joaquin Valley

5.4.1 Concerns Unique to the San Joaquin Valley

The two previous case studies examined community health needs in the urban communities of Wilmington-Harbor City-San Pedro and the City of Richmond. Largely rural Central Valley communities in California have their own unique health concerns. While many health outcomes are similar—for example, heart disease is the leading cause of death throughout California—the solutions to these issues may be driven by community needs and local environments.

This section will briefly highlight some of the health needs unique to the San Joaquin Valley, and use the findings to assess the potential impacts of AB 32 and a cap-and-trade program in these communities. Recommendations will be made to mitigate potential negative health effects and to boost health co-benefits.

5.4.2 General Methodology and Data Limitations

Detailed local community health data for the Central Valley are not routinely collected by State or county agencies, leaving large gaps in basic data needed to establish health baselines. Data presented here borrow heavily upon previous work by the Great Valley Center, the California Endowment (TCE) and the Central Valley Health Policy Institute. And The Great Valley Center has produced a series of reports entitled *The State of the Great Central Valley* which examine public health, the economy, and the environment in the Central Valley. The reports focus on using health, sociodemographic, economic, and environmental indicators to assess the region.

Data from TCE and the Central Valley Health Policy Institute are part of TCE's Building Healthy Communities initiative—a 10-year initiative to support community development in California's most vulnerable communities. Three of the fourteen sites of the initiative are located in the San Joaquin Valley. The *Building Healthy Communities in the San Joaquin Valley: Preliminary Baseline Data Report* compiles data from a community survey and sociodemographic data of the San Joaquin Valley. The report profiles both county-specific and aggregated county level data for the San Joaquin Valley.

The Central Valley consist of 3 subregions—the North Valley, the Sacramento Metropolitan Area, and the San Joaquin Valley—and encompasses 19 counties. For the purposes of this case study, data collected will focus on the San Joaquin Valley. The San Joaquin Valley consists of 8 counties—Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare. When data are reported for the Central Valley, the data are referring to all 3 regions. When data refer to the San Joaquin Valley, the data are an aggregate of the 8 counties cited above.

Assessing demographic, environmental, and health data at the county and regional level has limitations, but the data limitations are also telling: more frequent, systematic, and localized health risk surveillance is needed in many of California's neediest communities.

5.4.3 The San Joaquin Valley Community

The San Joaquin Valley is a large and diverse geographic area that is one of the world's leading agricultural economies. Communities large and small with distinct local identities are dotted throughout the region. In general, the San Joaquin Valley has a diverse population that is active in their communities and shares many of the same health risks as the rest of California. Many other economic, health, and environmental concerns are unique to its largely rural geography and agricultural-based economy. The populations living in the San Joaquin Valley are described in Table 46.

Table 46. Demographic characteristics of the San Joaquin Valley compared to California (data from 2009 unless otherwise indicated)

	San Joaquin Valley	California
Population	3,963,149	37,074,881
Population Density	1970	2234
Median Income	$44,766	$49,894
Families below federal poverty level	16%	15%
Non-Hispanic	52%	64%
Hispanic	48%	36%
Over 55 years of age	18%	20%
House with child	47%	38%
High school dropout, 2007-08	5.2%	3.9%
Middle school dropout, 2007-08	1.3%	0.9%
Unemployment rate (2006)	7.9%	4.9%

Source: Table reproduced from "Building Health Communities in the San Joaquin Valley: Preliminary Baseline Data Report"

Compared to the rest of California, the San Joaquin Valley is poorer and contains more Hispanic residents. The median income for the San Joaquin Valley is 8% lower than California's median income, and 16% families live below the federal poverty line. Unemployment is higher in comparison to the State, and more children dropout of high school. All of the above are social risks that contribute to community vulnerabilities.[186]

5.4.4 Community Health Indicators in the San Joaquin Valley

Poverty is a persistent health risk in the San Joaquin Valley, and can impact health outcomes and healthcare access. The San Joaquin Valley has the highest rate of children living in poverty across the Central Valley (31%), and exceeds child poverty in California (22% statewide).[187] According to the Great Valley Center, children that live in poverty who do not speak English as their first language are more likely to lack access to healthcare providers that are able to

account for the linguistic and cultural differences in care, resulting in challenges when accessing healthcare.

Access to health services represents an important factor in assessing the well-being of a population. Many factors impact a population's access to care: cost, education, a lack of awareness of public assistance and healthcare programs available, and language barriers. Sixteen percent of San Joaquin Valley residents between ages 0-64 are uninsured, 2% higher than the State average. Approximately 750,000 people still need to be insured in the Central Valley to reach the Healthy People's 2010 target. And a greater proportion of children in the San Joaquin Valley lack insurance compared to the State as a whole.[187]

California infant mortality is 5.5 deaths per 1,000 live births, an all-time low. Infant mortality is higher in the San Joaquin Valley, where the rate is 6.5 deaths per 1,000 live births. However, the prevalence of low birth weight for infants in the San Joaquin Valley is approximately 6.2%, similar to the State average. Poor birth outcomes can be attributed to insufficient access to health care, including lack of access to prenatal care, poor maternal nutrition, and exposure to smoking, among other factors. And existing discrepancies in healthcare access may be a contributing factor to infant mortality. The Great Valley Center reports that one in five pregnant women in the Central Valley do not receive prenatal care.[187]

San Joaquin Valley has a higher prevalence of childhood asthma than California as a whole. The prevalence of asthma in adults in the San Joaquin Valley is 10%, similar to the prevalence for the entire Central Valley region (11%).[187] The prevalence of childhood asthma in California is estimated to be 8%.

Other chronic diseases are also persistent in the region. The San Joaquin Valley has higher death rate associated with heart disease (212 per 100,000 people) than the State average of 197.5 deaths per 100,000.[187] Obesity and overweight can have a great impact on the prevalence of diabetes and heart disease. High rates of obesity have become an epidemic in the United States, and California has seen increase from 18.3% in 2001 to 22.7% in 2007. According to the UCLA's Center for Health Policy Research, the San Joaquin Valley region has a higher prevalence of adult obesity (30%) compared to the State (22.7%). Fresno and Tulare County have the highest diabetes prevalence in the San Joaquin Valley (Table 47). The UCLA Center for Health Policy Research found that the lowest-income counties in California, of which several are located in the San Joaquin Valley, have a higher prevalence of obesity and diabetes.[188]

Increases in obesity and diabetes—often preventable diseases that can be partially attributed to dietary factors and other health behaviors—carry significant medical costs. The estimated total cost of diabetes in California is $24 billion; $17 billion is spent on medical treatments for the disease.[188]

Table 47. Obesity and diabetes prevalence in California and the San Joaquin Valley, 2007, adults age 18 and over

	Obesity prevalence (%)	Diabetes prevalence (%)
California	22.7	7.8
San Joaquin Valley	30.0	9.4
Fresno County	28.7	10.5
Kern County	29.3	9.3
San Joaquin County	28.9	8.7
Stanislaus County	31.9	7.7
Tulare County	31.1	11.3
Merced County	34.3	7.5
Kings County	29.4	10.4
Madera County	30.0	8.1

Source: Table reproduced from "Obesity and Diabetes: Two Growing Epidemics in California"

Obesity, weight gain, and diabetes are associated with poor diet and physical inactivity. According to a survey from the San Joaquin Valley Community Cluster Survey, residents showed a propensity towards inactivity. The majority of residents failed to partake in physical activity more than 2 days a week (Table 48). And residents consumed less than five portions of fruit and vegetables over the previous week. Overall, many residents reported poor self-measures of health: 82% of the residents responded to having one diagnosed chronic condition, and nearly a quarter of residents sampled reported fair to poor health and high levels of depression.[186]

Table 48. Self-reported measures of health sampled from San Joaquin Valley residents

	San Joaquin Valley*
Physical Activity	
2 or fewer days the previous week	56%
Fruit and Vegetable Intake	
Fruits: <5 servings /previous 7 days	38%
Vegetables: <5 servings /previous 7 days	32%
General well-being	
Fair or Poor	23%
No physical in past year	26%
Depression score	
High depression score(>=3/5)	25%
Chronic conditions diagnosed	
At least 1 chronic condition	82%
2 or more chronic conditions	13%

Source: Table reproduced from "Building Health Communities in the San Joaquin Valley: Preliminary Baseline Data Report"
*Comparable State level data were not available

Overlapping chronic health conditions may lead to excess mortality. The San Joaquin Valley's rate of mortality from stroke is 64.5 deaths per 1,000 residents, which is slightly higher than the State average of 63 deaths by stroke per 1,000 persons. The cancer death rate in the San

Joaquin Valley is higher (191 cancer deaths per 100,000 people) than the California rate of 180 deaths per 100,000 people.[188]

5.4.5 Environmental Concerns in the San Joaquin Valley

The San Joaquin Valley's agricultural economy has an enormous influence on its environment. Approximately 62% of the total agricultural production for California comes from the San Joaquin Valley. In the Southern San Joaquin Valley, 20% percent of all jobs are agricultural.[189]

The role of agriculture has defined the use of land and access to open space. The long history of agriculture has encouraged the private ownership of the majority of land in the San Joaquin Valley. The San Joaquin Valley has one of the lowest percentages (7%) of publicly owned land (of all California regions.[190] The availability and accessibility of open space is an important factor in determining a community's access to outdoor recreation and physical activity. Physical activity prevents obesity, diabetes, and related diseases.

Reliance on agriculture also means the widespread use of pesticides (Table 49). According to the United States Environmental Protection Agency, pesticides have a wide range of health effects depending on the pesticide in question. Some pesticides can have detrimental effects on the nervous system, endocrine system, or hormones. Others may irritate the skin and eyes. Other pesticides are carcinogenic. Pesticides pose the greatest health risk to children and farm workers.[191] Evidence suggests that early exposure to pesticides increases the risks for early onset asthma in children.[192] All eight counties in the San Joaquin Valley ranked among the top ten users of pesticides across all 58 counties in California. Fresno ranked the highest in the state for both 2007 and 2008.

Table 49. San Joaquin Valley counties rankings by pounds of pesticide use, 2008

County	Pounds applied	*Rank
Fresno	27,543,587	1
Kern	25,441,400	2
Kings	6,239,993	9
Madera	7,578,258	5
Merced	6,912,082	6
San Joaquin	6,754,501	7
Stanislaus	5,677,506	10
Tulare	14,310,365	3

Source: California Department of Pesticide Regulation (DPR) 2008 Summary Data, http://www.cdpr.ca.gov/docs/pur/pur08rep/08_pur.htm

* Ranking is based upon fifty-eight California counties.

Population growth in the San Joaquin Valley has also added to environmental concerns and contributed to diminished air quality in the region. As the population has grown, mobile sources of emissions have accounted for a larger share of the total emissions in the region. Future growth in the region is expected to be a major factor for air quality related health effects.[193]

Air quality health risks in San Joaquin Valley counties often exceed established standards, and do so at a higher rate than the State average. Particulate matter is a respiratory irritant that can increase the frequency and severity of asthma and other types of respiratory illnesses such as bronchitis, and can cause premature death among vulnerable populations, especially children, the elderly, and those with existing respiratory illnesses.[194] Five counties in the San Joaquin Valley exceed the State 24-hour average PM10 concentration standard (50 µg/m^3) more frequently than the California average (Table 50). All counties in the San Joaquin Valley for which data were available exceeded federal 24-hour PM2.5 standard more frequently than the California average (Table 51).

Table 50. Estimated percentage of days with daily PM10 average concentrations over the CA standard (50 µg/m^3), 2006

County	Percentage of days
California	18
Tulare	43
Kern	46
Kings	34
Fresno	22
Stanislaus	13
Merced	13
San Joaquin	17
Madera	*Not available*

Source: California Environmental Health Tracking Program (CEHTP) Air Quality Data Query Results

Table 51. Estimated percentage of days with daily PM2.5 average concentrations over the US standard (35 µg/m^3), 2006

County	Percentage of days
California	3
Kern	11
Kings	8
Fresno	11
Tulare	8
Stanislaus	7
Merced	5
San Joaquin	6
Madera	*Not available*

Source: California Environmental Health Tracking Program (CEHTP) Air Quality Data Query Results

5.4.6 Core Findings from the San Joaquin Valley

The San Joaquin Valley, overall, has a unique profile of health risks compared to more urbanized communities in California. The area suffers from many poor health outcomes at a disproportionate rate when compared to California as a whole, but a community level analysis was not possible—however, disease prevalence is likely highly variable at a neighborhood level.

The region suffers from substantial air and water quality issues, and agricultural practices may expose communities to a variety of environmental health risks. Thus, there are indications of many serious health risks, but it is difficult to pinpoint local impacts with existing data systems. Given the dearth of localized data on health outcomes and health risks, engaging local communities in understanding local health concerns is a key step in designing any intervention to promote public health or increase community resiliency.

5.5 Assessment of Potential Health Effects in Local Communities

The cases studies above demonstrate the diversity of existing health needs and environmental health risks in communities in California. Because of local data gaps on health outcomes, it is difficult to establish a comparable health baseline for communities across all of California. For this reason, it is important to consider the environmental social, and economic health risks and determinants —not just health outcomes—when monitoring and mitigating health effects of communities.

Communities across California suffer from high rates of heart disease, cancer, and cerebrovascular disease, and diabetes. The underlying risks for disease are also similar—environmental pollution, social and economic stressors, and poverty. Vulnerable communities with high rates of existing disease are more susceptible to health effects from exposure to environmental health risks, compounding poor community health outcomes.[111] But they may also gain the most from positive environmental change associated with emissions reductions, community investments, and offset projects if these positive changes occur locally.

Many California communities are concerned that a cap-and-trade program could create pollution hot spots or excessive job losses, exacerbating existing health disparities. Because of limitations in local health data and an inadequate ability to model local economic and environmental impacts resulting from implementation of AB 32 and the cap-and-trade program, a precise community-by-community analysis of prospective local health impacts is out of the scope of this work. More research in this area is needed, and monitoring efforts should take this uncertainty into account.

Assembly Bill 32 mandates that the regulatory framework for GHG emission reductions is implemented in a manner that protects health, encourages co-benefits, and equitably distributes program benefits without negatively impacting low-income communities:

- The ARB is to design emissions reduction measures that "maximize additional environmental and economic co-benefits for California, and complements the state's efforts to improve air quality" {California Health and Safety Code §38501(h)};
- "The state board shall ensure that the greenhouse gas emission reduction rules, regulations, programs, mechanisms, and incentives under its jurisdiction, where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California and provide an opportunity for small businesses, schools, affordable housing associations, and other community institutions to participate in and benefit from statewide efforts to reduce greenhouse gas emissions" {CHSC §38565};

- The state board shall "consider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution" {CHSC §38570 (b)(1)}; and
- That state board shall "design any market-based compliance mechanism to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants" {CHSC §38570 (b)(2)}.[10]

Communities with existing disparities in environmental health risks and health outcomes are likely to gain the most from improvements in air quality, and existing vulnerabilities likely expose these communities to the greatest health risks from detrimental impacts. The magnitude of health problems and health risks suggests that investment to promote improved community and population health would be of great value.

5.5.1 Potential for Differential Impacts in Local Air Quality

A more detailed quantitative assessment of hypothetical local emissions impacts is performed in the ARB Co-Pollutant Emissions Assessment. A brief qualitative discussion of air pollutants and health is included here, and not reflective of the separate Co-Pollutant Emissions Assessment. The combustion of CO_2 generates criteria pollutants that are known to be harmful to human health: sulfur dioxide, particulate matter, carbon monoxide, nitrogen oxides, and precursors to ozone (as well as other additional known air toxins not considered as criteria pollutants). In addition, recent research has demonstrated the direct impact of local CO_2 emissions on health. Local CO_2 emissions are a causal factor in increasing local ozone and particulate matter, leading to 50-100 deaths per year in California.[106] Thus, a cap-and-trade program in California that is implemented to lower CO_2 emissions has the potential to decrease pollution in California communities and improve health. But the distribution of these impacts is uncertain; market-based systems are designed to reduce aggregate emissions, but can be "distribution neutral".[195]

Complying facilities participate in an allowance market, allowing for flexibility in where and how emissions reductions are achieved in reaching the goal set by the aggregate emissions cap. Theoretically, there are instances in which pollution could increase in some communities even though it would decrease overall statewide, but the distribution of such instances cannot be predicted with precision. This is examined in the ARB *Co-Pollutant Emissions Assessment* by evaluating the impacts of hypothetical scenarios.

It should be noted that a cap-and-trade program will be implemented in the context of an existing regulatory framework that limits emissions. However, monitoring of GHG emissions and co-pollutants could ease concern regarding the possibility of increases in local pollution, and ensure that vulnerable and impacted communities are not adversely impacted. Community investments focused on eliminating existing environmental, social, and economic health risks and reducing existing health inequities will reduce community vulnerability and promote community health.

5.5.2 Potential for Differential Economic Impacts in Local Communities

Similar to environmental impacts, it is difficult to precisely assess the economic impacts of AB 32 on local communities and the subsequent health effects. Though statewide impacts on labor demand, income, and energy costs may be predicted with some degree of confidence, the geographic distribution of these impacts is less predictable—city residents often leave their city boundaries for jobs, and local businesses hire employees from outside city limits. Positive or

negative impacts to employment could occur in some communities as a result of firms shifting production to other sites (within or outside of California), the emergence of new industries, or from broader shifts in labor demand across job sectors.

However, it is well documented that some demographics are more susceptible to negative impacts associated with unemployment and home energy costs. Persons of color, low-income households, and individuals with limited education attainment are at the greatest risk for unemployment and subsequent negative health impacts (as described in Section 3.2.2). Communities with a high proportion of low-income households and/or persons of color are often vulnerable communities, and in many instances are already exposed to a disproportionate burden of health risks (as is the case in the Wilmington-Harbor City-San Pedro area, the City of Richmond, and many communities throughout the Central Valley). Similarly, negative health effects from increases in residential fuel costs—most likely to be a burden for low-income households—may disproportionately accrue in vulnerable communities with a high proportion of low-income households. Existing vulnerabilities may leave these communities more susceptible to negative program impacts.

These same communities also stand to gain the most from positive economic impacts associated with AB 32. Targeting job growth and job training in emerging clean energy sectors in vulnerable communities can promote health and improve community resiliency. The use of allowance revenue to improve home energy efficiency in low-income households could create positive health co-benefits while achieving broader program goals. Improvements in the insulation of existing houses can create a warmer, drier indoor environment and improve upon self-reported health, school and work days lost, and visits to the doctor for respiratory issues.[196] Improvements in respiratory illnesses, asthma, and allergy symptoms have been reported in response to cleaner, more efficient indoor environments.[197]

5.5.3 Core Conclusions for Local Health Risks and Opportunities

Communities throughout California face health challenges, but also have rich resources upon which to build future opportunities—diverse and vocal residents, engaged community leadership, and a commitment to improving neighborhood conditions. A carefully designed cap-and-trade program can support their efforts. Assembly Bill 32 is an opportunity to achieve health co-benefits in California's most highly impacted communities and support community investments that will improve health while attaining the goals of greenhouse gas emissions reduction.

But existing environmental health disparities pose a health risk for many communities. Vulnerable communities have overlapping social and economic stressors that are likely to modify the negative health impacts associated with environmental exposures. Additional environmental or economic stress on vulnerable communities could negatively impact health and should be monitored and mitigated as needed. The following recommendations, intended to minimize health risks and promote health co-benefits, are discussed in greater detail in Section 6:

- Monitoring systems should be in place to assess in a timely and transparent manner changes in emissions, co-pollutants, and toxic air contaminants that negatively impact health. In cases in which environmental health risks are negatively impacted, mitigation strategies should be instituted. Any additional monitoring systems should be appropriately funded to ensure adequate resources to perform the tasks.

- Directing program benefits (such as decreases in emissions, offset protocols with positive health co-benefits, or community investments and investments in emerging clean energy technologies) to vulnerable communities in California would be consistent with program goals to maximize health co-benefits.
- Finally, using mitigation strategies and allowance revenue to address existing environmental and health inequities is an opportunity to increase a community's ability to adapt to future environmental hazards and to cope with social and economic stress, some of which may be related to a shift towards a low-carbon economy.

A portion of revenue from the cap-and-trade program—created through the auction of emission allowances—should be allotted for these purposes. The most impactful community investment of allowance revenue will vary from one community to the next, and as discussed in the next section, should be based on assessment of community health status and need, and evidence as to effective interventions. The Wilmington-Harbor City-San Pedro community is underserved by park and recreational spaces: community interventions, for example, could begin with the transformation of brownfields and unused lands into community recreation sites or other uses. In Richmond, recreational space is more abundant, but high rates of crime may limit resident access and diminish park quality: addressing crime may a key strategy for reducing a broad range of community health risks associated with stress and physical activity. Similarly, solutions to low rates of educational attainment, elevated pollution risks, or an aging housing stock—all risk factors for poor health outcomes—may differ from one community to the next throughout all of California. Attention to reducing health inequities and promoting more resilient communities with greater capacity to adapt to environmental and other changes will require addressing the physical, social, economic, and services determinants of health that shape community health profiles.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Overview of Health Effects

This assessment examined the health effects of three main health pathways impacted by the implementation of a cap-and-trade program in California:

1. Statewide changes in the social and economic drivers of health;
2. Health effects of various emission offset projects; and
3. Impacts on communities throughout California, particularly those with existing air pollution concerns and environmental health risks.

This section provides an overview of the assessment findings and offers recommendations to increase health co-benefits, reduce potential negative health effects, avoid disproportionate impacts on low-income communities, address community concerns regarding program uncertainties, and direct investments in disadvantaged communities to maximize health gains. These goals are concordant with the legal framework for AB 32:

- The ARB is to design emissions reduction measures that "maximize additional environmental and economic co-benefits for California, and complements the state's efforts to improve air quality" {California Health and Safety Code §38501(h)};
- The state board shall "ensure that activities undertaken to comply with the regulations do not disproportionately impact low-income communities" {CHSC §38562(b)(2)};
- The state board shall "consider overall societal benefits, including reductions in other air pollutants, diversification of energy sources, and other benefits to the economy, environment, and public health" {CHSC §38562(b)(6)};
- "The state board shall ensure that the greenhouse gas emission reduction rules, regulations, programs, mechanisms, and incentives under its jurisdiction, where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California and provide an opportunity for small businesses, schools, affordable housing associations, and other community institutions to participate in and benefit from statewide efforts to reduce greenhouse gas emissions" {CHSC §38565}; and
- That state board shall "design any market-based compliance mechanism to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants" {CHSC §38570 (b)(2)}.[10]

6.1.1 Social and Economic Health Effects Statewide

Statewide, the implementation of a cap-and-trade program and associated complementary measures is unlikely to cause major or permanent health effects associated with labor demand shifts, energy costs, or changes in income. Local effects are unknown and likely to be variable.

Overall, the cap-and-trade program as assessed in Case 1 and Case 2 of ARB's *Updated Economic Analysis* will have negligible to moderate health effects. Health impacts related to effects on employment, income, and energy costs will all be slightly greater in Case 2 than in Case 1, and thus mitigation of potential adverse health impacts will be more important in Case 2.

- *Employment:* Health effects on employment transition and labor demand shifts are minor, but are most likely to impact low-income populations, individuals with lower educational attainment, workers in economic sectors and industries that experience the greatest labor shifts, and groups with historically high unemployment rates, such as people of color. Health effects related to job insecurity and employment include uninsurance rates, stress and well-being, and workplace morbidity/mortality. In turn, employment can impact mental health, cardiovascular disease, food security, and a wide variety of other health determinants and outcomes.

- *Income:* Health effects of changes in income are negligible and no mitigations are recommended.

- *Energy Costs:* Health effects associated with increases in residential energy costs are mixed. Increased energy costs send a price signal to conserve energy and reduce consumption, improving air quality and meeting core program goals to reduce emissions. However, low-income households, already living on strained household budgets, have diminished capacity to absorb these costs and few resources available to support behavioral change—threatening utility shut-off, limiting access to basic household needs, increasing household stress, and increasing the risk for heat-related morbidity. Net health effects are expected to be minor, but will disproportionately burden low-income households. Mitigation efforts should target low-income populations and assist in transitioning to higher fuel costs while meeting core program goals of energy efficiency and conservation.

6.1.2 Health Effects of Offset Projects

Overall, health effects associated with offset projects are expected to be small, positive, and localized. Positive health effects associated with urban forest are likely to be substantial, and include impacts on air quality, allergen exposure, heat exposure, cardiovascular disease, and other health determinants and outcomes. Health effects associated with ODS and MMD protocols are likely positive, but less positive than health effects from urban forest; these mainly include impacts on air quality and water quality. Human health effects associated with forest projects are likely positive but modest and on a much longer time scale, largely because of the potential to be in more remote areas removed from population centers. Forest protocols could potentially improve water quality, air quality, and provide additional spaces for recreational opportunities.

The use of offsets has a net positive effect on economic health determinants, as shown in Case 1 of the statewide assessment. However, there is a trade-off: the use of offsets allows on-site emission reductions to be reduced, limiting the potential positive air quality impacts associated with on-site emission reductions. Steps should be taken to maximize the health benefits of offset projects when used.

- *Location:* Offsets projects that occur outside of California will not have a positive health effect in California. Offset projects that occur in California—particularly urban forest projects—may spur employment, positively impact air quality, reduce urban heat islands, and improve environmental quality. Efforts should be taken to develop offset projects in California, particularly in vulnerable communities.

- *Urban Forest:* Promoting urban forest would have very positive health co-benefits, particularly in communities with existing environmental and health disparities. Urban forest

projects targeted to tree-poor communities, particularly vulnerable communities, would likely have the greatest positive health impact. In general, offset projects with the greatest co-benefits should be promoted, particularly within California.

6.1.3 Impacts on California Communities

The community-level impacts of cap-and-trade are unknown and difficult to precisely project. Though statewide impacts are largely negligible, some communities will likely benefit more than others, and a few communities may be negatively impacted. Despite these uncertainties, the implementation of AB 32 and cap-and-trade is an opportunity to target positive program effects to California communities most highly impacted by air pollution and health disparities.

Core findings include:

- *Existing Vulnerability:* Communities with existing health disparities face overlapping social, environmental, and economic health risks. These overlapping risks increase community vulnerability and negatively impact a community's ability to respond and adapt positively to environmental and economic stressors. These same communities may benefit the most from the potential air quality improvements, new job creation, or positive benefits of offsets associated with the implementation of AB 32.

- *Uncertainty & Monitoring:* Local impacts from AB 32 and cap-and-trade are unknown and likely variable. Mitigation measures should address this uncertainty by enhancing local and statewide surveillance systems of environmental health risks, addressing existing health disparities, and making community investments that increase resiliency to environmental health risks and promote a community's adaptive capacity to climate change.

- *Opportunity:* Local mitigation efforts and community investments should be pro-active, include local community participation whenever feasible, and commence with the beginning of the cap-and-trade program in 2012. Targeted community investments have the greatest potential for positive health effects, and can proactively reduce health risks.

6.2 Recommendations to Maximize Heath Benefits and Minimize Potential Adverse Health Consequences

Recommendations can be separated into two broad categories: program-specific mitigations and health-supportive mitigations. In all cases, mitigation efforts are intended to minimize health risks, promote health, and reduce uncertainty. Program-specific mitigations address the most immediate impacts of program implementation. Health-supportive mitigations are intended to minimize health risks associated with environmental and economic determinants by increasing the resiliency and adaptive capacity of vulnerable communities.

6.2.1 Program-Specific Recommendations

Program-specific recommendations are intended to address the most direct impacts and uncertainties associated with the implementation of AB 32 and a cap-and-trade program. The recommendations below are described broadly; final mitigation measures can be designed to alleviate negative health effects while improving California's environment and strengthening its economy. A review of program-specific mitigation measures are shown below, and include:

- Mitigations of adverse impacts of employment transition due to labor market shifts;

- Measures to address impacts on low-income households due to potential rising energy expenditures; and
- Support for surveillance of health risks to monitor impacts of implementation of AB 32 and cap-and-trade.

Employment and Labor Transition Mitigations

In order to reduce impacts of employment shifts and labor transition, a portion of allowance revenue should be devoted to worker transition assistance. Investments can be made in adult education, worker training, and the extension of unemployment benefits to affected parties. Targeting these investments to the most vulnerable communities—low-income communities and communities of color, individuals with low educational attainment, and workers in impacted, energy-intensive industries—is likely to increase the efficacy of these mitigation measures. Increasing workforce development in energy technologies would have substantial ancillary benefits to California's role as leader in clean energy, and if targeted to disadvantaged communities could promote community health by addressing social and economic determinants of health, including unemployment, poverty, and low educational attainment.

Investments in worker transition assistance, adult education, and temporary insurance offer displaced workers the time, resources, and skills to pursue a career in a new industry; and reduce the economic dislocation and related adverse health impacts that are related to unemployment and job insecurity, including health insurance gaps, stress, and reduced ability to purchase health-promoting resources such as nutritious foods. Labor investments will increase the competitiveness of California's workers, spur growth in emerging 'green' industries, and positively impact the health of California communities and households.

Income Related Mitigations

No mitigations needed.

Residential Fuel Cost Mitigations

A portion of allowance revenue should be used to fund household energy efficiency programs and subsidize utility costs, as needed, in low-income communities. The majority of California households would not be negatively impacted by small rises in residential fuel costs; and an over-dampening of energy prices across all households may limit the positive health co-benefits associated with energy conservation. Assistance should be targeted to low-income households with the greatest energy cost burden. Improvements in household efficiency would limit negative household budget impacts while also improving air quality and indoor air environments. Direct utility subsidies should also be considered as needed. Efforts should be made to protect both low-income homeowners and renters, and policies implemented to overcome split-incentive barriers.

Currently, California has energy assistance programs geared towards utility bill assistance and home weatherization with funds from the Department of Energy and the U.S. Department of Health and Human Services. Direct payment assistance is invaluable in ensuring that vulnerable households do not face utility shut-off, and improvements in home energy efficiency can decrease energy consumption, lower utility bills, and ultimately improve air quality.

Current energy efficiency programs in California include the Low-income Home Energy Assistance Program (LIHEAP), the Weatherization Assistance Program (WAP), California Alternate Rates for Energy (CARE), and Low-income Energy Efficiency (LIEE), among others. Using allowance revenue to build upon existing programs should lower administrative costs and maximize investment efficacy. Investments should be made to:

- Maximize enrollment of qualifying low-income families and households negatively impacted by increases in household energy costs—this may include more expansive community outreach efforts, lowering barriers to entry, and/or other enrollment strategies as necessary;
- Expand efforts to improve home energy efficiency, including upgrades to energy-intensive appliances; and
- Coordinate Federal, State, local, and utility assistance programs to maximize existing resources.

Monitoring Environmental Health Risks and Addressing Uncertainties

Given the uncertainty of local impacts (as discussed in 5.5.1), monitoring should be treated as a component of policy implementation. Improving statewide surveillance of environmental health risks and related health outcomes will minimize uncertainty associated with implementation of a cap-and-trade program, assist in identifying the most vulnerable communities in California and confirming there are no disproportionate impacts, and simultaneously serve wide-ranging planning and health needs throughout California.

Environmental health surveillance is the systematic, ongoing collection, collation, and analysis of information related to disease and the environment, with emphasis on environmental exposures monitoring and health outcome surveillance. This includes monitoring or tracking indicators related to climate change such as air pollution, asthma, cardiovascular disease, heat illness, and other health determinants and health outcomes.

Monitoring systems should be implemented to track the impacts of cap-and-trade regulation in California. Data should be collected on GHG emissions, criteria pollutants, and toxic air contaminants. Data should be facility-specific, publicly available, and tracked on a continuous basis with annual update reports. Program-specific surveillance systems should be integrated with other relevant environmental risk surveillance networks, including surveillance systems tracking health outcomes. Broadly, recommendations include routine data collection at high geographic resolution, accessible geocoding services, data interoperability standards, the accessibility of data for public use, and the dissemination of understandable and timely data reports.

6.2.2 CDPH Recommendations on the Use of Proceeds

Cap-and-trade will produce significant proceeds, which will be placed into the Air Pollution Control Fund and made available for appropriation by the Governor and the Legislature for the purposes outlined in AB 32. AB 32 explicitly promotes economic, environmental, and public health co-benefits and requires ARB to direct public and private investment to the extent feasible toward disadvantaged communities. There has been a wide range of proposals for the use of revenues, most notably those of the EAAC, which addressed investments in energy efficiency, research and development of low-carbon technologies, land use planning and transit, green technology job training, disadvantaged communities, financing agencies implementing AB

32, and investments in climate change adaptation. Assembly Bill 1405 "Global Warming Solution Act of 2006: Community Benefits Fund", supported by the American Lung Association and other advocacy groups, proposed the creation of a community benefit fund for purposes of reducing GHG emissions through the installation of clean energy generation systems and mass transit in the most impacted and disadvantaged communities. Other proposals have included consumer rebates to help consumers avoid negative impacts of higher fuel expenditures.

The distribution of revenues requires further broad-based public discussion. Here, CDPH supports the allocation of a significant portion of revenues to improve the health of vulnerable and disadvantaged communities, and proposes an approach to the distribution of revenues that are targeted to improve health. The recommendations are directed to the ARB Board, and ultimately the Governor and Legislature.

Investment of Cap-and-Trade Revenues in Health

Health is a key component of sustainable communities, and is critical for economic sustainability, as it increases workforce participation and productivity and reduces run-away health care costs.[198]

Many of the communities that are most impacted by sectors covered under cap-and-trade are also low-income communities with little access to health-supporting resources and have resultant poor health status. These communities often experience multiple health risks, including high levels of air pollution from stationary sources and proximity to busy roadways and goods movement; poverty and low educational attainment; limited access to affordable housing, healthy foods, safe places for physical activity, and parks; high levels of violence and tobacco smoke exposure; and inadequate access to health care and to living-wage jobs and economic opportunities. The nexus among these multiple risks is complex and is the risks are cumulative.[39 198]

People in these communities have high rates of chronic illness and injuries, with resultant life expectancies that may be as much as 10-18 years shorter than those of people who reside in wealthier communities with more access to health promoting resources.[39 199]

Both the pre-existing risk conditions and the high rates of illness leave disadvantaged populations more vulnerable to the health consequences of climate change. These communities could also disproportionately bear adverse consequences of climate mitigation and adaptation strategies. For example, low-income people are more likely to live in urban areas subject to urban heat islands, increasing the risk associated with extreme heat events; this risk is exacerbated by pre-existing chronic disease. Similarly, higher baseline levels of exposure to air pollutants places communities at higher risk for the impacts of warming on air pollution. Improvements in existing health conditions will increase community resiliency to the threats of climate change in the face of health and other impacts of climate change and related mitigation strategies.[116]

Opportunities for co-benefits are great. Many of the strategies to create healthier communities will also yield reductions in greenhouse gas emissions and achieve other important goals. For example, promoting local sustainable food systems that increase access to locally grown affordable fruits and vegetables will improve nutrition, reduce chronic illness and obesity, reduce emissions associated with food transport, and reduce vulnerability to climate-induced

food system disruptions. Support for active transportation and affordable public transit will increase physical activity levels, decrease obesity and chronic illness, and reduce air pollution, GHG emissions, noise, and motor vehicle injuries.[200] [201]

In California, it has been estimated that a $10 per capita investment in proven public health programming would save the State $1.7 billion in five years; a return on investment of $4.80 for each dollar spent. Over a 10-20 year period, this investment would grow to $5.41 for each dollar spent.[202] For more information about the potential fiscal and economic benefits of community health investments, see Box 1.

Devoting a portion of allowance revenue to building healthier community environments and improving health in disadvantaged and vulnerable communities will meet the AB 32 goals of achieving positive health co-benefits, and reducing any risk that disadvantaged communities are be adversely impacted by climate change or by market mechanisms to reduce greenhouse gas emissions. Improving health and community health environments will also yield significant health expenditure savings, increase community resilience and capacity to adapt to climate change, and increase ability of these communities to participate in strategies to reduce greenhouse gas emissions. It is recommended that a minimum of 10% of allowance proceeds be allocated for community health investments.

Box 1. Economic benefits of community health investments

Cost-effective evidence-based prevention of illness and injury yields improved population health, significant boosts in productivity, and large medical care savings. These savings can be invested in other priorities, such as new green technologies to reduce greenhouse gas emissions, which may also improve the health of Californians.

The U.S. spends $2.2 trillion on health care each year. And 75% of all health care costs go to the treatment of chronic diseases, many of which are preventable. Chronic diseases cost an additional $1 trillion each year in lost productivity. Furthermore, injury and disease prevention programs can be cost-effective and save lives. While increasing the use of five of the most targeted, effective preventive care services could save more than 100,000 lives each year in the U.S. For example:

- An investment of $10 per person per year in proven, community-based programs to increase physical activity, improve nutrition, and prevent tobacco use could save the country more than $16 billion annually within 5 years.
- Over half of new cases of type 2 diabetes could be prevented through evidence-driven, community-based prevention programs and could result in total savings over 10 years of $191 billion, 75 percent of which would be savings to Medicare or Medicaid.

Source: Research compiled by *Trust for America's Health* (http://healthyamericans.org/).

Proposed Strategy for Distribution of Revenues for Community Health Improvement

The strategy proposed is for the distribution of a portion of cap-and-trade proceeds that is devoted for investments in community health improvement and the creation of healthy community environments. The proposed strategy is modeled on the highly successful CDPH

Tobacco Control Program to create an integrated but flexible approach that builds on existing public health infrastructure and ensures robust community engagement in order to meet diverse local and community health needs as seen in Section 5 of this assessment. This strategy provides for accountability, facilitates alignment with other programs and the leverage of existing resources, and helps to assure a wise and efficient use of funds invested in community health

Program administration and structure

The California Department of Public Health and 61 Local Health Departments (LHDs) make up the back-bone of California's public health infrastructure, working in conjunction with a wide array of local and statewide community-based and non-governmental organizations that provide essential services and advocate for healthy communities and policies. The California Conference of Local Health Officers (CCLHO), County Health Executives Association of California (CHEAC), and California Department of Public Health recently reviewed various structures for the allocation of public health funding, including discussions with NGO partners. CCLHO, CHEAC, and CDPH agreed that the California Tobacco Control Program (CTCP) provides a proven effective model, and that this model should serve as the framework for future federal or state distribution of public health funds (*personal communication: Jeffrey Brown, President, County Health Executives Association of California*). The CDHP-CTCP model was also the basis for legislative language on prevention and "community makeover grants" that was proposed as a part of California health care reform efforts and was widely supported by health advocates.[203] Box 2 describes the CDPH-CTCP model.

Box 2. CDPH Tobacco Control Program

Over the past quarter century, the California Department of Public Health Tobacco Control Program has succeeded in averting a million tobacco-related deaths and lowering health care expenditures by $86 billion. This remarkable achievement grew from a coordinated and comprehensive effort to change community environments through changing social norms, countering tobacco industry advertising, increasing the price of tobacco, reducing access to tobacco products, and providing smoking cessation support services. Analogous strategies must be implemented to address other risk factors, resultant illnesses, and health inequities.

The tobacco program infrastructure consists of a centralized media campaign and state and community interventions. The California Department of Public Health:

(1) Manages the program;
(2) Builds capacity of community projects through guidance, training, and technical assistance – much of which is provided through competitive statewide grants;
(3) Produces media and social marketing messages and materials;
(4) Awards community-based competitive grant projects which may conduct single-issue or specific-population focused campaigns; and
(5) Conducts evaluation and surveillance activities to measure the effectiveness of the interventions.

An appointed oversight committee advises the program.

Local health departments (LHDs) serve as "local lead agencies". All LHDs receive a base allocation. By providing funding to each health department, CTCP has been able to create critical mass around a few key policy issues for which state policy change is required to facilitate local change. LHDs are required to implement broad-based community coalitions, and to ensure robust engagement of stakeholders in the design of local programs.

This mix of funding has provided continuity, diversity, and balance. It has allowed CDPH to balance the need for local autonomy with the state's need for an evidenced-based approach, has allowed for development of capacity statewide, and has provided infrastructure for coordinated statewide efforts that build on the innovation and learnings of local communities.

Sources:
Lightwood JM, Dinno A, Glantz SA. Effect of the California tobacco control Program on personal health care expenditures. PLoS Medicine. 2008. 5:e178.
Roeseler A, Burns D. The quarter that changed the world. Tobacco Control. 2010. 19:i3-i15.

Administration of Community Health Investment Funds

A CDPH-CTCP model is proposed to create an integrated approach between state and local health department and community partners to promote healthy community environments and improve population health outcomes. CDPH would oversee the program, under the auspices of an appointed oversight committee. The CDPH role would be to provide guidance, technical assistance, training, support to communities, and overall program evaluation, and to administer competitive grant awards for those services and for statewide programs to address policy or other issues that impact communities. Local health departments would develop and implement

community health assessments and community health improvement programs (as detailed below). LHDs would be required to establish and support multi-sector coalitions and to partner with and fund community-based organizations to develop and implement community health improvement programs.

Process for the Distribution of Funds for Investment in Community Health Improvement
Community investments for health should:

- Improve population health;
- Reduce existing health inequities;
- Promote healthy community environments;
- Reduce existing environmental, social, and economic health risks;
- Promote strategies with co-benefits such as greenhouse gas emissions reductions, and
- Increase community resilience and the capacity to adapt to climate change as well other social, economic, and environmental changes.

These objectives implicitly require that:
(a) There is an initial assessment of the burden of illness, injuries, and health inequities in communities to ensure that interventions will have a substantial impact on population health and health inequities, and on-going monitoring to track the impact of interventions (see recommendations regarding surveillance in Section 6.2.1).
(b) Interventions will address key determinants of health outcomes and health risk factors.

Health and illness are influenced by the interaction of many factors. For example, inadequate physical activity, poor nutrition, and smoking are key risk factors for the major causes of death - heart disease, stroke, and cancer. But these health behaviors are largely shaped by community environments—including the social, economic, and physical environments, as well as local service environments. While medical care is vitally important, it contributes only a small portion (between 10-15 percent) to our overall health and longevity. The broader social, economic, and environmental determinants of health have a far greater impact on the length and quality of life compared to medical care.[198] Thus, successful community health improvement interventions will address a wide range of risks, risk factors, and outcomes, and will focus on policy and environmental change rather than on medical services.

A tiered process is proposed for the distribution of cap-and-trade revenues that are allocated for investment in community health improvement:

1. Identification of vulnerable and disadvantaged communities
2. Community health assessments
3. Community health improvement programs

1. Identification of vulnerable and disadvantaged communities:
The first step in the proposed process is the identification of vulnerable and disadvantaged communities. A methodology should be used that explicitly incorporates multiple aspects of community need, including environmental risks (e.g. air pollution, water quality, proximity to busy roadways or goods movement), demographic data (e.g. poverty and income, race and ethnicity, education level), health status (e.g. obesity, chronic illness, injury, child health), and community environment (e.g. housing affordability, parks access, tree canopy). CDPH recommends use of an available methodology developed under contract to the CARB,

developed by Drs. Pastor, Morello-Frosch, and Sadd.[xxii]

2. Community health assessments
Communities identified through the above methodology would be eligible to submit requests for funding to conduct community health assessments (CHA), led by the Local Health Department with technical assistance provided by CDPH. The CHA will utilize available data (e.g. mortality, hospitalization, environmental and other community health indicators, and including any relevant information from the Step I Identification of vulnerable communities) to assess both health status and determinants of health, and to identify specific priority areas for community health interventions. Grants would require demonstration of a robust community engagement process to ensure that community concerns and community perceptions of priority health and well-being issues are adequately represented in the CHA. Data from ongoing health and environmental monitoring and surveillance could be used for updating the CHAs over time, as well as for evaluation of intervention effectiveness.

3. Community health improvement programs
Based on the CHA (or equivalent information), vulnerable and disadvantaged communities would submit grant proposals to CDPH to plan and implement Community Health Improvement Programs (CHIPs). Grants would be submitted via the LHDs, and would require demonstration of a substantive community coalition engaged in both the planning and implementation components.

The use of the following criteria to guide and prioritize investments will help to ensure sound investments; these criteria are based in part on the California Department of Public Health Decision Framework —a framework adopted by CDPH to guide decision making in order to effectively meet CDPH goals to improve population health and promote healthy community environments.

Core criteria for prioritizing interventions to improve public health and for scoring applications would include:

- The net impact of the intervention on overall burden of disease and injury;
- The ability of an intervention to address health inequities due to race, ethnicity, or socioeconomic status;
- The community health intervention's potential greenhouse gas co-benefits;
- The degree to which a disease or injury burden is preventable or reducible;
- The availability of evidence that the proposed intervention is effective, and
- The cost-effectiveness of the intervention, when such data is available.[204]

Additional criteria may include overall feasibility, pilot projects with the potential to scale-up statewide, linkage to and the leverage of other community programs and resources, and the ability to address and reflect concerns and needs of diverse communities.

There is a substantial body of literature that assesses the effectiveness of health improvement interventions and/or identifies evidence-informed best practices to improve community health.

[xxii] The report, *Air Pollution and Environmental Justice: Integrating Indicators of Cumulative Impact and Socio-Economic Vulnerability into Regulatory Decision-Making*, is available at http://www.arb.ca.gov/research/apr/past/04-308.pdf.

The California Department of Public Health would provide guidance to assist communities in the identification of evidence-based and evidence-informed interventions to address priority needs. The range of evidence-based effective interventions is broad. Programs to promote healthy child and adolescent development, expand neighborhood resources for health, create healthier built environments, provide healthy school environments, healthy affordable housing, and economic development opportunities, and violence prevention improving access to and delivery of clinical preventive services are all examples of strategies to promote healthy communities and improve health while building community resiliency. Some examples of evidence-based interventions are provided in Appendix B.

A key consideration would be identification of interventions that provide synergies or co-benefits. Many health improvement interventions provide multiple benefits for health, improve outcomes in other arenas (e.g. better educational outcomes or reduced crime), provide synergy with clinical treatment, and (as noted above) provide co-benefits with respect to other key program goals such as reducing greenhouse gas emissions. Because of the complex inter-relationships among environmental risks, risk behaviors, and health outcomes, addressing individual factors will often have many impacts and may help to reduce adverse impacts of environmental exposures and to increase resilience and adaptive capacity to withstand environmental and economic changes.

For example, investments in evidence-based healthy early child development programs yield diverse long-term benefits, including increased cognition, improved physical health, improved educational attainment, and improved labor market success. Demonstrated benefits occur soon after programs end and have been tracked into adulthood.[205] Effective violence prevention programs reduce injuries and deaths, especially in young people of color, provide safer environments for walking for physical activity, and increases investments in disadvantaged neighborhoods. Reducing the density of alcohol outlets is a proven strategy for reducing violent crime. Becoming a smoke-free state remains one of the best investments to increase health and longevity. Reducing smoking will also reduce environmental cigarette litter that impacts California waterways and beaches. Increasing walking and bicycling trips will increase physical activity (which in turn reduces the risk of obesity, heart disease, osteoporosis, some cancers, and depression) and also reduces greenhouse gas emissions and air pollution by reducing vehicle miles traveled. Access to affordable healthy foods and reduced exposure to unhealthy foods and beverages will make it far easier for people with hypertension or diabetes to follow their physicians' dietary advice; increasing availability of local healthy foods will also reduce greenhouse gas emissions and air pollution.

6.2.3 Conclusions

In summary, potential negative health impacts of a cap-and-trade program in California are minor, and significant potential positive health impacts are possible if revenue generated by the auction of carbon allowances is directed to health-promoting uses, particularly within California's most vulnerable communities.

The potential health Impacts associated with the economic determinants in Case 1 are expected to be negligible to minor. There is a potential for minor negative health effects associated with transition within the labor market and residential fuel costs in low-income households. However, positive air quality impacts may accrue from increases in energy conservation.

Negative and positive health effects may potentially be more pronounced in a Case 2 scenario in which offsets were not allowed.

Overall, the use of offsets has a positive impact on economic health determinants, reducing the impacts of cap-and-trade on labor market shifts and energy costs for low-income households; some offsets—notably urban forest—also have significant potential health benefits for the communities in which they are located. However, offset use and the ability to trade allowances may reduce the potential positive air quality benefits associated with decreased emissions in communities already impacted by air pollution, causing those communities to forego health benefits. The positive health benefits of offsets can be maximized by:

(1) Limiting the overall use of offsets to ensure the majority of positive air quality impacts occur within California borders and

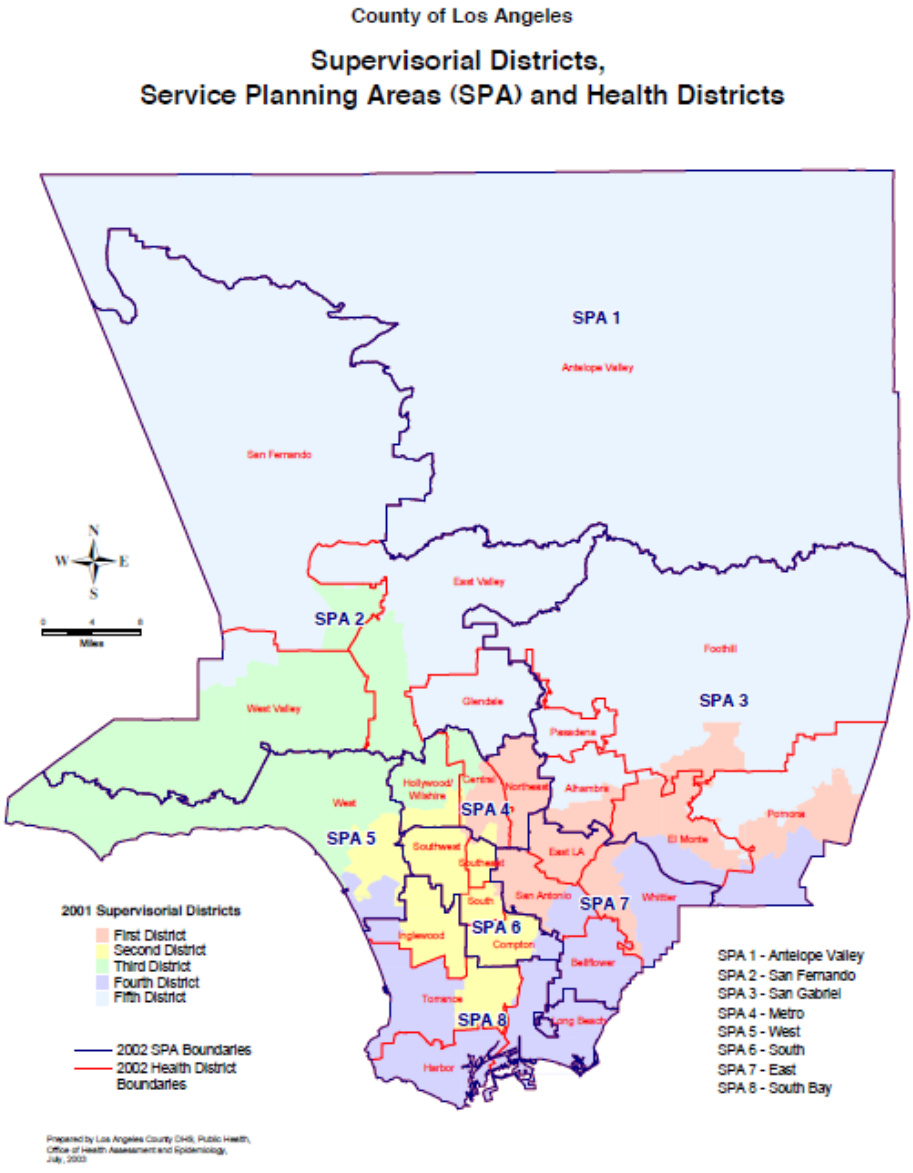
(2) Encouraging offset projects with health co-benefits—urban forest in particular—within California, while targeting vulnerable communities.

There is a need to monitor potential changes in health determinants throughout California. Improvements in environmental health surveillance should include monitoring of health exposures and health outcomes. Surveillance efforts will guard against negative changes in health effects and bolster planning and health needs throughout California. Should negative impacts be seen, mitigations strategies should be in place to advert potential negative health outcomes.

Finally, the most significant potential health impacts of the proposed cap-and-trade would accrue from distribution of revenue to promote community health, resiliency, and a community's adaptive capacity. Thus program design elements that maximize allowance proceeds available for investments in community health, particularly in disadvantaged and impacted communities, would increase positive health impacts and mitigate any adverse health consequences associated with the implementation of cap-and-trade in California.

Appendix A: Data Sources for Local Community Case Studies

LA County Service Planning Areas and Health Districts



Defining Geographic Boundaries of Richmond for Analysis

Census tracts defining Richmond include: 3630, 3710, 3720, 3730, 3740, 3750, 3760, 3770, 3780, 3790, 3800, 3810, 3650.01, 3650.02, 3671, 3700, 3820, 3830, 3601, 3602, and 3610.

Block groups defining Richmond include: Census track 360100 - Block groups: 1, 3; Census track 360200 – Block groups: 1-3; Census track 361000 – Block group: 2; Census track 363000 – Block

group: 3; Census track 365001 – Block groups: 1-3; Census track 365002 – Block groups: 2, 4; Census track 367100 – Block groups: 1-4; Census track 370000 – Block groups: 1-3; Census track 371000 – Block groups: 1-6; Census track 372000 – Block groups: 1-7; Census track 373000 – Block groups: 1-3; Census track 374000 – Block groups: 1-4; Census track 376000 – Block groups: 1-6; Census track 377000 – Block groups: 1-6; Census track 378000 – Block groups: 1-2; Census track 379000 – Block groups: 1-5; Census track 380000 – Block groups: 1-4; Census track 381000 – Block groups: 1-5; Census track 382000 – Block groups: 1-4; Census track 383000 – Block groups: 1-3.

Nomenclature referring to Richmond, West Contra Costa County, and Contra Costa County may also vary throughout the community health assessment. The City of Richmond may be referred to as Richmond or the City of Richmond.

Data Sources for Community Needs Analysis

Data	Source	Notes
Air Quality	California Air Resources Board's (ARB) Air Quality Trend Summaries, available at http://www.arb.ca.gov/adam/trends/trends1.php. Wilmington air quality data came from ARB's Community Air Quality Monitoring Special Studies for Wilmington, November 2003, available at www.arb.ca.gov/ch/reports/wilmington_sb25_report.pdf. Richmond air quality data came from Pacific Institute's report, "Deluged by Diesel" (2005) (available at http://www.pacinst.org/reports/west_county_diesel/west_county_report.pdf) and the Bay Area Air Quality Management District's "Community Air Risk Evaluation Program: Phase 1 Findings and Policy Recommendations Related to Toxic Air Contaminants in the San Francisco Bay Area" (available at http://www.baaqmd.gov/Divisions/Planning-and-Research/CARE-Program.aspx).	The Air Quality Trend Summaries did not have PM10 data for counties.
Demographic data	2000 U.S. Census Data from American FactFinder Survey Summary File 3, available at http://factfinder.census.gov/home/saff/main.html?_lang=en	

Data	Source	Notes
Disease prevalence and health risk behavior data	For LA and WHCSCP, data were obtained from several sources: 1) The 2007 LA County Health Survey, Office of Health Assessment and Epidemiology, LA County Department of Public Health. Available at http://publichealth.lacounty.gov/ha/hasurveyintro.htm. 2) Contra Costa Health Services' Community Health Indicators for Contra Costa County Report, June 2007, available at http://cchealth.org/health_data/hospital_council_2007/.	Health indicators taken from the LA County Health Survey for Wilmington-Harbor City-San Pedro communities included prevalence of diabetes, heart disease, hypertension, current asthma, high cholesterol, obesity and overweight. Physical activity and current cigarette smoking were also included. Prevalence data and health risk behavior data were not available in Richmond for all health indicators—very common in small to medium sized California communities.
Fast Food Restaurants	California Department of Public Health Network for a Healthy California GIS Map Viewer, available at http://www.cnngis.org/.	Fast food restaurants are defined as a fast food chain, pizza chain, or sub/deli/ sandwich chain.
Greenhouse gas emitting facilities	Pastor M, Morello-Frosch R, Sadd J, Scoggins J. (April 2010). Minding the Climate Gap: What's at Stake if California's Climate Law isn't Done Right and Right Away. Available at http://college.usc.edu/pere/documents/mindingthegap.pdf. California EPA, Air Resources Board. Greenhouse Gas Inventory Data—2000 – 2008. Available at http://www.arb.ca.gov/cc/inventory/data/data.htm.	
Grocery stores	California Department of Public Health Network for a Healthy California GIS Map Viewer, available at http://www.cnngis.org/.	Only stores with listed addresses were mapped.
Hazardous sites	California Department of Toxic Substances Control's (DTSC) Envirostor website, available at http://www.envirostor.dtsc.ca.gov/public/.	Hazardous sites include properties regulated by DTSC where extensive investigation and/or cleanup actions are planned or have been completed at permitted facilities and cleanup sites. Hazards sites can include Federal Superfund Sites, State Response Sites, Voluntary Cleanup Sites, School Cleanup Sites, and Corrective Action Sites.

Data	Source	Notes
Hospitals	California Office Statewide Health Planning and Development (OSHPD), hospitals licensed as of June 30, 2009. Available at http://www.oshpd.state.ca.us/HID/Products/Listings.html.	Hospitals' locations were geocoded based on the address of record. Information included number of beds per facility.
Leading causes of mortality	For LA and WHCSP, data were obtained from LA County Department of Public health, Mortality in Los Angeles County 2006 Leading Causes of Death and Premature Death with Trends for 1997-2006. Available at http://publichealth.lacounty.gov/dca/data/documents/2006%20Mortality%20Report.pdf and LA County Department of Public Health, Data Collection and Analysis Unit. (2007). Death in selected zip codes: 90744, 90710, 90731, and 90732. For Richmond, data were obtained from the Contra Costa Health Services' Community Health Indicators for Contra Costa County Report, June 2007, available at http://cchealth.org/health_data/hospital_council_2007/.	
Leaking underground storage tanks (LUSTs)	California State Water Resources Control Board's (SWRCB) GeoTracker website, available at http://geotracker.swrcb.ca.gov/.	Tanks included in assessment were listed as "open" status at the time of analysis.
Licensed residential care facilities for the elderly (RCFE)	The Community Care Licensing Facility of the California Department of Social Services, available at https://secure.dss.cahwnet.gov/ccld/securenet/ccld_search/ccld_search.aspx .	
Licenses child care centers	The Community Care Licensing Facility of the California Department of Social Services, available at https://secure.dss.cahwnet.gov/ccld/securenet/ccld_search/ccld_search.aspx .	All licensed or pending facilities were included. The addresses were geocoded based on the street addresses provided.
Low birth weight infants	For LA and WHCSP, obtained from CA Department of Public Health, Birth Profiles by Zip Code. Available at http://www.cdph.ca.gov/data/statistics/Pages/BirthProfilesbyZIPCode.aspx. For Richmond, data was obtained from the Contra Costa Health Services' Community Health Indicators for Contra Costa County Report, June 2007, available at http://cchealth.org/health_data/hospital_council_2007/.	Low birth weight infant is defined as an infant born weighing less than 5.5 pounds or 2,500 grams regardless of gestational age.
Perceived safety	For LA County and the Harbor Health District – the health district that encompasses WHCSP, perceptions of safety were obtained from the 2007 LA County Health Survey. Available at http://publichealth.lacounty.gov/ha/hasurveyintro.htm. For Richmond, perceptions of safety were obtained the City of Richmond National Citizen Survey, 2009. Available at http://www.ci.richmond.ca.us/index.aspx?NID=1872.	

Data	Source	Notes
Pesticide use	California Department of Pesticide Regulation's (DPR) Pesticide Use Reporting website, available at http://www.cdpr.ca.gov/docs/pur/purmain.htm.	Pesticide release information was calculated by summing the pounds of total pesticides applied and dividing by the total number of treated areas. Due to the nature of the reported data, calculations may include some surrounding communities outside of designated areas.
Public schools	California Department of Education (CDE), available at http://www.cde.ca.gov/ds/si/ds/pubschls.asp .	Public school information for all public schools in LA County, grades pre-school through 12th grade were included. All public schools with a status type of active or merged were included. The public schools were geocoded based on the street addresses provided.
Roadways, waterways, parks, county boundaries, city boundaries, and census block group boundary files	2009 U.S. Census Bureau TIGER/Line boundary files, available at http://www.census.gov/geo/www/tiger/.	Major roadways are defined by their MTFCC (feature class code) attribute as S1100, S1200, or S1630. S1100 are primary roads that are generally divided, limited-access highways within the interstate highway system or under state management, and are distinguished by the presence of interchanges. S1630 are ramps that allow controlled access from adjacent roads onto a limited access highway. S1200 are secondary roads or main arteries. These roads have one or more lanes of traffic in each direction, may or may not be divided, and usually have at-grade intersections. Parks and recreational spaces are defined by their MTFCC (feature class code) attribute as K2180 through K2190 and K2561. These are parks, recreational areas, forests, or golf courses.

Data	Source	Notes
Toxic Release Inventory (TRI) data	Environmental Protection Agency's (EPA) TRI website, available at http://www.epa.gov/tri/.	Facilities included had greater than zero pounds of total releases in 2008. Data for latitude and longitude were used for mapping purposes.
Voter turnout	Compiled by Bill Jesdale, PhD, from the California Secretary of State and/or various county governments and was subsequently reworked into the "Statewide Database" maintained by the Berkeley Law, Center for Research, available at http://swdb.berkeley.edu/about.html.	Some census track data were missing.

Appendix B: Sample of Evidence-Based Interventions

The following have been shown to be effective and cost-efficient interventions. They have been selected from a wide variety of sources, listed in brief at the end of Appendix B. The interventions compiled here are intended to be illustrative, not exhaustive.

Risk Factor or Health Outcome	Evidence-Based Intervention
Physical activity	• Safe Routes To Schools • Safe, attractive accessible places for activity (i.e., affordable outdoor recreation facilities, enhance bicycling and walking infrastructure, place schools within residential areas, increase access to and coverage area of public transportation, mixed use development, reduce community design that lends to increased injuries) • Incentives for active transit and reduced fares for children, students • Signage for neighborhood destinations in walkable/mixed-use areas and signage for public transportation, bike lanes/boulevards • City planning, zoning, land use, and transportation planning (e.g., planning to include the provision of sidewalks, parks, bike/pedestrian infrastructure, mixed use, parks with adequate crime prevention measures, and Health Impact Assessments) • Promote active transportation and use of public transit • Sidewalks/street crossings to connect schools, parks, destination; retrofit streets to reduce vehicle speeds, accommodate bikes, improve walking; school siting; • Community policing strategies to improve safety of streets and parks • Increase access to parks, recreation facilities, green space in park poor neighborhoods and through public safety efforts (e.g. outdoor lighting, police patrols)
Nutrition & obesity	• Public-private partnerships to increase community access to healthy food retail (zoning regulations and financial incentives to locate retail grocery in underserved neighborhoods) • Realign bus routes/transport to ensure access to healthy food retail outlets • Provide sites for community gardens and farmers markets (e.g. vacant lots, unused parking lots) • School and community gardens • Farm to institution, including schools, worksites, hospitals, and other community institutions; Healthy procurement policies • Increase access to free safe drinking water in public places • Support breastfeeding through policy change and maternity care practice

Risk Factor or Health Outcome	Evidence-Based Intervention
Healthy child development	• Access to high-quality early developmental support especially for children in low-income families, including universal pre-K • Early childhood home visiting and parent education programs e.g. Nurse Family Partnership
Violence	• Mentoring programs (e.g. Big Brothers Big sisters of America) • Universal school-based programs to reduce bullying and violence • Cease Fire • Crime prevention through environmental design
Injury prevention	• Engineering and traffic calming to reduce motor vehicle crashes • Vehicle speed reduction
Tobacco	• Use evidence-based pricing strategies to discourage tobacco use • Smoke-free workplaces and schools • Expand access to Quitline and other cessation services
Alcohol	• Decrease density of alcohol retail outlets • Multi-component interventions with community mobilization to reduce alcohol-impaired driving
Chronic disease management	• Chronic Disease self-management (hypertension, diabetes, asthma)
Reduce environmental exposures: Air pollution	• Bus retrofits • No idling rules • "Green" schools • Bus pass incentive programs • Safe Routes to schools
Reduce environmental exposures: Water quality	• Groundwater stewardship program • Conservation tillage or "no till" farming
Reduce environmental exposures: Pesticides	• Integrated pest management
Asthma	• Home-based multi-trigger/multi-component interventions (children and adolescents)
Diabetes	• Diabetes Prevention Program • Case management and disease management programs • Diabetes self management programs in community gathering places and in home (children/adolescents)
Cardiovascular disease / Hypertension	• Appropriate screening and treatment for hypertension and CVD risk • Sodium reduction strategies
Cancer	• Breast, cervical, and colorectal cancer screening
Poverty	• Earned income tax credit

Risk Factor or Health Outcome	Evidence-Based Intervention
Educational attainment	• Career academies • Comprehensive school reform to improve student achievement • Drop-out prevention program, e.g. Check and Connect • Teen pregnancy prevention programs • Mentoring

Sources for Intervention Strategies:

1. USPSTF Guide to Clinical Preventive Services:
http://www.uspreventiveservicestaskforce.org/
2. USPSTF Guide to Community Preventive Services:
http://www.thecommunityguide.org/about/Conclusion_Report_071210.pdf
3. Cochrane Collaboration:
http://www.cochrane.org/cochrane-reviews
4. The International Campbell Collaboration:
http://www.campbellcollaboration.org/library.php
5. RWJ Commission to Build a Healthier America:
http://www.commissiononhealth.org/Recommendations.aspx
6. CDC MAPPS Strategies:
http://www.cdc.gov/CommunitiesPuttingPreventiontoWork/strategies/index.htm
7. University of Wisconsin Population Health institute What Works for Health database:
http://WhatWorksForHealth.wisc.edu
8. Social Programs That Work. Coalition for evidence-based policy:
http://evidencebasedprograms.org/wordpress/?page_id=23
9. Blueprints for Violence Prevention University of Colorado:
http://www.colorado.edu/cspv/blueprints/
10. The Best Evidence Encyclopedia Center for Data-Driven Reform in Education Johns Hopkins University: http://www.bestevidence.org/
11. Institute of Medicine Local Government Actions to Prevent Childhood Obesity:
http://iom.edu/~/media/Files/Report%20Files/2009/ChildhoodObesityPreventionLocalGovernments/local%20govts%20obesity%20report%20brief%20FINAL%20for%20web.pdf
12. What Works Clearinghouse: U.S. Department of Education's Institute of Education Sciences:
http://ies.ed.gov/ncee/wwc/

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[6] Bay Area Air Quality Control District. Research and Modeling Section Publication No. 200909-01-03. September 2009.

[7] Romley JA, Hackbarth A, Goldman DP. The Impact of Air Quality on Hospital Spending. RAND Corporation: Santa Monica, CA. 2010. Last accessed July 20, 2010 http://www.rand.org/pubs/technical_reports/TR777/.

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