Linking the Environment and the Economy

An Economic Impact Analysis of California Climate Resilience Bond Proposals

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BAY AREA COUNCIL ECONOMIC INSTITUTE

Executive Summary

In the last few years, drought, wildfire, and extreme heat events have had significant impacts on California, and sea level rise is a looming threat for coastal communities. Given an urgency to limit the state's exposure to climate change, multiple bond proposals have been put forward that would significantly expand the state's ability to make investments in climate resilience.

While the environmental benefits of climate resilience investments are well understood, the economic impacts are not. And with nearly 4 million Californians recently filing for unemployment benefits, there is also an immediate need for the state to make policy decisions and investments that catalyze job creation.

This study finds that climate resilience investments do provide significant employment and economic stimulus:

- A package of climate resilience expenditures in California can support nearly 120,000 full-time equivalent jobs under an $8 billion spending program, or nearly 75,000 jobs under a smaller $5 billion package.
- These jobs include positions across the wage spectrum, from roles such as construction equipment operators, truck drivers, and landscapers, to more technical positions in environmental consulting and engineering.

Across all four climate resilience spending categories analyzed—wildfire/forest health, water, coastal resilience/sea level rise, and extreme heat/community resilience—between 12.54 and 16.26 full-time equivalent job-years are produced from $1 million in spending in each category. These numbers are consistent with findings from similar studies that have analyzed the economic impacts of projects such as road and bridge repair, smart grid installation, and building retrofits for energy efficiency.

Investments in climate resilience categories also have the potential to save billions of dollars in the long term by preventing or reducing the magnitude of damage that climate-induced natural disasters will cause. As one example of a suite of multi-benefit projects, this study finds that restoration programs along San Francisco Bay can create between 3,300 and 6,600 jobs, in addition to improving quality of life for residents, restoring natural ecological functions, and protecting the region's communities from sea level rise.

Report findings are based on publicly available climate resilience bond proposals from the California State Senate, Assembly, and Administration as of publication.

Economic Impacts of Climate Resilience Investments in California

	$5 Billion Total Spending	$8 Billion Total Spending	
Spending Category	Employment Impact	Employment Impact	Jobs per $1 Million
Wildfire / Forest Health	28,456	45,530	16.26
Water	21,346	34,153	13.77
Coastal Resilience / Sea Level Rise	15,919	25,471	15.92
Heat / Community Resilience	8,776	14,042	12.54
TOTAL IMPACT	**74,498**	**119,197**	**14.90**

Analysis: Bay Area Council Economic Institute using IMPLAN

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Introduction

The impacts of the changing climate in California have already been felt in numerous ways. Seven of the state's 10 most destructive wildfires have occurred in the last five years. The state spent much of the last decade experiencing drought conditions, exiting a 376-week drought in March 2019. And sea level rise threatens the state's coastline, endangering wetlands, estuaries, beaches, and floodplains, and the habitats they provide and the communities they protect.

With these threats already here and others looming, the state and its regions have taken extensive actions to invest in climate resilience. The state's cap-and-trade program has provided nearly $12 billion in funding to more than 428,000 individual projects since its inception, with many of those investments focused on environmental resilience projects.[1] At the regional level, voters in the nine-county San Francisco Bay Area approved a first-ever regional parcel tax in 2016 to fund restoration projects along the bay.

These types of investments provide a multitude of benefits. With their clear connection to the environment, first-order benefits include carbon capture, greenhouse gas emissions reductions, habitat protection, additional recreation opportunities, cleaner air and drinking water, and a better quality of life for California residents. Looking ahead, climate resilience can also help to mitigate the economic impact of increased drought, flooding, wildfires, heat, and sea level rise. If catastrophic wildfires can be prevented, floods are less frequent, drinking water made more secure, and sea level rise made less impactful on coastal communities, significant economic hardship—for both households and public agencies—can be avoided.

While these outcomes and their relationship to the initial investment are relatively well understood, less is known about climate resilience investments' ability to stimulate the economy and create jobs. Infrastructure programs have long been used as a policy tool to create jobs in times of slowing economic growth. As California enters an economic downturn, it is important to better understand the job creation aspects of multi-benefit climate resilience projects.

Project Methodology

This analysis seeks to quantify the job creation benefits of a suite of climate resilience investments in California by analyzing the impact of existing spending proposals from the California legislature (Senate Bill 45 and Assembly Bill 3256) and the Governor (January proposed fiscal year 2020-2021 budget). For the purposes of this analysis, two investment packages are analyzed: a $5 billion package and an $8 billion package. In both scenarios, project spending allocation percentages are assumed to be the same.

Economic impact is commonly measured through an input-output model that relies on national data to quantify the relationship between industries, their suppliers, and their customers. This report uses the IMPLAN modeling system to estimate the economic impacts on California using 2018 industry, transaction, and wage data for the state. IMPLAN examines the effect of a change in wages or employment due to an activity, and then analyzes its cumulative impact as the initial spending flows through the economy.

For the purposes of this report, the key outputs of the IMPLAN model are:

- **Jobs:** This measure captures the number of full-time equivalent job-years produced. For example, two 40-hour-per-week jobs that each last for six months would result in one full-time equivalent job-year in the model.
- **Economic Output:** The measure of total economic activity related to the initial activity, reflecting the total spending by firms, organizations, and households that is made possible by the initial input.

Both of these economic impacts are described as direct, indirect, or induced effects. The direct effects derive from the initial climate resilience investments. For example, the hiring of a construction contractor and the subsequent wages to an equipment operator are direct effects. The indirect effects are the transactions that flow from the areas of initial spending—for example, construction companies hired to restore a river will need to purchase equipment or materials. Lastly, the model generates induced impacts, which derive from spending created by the wages related to the initial activity. In this example, as construction workers spend their wages, they create impacts in restaurants, retail, the healthcare system, and in other sectors.

To build a model, numerous assumptions must be made as to how the expenditures are initially made. Most significantly, each analysis must assign investment values to industries. While resilience funding is generally controlled by state or local organizations, these agencies will use the funds to contract out to construction companies, consultants, engineers, and other groups. The mix of spending, and the wages and capital expenditures associated with each industry, will determine an activity's job production potential and economic output.

In order to allocate percentages of climate resilience spending to specific industries, this analysis has identified 12 of the 546 industries within IMPLAN that benefit directly from climate resilience-related investments (shown below). Expenditure percentages are estimated using academic research and existing project documentation. Throughout the analysis, it is assumed that 10% of total program spending goes to management of the project, which is in line with numbers taken from CAL-FIRE grant reporting and other greenhouse gas reduction state programs.[2]

To better incorporate the differential effects of multiple types of resilience investments, this analysis highlights four key areas: **wildfire / forest health, water, coastal resilience / sea level rise, and heat / community resilience.** Projects were placed into categories based on language taken from Senate Bill 45, Assembly Bill 3256, and the Governor's 2020-2021 Budget Summary – all of which contain climate resilience investment programming. The expenditure amounts inserted into each spending categorization use a blend of the three proposals to arrive at the project mix analyzed.

Industries Related to Resilience Used to Calculate Economic Impact

IMPLAN Code	Industry Name
19	Support Activities for Ag/Forestry
56	Construction of Other New Non-residential Structures
60	Maintenance/Repair of Non-residential Structures
417	Truck Transportation
447	Other Real Estate
457	Architectural, Engineering, and Related Services
463	Environmental and Other Technical Consulting
464	Scientific Research and Development Services
477	Landscape and Horticultural Services
479	Waste Management and Remediation
531	Other State Government Enterprises
534	Other Local Government Enterprises

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Wildfire / Forest Health

35% of Total Climate Resilience Expenditure Package

Wildfire- and forest-related investments include a number of different potential activities, most of which involve some level of combined construction (e.g., moving land and materials) and agriculture activity (e.g. clearing and/or planting), with engineering and consulting often needed for project scoping plans. Resilience expenditures related to wildfire protections and forest health are less varied in terms of their potential economic impact—compared to other categories analyzed within this report—because the bulk of expenditures described below have similar levels of labor intensivity:

- **Disaster mitigation:** Within high fire-risk areas, investments in hardening critical infrastructure can include improvements to response planning, removal of combustible materials near populated areas, and installation of backup utility infrastructure. The jobs within this category are likely to skew toward those related to construction, maintenance/repair, and waste remediation.
- **Forest health:** Investments related to the restoration of natural ecosystem functions include prescribed fires, fuel reductions through removal of certain vegetation, meadow and stream restoration to allow for better absorption and retention of water, inland wetland revegetation, and natural habitat resilience through reforestation. The jobs produced via this category of spending will include multiple types of employment, most notably in activities related to agriculture and forestry, as well as environmental consulting.
- **Wildfire prevention and mitigation services:** Largely related to fire response, investment types include improvements to CAL-FIRE facilities, for firefighting equipment, and for suppression and fuel reduction crews. Many of the jobs supported in this category are likely to fall within the support activities for agriculture and forestry category.
- **Conservancy:** Related investments and projects could include protection and restoration of large forests, reduction of tree mortality, land acquisition, carbon storage monitoring, landscape projects that benefit biological diversity, and removal of biomass waste that could be used as fuels or wood products. This category of spending may produce a broad range of jobs, related to construction, agriculture and forest activities, trucking, waste remediation, environmental consulting, and real estate.

The studies that do exist regarding the economic impacts of forest investments are largely focused on forest health, and few studies explore wildfire-related investments. The most comprehensive study on restoration and conservancy, from the University of Oregon, compiled budget data from 99 Oregon Watershed Enhancement Board grants and conducted

surveys with 190 businesses that provide forest and watershed restoration projects.[3] The study found that between 14.7 and 23.1 jobs were supported for every $1 million spent on these activities. The focus of this study largely was on in-stream improvements, riparian projects, and forest health investments.

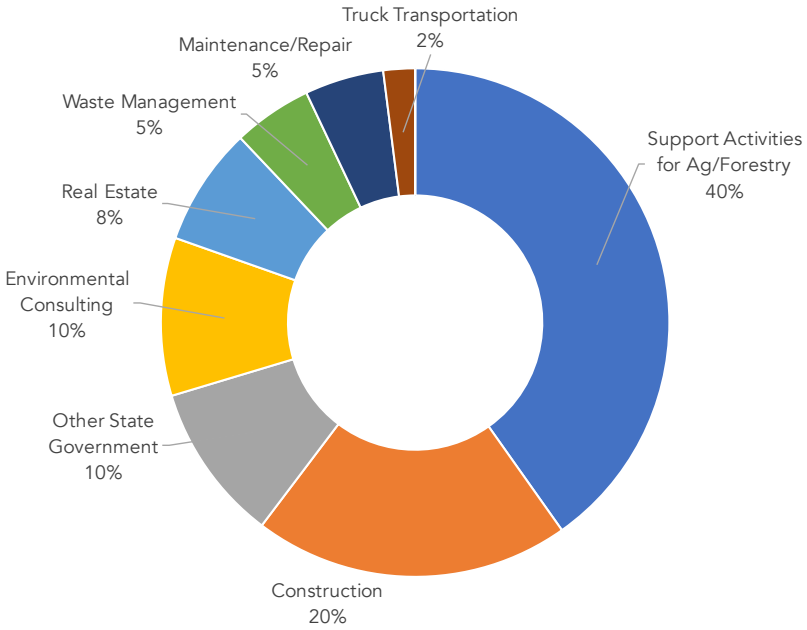
A study by the U.S. Fish and Wildlife Service provides another lens on the economic benefits of wildlife habitat restoration activities.[4] This study looked at numerous types of climate resilience projects and categorized spending into three groups: Agriculture, Construction, and Services. Forest and wildfire-related expenditures were assigned the following characterizations in the study (further definition of the Services category provided in parentheses):

- Assessment – 100% of spending allocated to Services (Environmental Consulting)
- Fire Management – 100% to Agriculture
- Hazard Removal – 100% to Services (Waste Management and Remediation)
- Planting – 90% to Agriculture and 10% to Services (Environmental Consulting)
- Vegetation Management – 90% to Agriculture and 10% to Services (Environmental Consulting)
- Wildlife Habitat Structures – 90% to Construction and 10% to Services (Environmental Consulting)

CAL-FIRE's State Responsibility Fire Prevention Fee program provides a final example of the types of activities that are included in wildfire prevention and forest health efforts.[5] Between fiscal year 2012 and fiscal year 2017, expenditures in the program totaled over $400 million. Using project information documents, approximately 70% of the funding was spent on forestry activities and construction, another 15% on consulting and professional services, 10% on program administration, and 5% on remediation activities.

Using these data points to inform the economic impact modeling along with assumptions regarding the types of jobs produced in each category, this report uses the expenditure breakdown below to approximate the number jobs that wildfire- and forest health-related investments support. Spending related to earth movement, planting, vegetation removal, and site cleanup make up the majority of the assumed expenditures in the model. Consulting work and real estate-related expenditures related to land acquisition are also included as significant percentages.

WILDFIRE / FOREST HEALTH EXPENDITURE INPUTS



The economic impact model for wildfire and forest health investments yields 16.26 full-time equivalent job-years supported per $1 million spent. For a comparison closer to the dollar amounts in proposed packages, $1 billion invested in this category would support 16,260 full-time equivalent job-years. Investments in this category produce an economic multiplier effect of 1.85x; meaning for every dollar spent, an additional $0.85 of economic activity occurs within the state. The potential employment profile for forest-related investments skews more labor-intensive, which results in high job production numbers when compared to other categories analyzed within the remainder of this report.

Forest health investments, for example, produce 17.3 jobs per $1 million invested according to a UCLA study of climate investments in California.[6] Because the suite of investments analyzed here includes conservancy investments—where dollars may be spent on land acquisition—and infrastructure hardening investments—where dollars are spent on materials and equipment—the job-production benefits are slightly less robust. Support activities for agriculture and forestry make up nearly half of the job creation potential for this category.

Employment Impacts by Industry per $1 Million of Investment

TOP 15 IMPACTED INDUSTRIES - WILDFIRE / FOREST HEALTH	DIRECT	INDIRECT	INDUCED	TOTAL
Industry Display	**Employment**	**Employment**	**Employment**	**Employment**
19 - Support activities for agriculture and forestry	7.53	0.00	0.00	**7.54**
56 - Construction of other new nonresidential structures	2.08	0.00	0.00	**2.08**
463 - Environmental and other technical consulting services	0.88	0.01	0.01	**0.90**
447 - Other real estate	0.30	0.09	0.09	**0.48**
60 - Maintenance and repair construction of nonresidential structures	0.22	0.02	0.01	**0.25**
479 - Waste management and remediation services	0.20	0.02	0.01	**0.23**
509 - Full-service restaurants	0.00	0.03	0.19	**0.22**
510 - Limited-service restaurants	0.00	0.01	0.18	**0.19**
417 - Truck transportation	0.11	0.05	0.03	**0.19**
472 - Employment services	0.00	0.09	0.06	**0.15**
493 - Individual and family services	0.00	0.00	0.13	**0.13**
490 - Hospitals	0.00	0.00	0.12	**0.12**
476 - Services to buildings	0.00	0.07	0.04	**0.11**
511 - All other food and drinking places	0.00	0.01	0.09	**0.11**
442 - Other financial investment activities	0.00	0.01	0.09	**0.10**
TOTAL EMPLOYMENT IMPACT	**11.34**	**1.37**	**3.56**	**16.26**

Analysis: Bay Area Council Economic Institute using IMPLAN

This analysis assumes forest- and wildfire-related investments will account for 35% of all spending in a climate resilience expenditure package. Extrapolating these findings out over the two assumed expenditure scenarios ($5 billion package and $8 billion package) yields the results to the right for job creation and overall economic impact. **Job impacts from the forest health and wildfire category range between 28,456 and 45,530 depending on the amount of overall spending.**

WILDFIRE / FOREST HEALTH				
Total Package (millions)	$	5,000	$	8,000
Category Investment (millions)	$	1,750	$	2,800
EMPLOYMENT				
Direct		19,837		31,739
Indirect		2,392		3,827
Induced		6,228		9,964
Total Employment		**28,456**		**45,530**
OUTPUT				
Direct	$	1,575,000,000	$	2,520,000,000
Indirect	$	526,891,671	$	843,026,674
Induced	$	1,134,744,207	$	1,815,590,732
Total Output	**$**	**3,236,635,879**	**$**	**5,178,617,406**

Analysis: Bay Area Council Economic Institute using IMPLAN

Water

31% of Total Climate Resilience Expenditure Package

The types of investments that are included in the water-related expenditure category are extremely diverse—ranging from programs for safe drinking water infrastructure, to sustainable groundwater management, to restoration of rivers, lakes, and streams, to recycled water projects. This analysis takes proposed investments and separates them into five categories, outlined below:

- **Safe drinking water:** Investments include projects that improve water supplies, treatment, and distribution in vulnerable communities. These projects can range from the minimally capital- and labor-intensive (e.g., community technical assistance) to large-scale engineering projects that create new or upgraded water delivery infrastructure.
- **Groundwater sustainability:** Funding from this category could go to the Wildlife Conservation Board or to local agencies in support of groundwater programs and projects. Wetlands that provide aquifer replenishment or other groundwater recharge programs that result in improved flows to rivers and streams are included here. Local well mitigation investments are also part of this category.
- **Water resilience:** This category has a focus on regional or inter-regional capital projects, including stormwater management, wastewater treatment, water recycling, agricultural conservation programs, storage and conveyance, watershed protection, and water quality improvements. Included here are river, lake, and stream restoration projects that improve habitats for fish and wildlife, add to climate resilience, and restore watersheds. These projects are likely to be capital- and consultant-intensive.
- **Flood control:** Projects included in this category could include levee setbacks, enhancement of floodplains and bypasses, debris control in streams and rivers, off-stream groundwater recharge, land acquisitions and easements, and other projects to reduce flood intensity and slow watershed runoff. Flood-related projects can also benefit ecosystems and wildlife habitats that can serve to simultaneously mitigate certain flood hazards.
- **Restoration and revitalization projects:** These investments are particular to certain waterways and bodies of waters across the state, specifically the Salton Sea, San Joaquin River, Los Angeles River, and other waterways. Funding would go toward existing plans that seek to remediate ecological health, in many cases with additional public health, recreation, and other benefits.

Studies of the economic impacts of water-related resilience investments are most often focused on river and wetland restoration projects. In Massachusetts, multiple studies have been commissioned to better

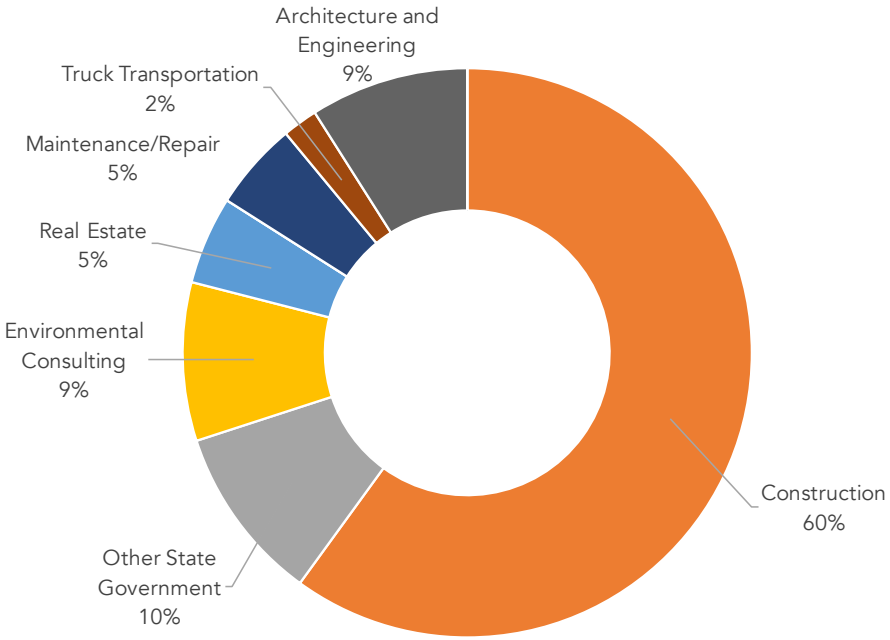
understand the economic benefits of these types of projects. A 2014 study that analyzed the Hoosic River restoration project in Massachusetts found that 13.9 jobs were created per $1 million spent on flood control and recreation investments.[7] More than 75% of the project costs were characterized as construction, with the remainder split between engineering and other consulting services. Another study of the Eel River headwaters restoration project—which included six dam removals, two culvert replacements, and 40 acres of wetlands restoration—calculated that 56% of the project costs were construction-related, and that the entire investment produced 13.2 jobs per $1 million spent.[8]

In California, a 2012 study on the San Joaquin River Restoration Program analyzed the impacts of channel and structural improvements, flow restoration, fish reintroduction, and water management.[9] The research from UC Merced found that 14.1 jobs were created per $1 million invested, in addition to other jobs created in the recreation industry and within nonprofit organizations. Construction-related activities made up the majority of project expenditures that were analyzed, approximately 70.50% of the total, with 8.45% in environmental consulting services, 11.25% on project administration, 8.02% on scientific and engineering services, and 1.78% on agricultural work.

These previous studies have largely focused on environmental and ecological restoration projects; however, the proposed investments within this category also include drinking water investments. These types of infrastructure projects have a similar ability to produce jobs as compared to the findings in the studies outlined above. Analyses compiled by the Value of Water Campaign have calculated between 15 and 18 jobs are produced per $1 million of spending on water-related investments.[10] Research across multiple projects showed that project expenditure percentages were allocated to the following categories: Construction (73%), Engineering (10%), Capital Purchases (6%), Program Management (5%), Other (5%), and Land Acquisition (1%).

From these previous studies, it becomes clear that construction-related costs make up a significant portion of expenditures in the water-related investment category. This analysis places 60% of the possible spending mix within the construction industry, with other significant uses for consulting, engineering, and maintenance activities. Program administration costs are borne by state entities, at 10% of total spending. The chart below displays the full allotment of expenditures by industry.

WATER EXPENDITURE INPUTS



The economic impact model for water investments in California yields 13.77 full-time equivalent job-years supported per $1 million spent. At a larger scale, $1 billion invested in this category would support 13,770 jobs. Spending in this category also produces an economic multiplier effect of 2.03x; meaning that for every $1 spent, an additional $1.03 of economic activity occurs within the state. Lower jobs output and higher economic output in this category are the result of the spending mix being skewed more toward purchases of materials and equipment. Construction-related employment is the top industry for job creation, followed by environmental consulting and engineering services.

Employment Impacts by Industry per $1 Million of Investment

TOP 15 IMPACTED INDUSTRIES - WATER	DIRECT	INDIRECT	INDUCED	TOTAL
Industry Display	**Employment**	**Employment**	**Employment**	**Employment**
56 - Construction of other new nonresidential structures	6.25	0.00	0.00	**6.25**
463 - Environmental and other technical consulting services	0.80	0.02	0.01	**0.82**
457 - Architectural, engineering, and related services	0.40	0.11	0.01	**0.52**
447 - Other real estate	0.19	0.11	0.10	**0.39**
60 - Maintenance and repair construction of nonresidential structures	0.22	0.02	0.01	**0.25**
509 - Full-service restaurants	0.00	0.04	0.20	**0.24**
417 - Truck transportation	0.11	0.08	0.03	**0.23**
510 - Limited-service restaurants	0.00	0.01	0.19	**0.20**
472 - Employment services	0.00	0.14	0.06	**0.20**
405 - Retail - Building material, garden equipment, and supplies stores	0.00	0.14	0.02	**0.16**
493 - Individual and family services	0.00	0.00	0.14	**0.14**
490 - Hospitals	0.00	0.00	0.13	**0.13**
476 - Services to buildings	0.00	0.08	0.04	**0.12**
511 - All other food and drinking places	0.00	0.02	0.10	**0.12**
442 - Other financial investment activities	0.00	0.01	0.10	**0.11**
TOTAL EMPLOYMENT IMPACT	**7.97**	**2.02**	**3.78**	**13.77**

Analysis: Bay Area Council Economic Institute using IMPLAN

This analysis assumes water-related investments will account for 31% of all spending in a climate resilience expenditure package. Extrapolating these findings out over the two assumed expenditure scenarios ($5 billion package and $8 billion package) yields the below results for job creation and overall economic impact. **Job impacts from the water category range between 21,346 and 34,153 depending on the amount of overall spending.**

	WATER	
Total Package (millions)	$ 5,000	$ 8,000
Category Investment (millions)	$ 1,550	$ 2,480
EMPLOYMENT		
Direct	12,349	19,758
Indirect	3,137	5,019
Induced	5,860	9,376
Total Employment	**21,346**	**34,153**
OUTPUT		
Direct	$ 1,395,000,000	$ 2,232,000,000
Indirect	$ 689,441,240	$ 1,103,105,984
Induced	$ 1,067,105,714	$ 1,707,369,143
Total Output	**$ 3,151,546,954**	**$ 5,042,475,126**

Analysis: Bay Area Council Economic Institute using IMPLAN

4

Coastal Resilience / Sea Level Rise

20% of Total Climate Resilience Expenditure Package

California has 3,427 miles of shoreline, making up 43.5% of the coastal area on the west coast. Sea level rise and coastal flooding have the potential to have significant impacts on the state. A 2015 analysis by the Bay Area Council Economic Institute estimated the economic cost of a 100-year flood event in the San Francisco Bay Area to be $10.4 billion.[11] Investments in coastal resilience not only limit the negative effects of climate change for communities along the coast, they also bring immediate job benefits. Project categorizations related to sea level rise and coastal resilience are outlined below:

- **Coastal wetlands restoration:** One of the first lines of defense to sea level rise is coastal wetland areas. Investments within this category could include the protection and revegetation of coastal lands, restoration of estuaries, and salt pond and marsh revitalization. The State Coastal Conservancy's Climate Ready Program also provides a model of how funds could be used to assess and plan for sea level rise.
- **Critical infrastructure projects:** Projects within this category closely resemble major civil engineering projects, as they could include dam removal, waterway restoration, bridge widening, and other investments that can protect railways, roadways, and utility plants.
- **Natural ecosystem revitalization:** These nature-based solutions include investments in ocean ecology and subtidal habitats, including kelp forests, marine protected areas, fisheries and aquaculture, and seagrass beds. These projects are more likely to include significant amounts of environmental consulting and scientific study.

As opposed to the previous two spending categories, where economic impact studies have either been limited in scope or quantity, job production related to coastal investments is relatively well analyzed. The most wide-ranging study, completed in 2012, looked at numerous restoration projects that received funding from the American Recovery and Reinvestment Act of 2009 (ARRA) that were administered by the National Ocean and Atmospheric Administration.[12]

The study looked at the job creation benefits of 44 different ARRA-funded projects using their budget documentation to classify expenditures into specific sub-industries. Findings were grouped into different categories, explained below:

- Marine debris removal (15 jobs per $1 million spent): Job types include cleanup laborers, boat operators, heavy equipment managers, and administrative staff

- Fish passage / dam removal (14): Job types include environmental consultants, engineers, construction workers, landscapers, lawyers, and scientists
- Hydrologic reconnection (15): Job types include geologists, engineers, landscapers, heavy equipment operators, construction workers, and project managers
- Oyster reef restoration (16): Job types include barge and tug operators, fishermen, scientists, quarry workers, truck drivers, projects managers, and administrative staff
- Living shorelines (15): Job types include construction workers, surveyors, heavy equipment operators, laborers, environmental consultants, administrative positions

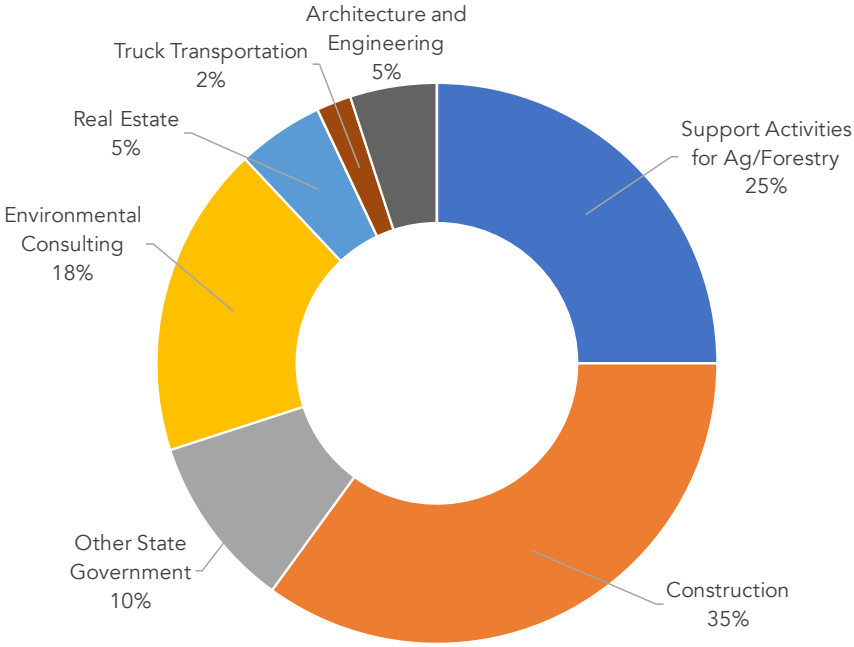
Across all projects analyzed, the study found that 15 jobs were created per $1 million spent, with the most impactful projects being the ones that were most labor intensive, with relatively more low-skilled, low-wage positions deployed.

Other studies also produced similar results. An analysis by the Center for American Progress on ARRA-funded resilience projects found that the Virginia Seaside Bays restoration created 12.57 jobs per $1 million invested.[13] The Oregon Watershed Enhancement Board study, referenced previously, also analyzed coastal wetland projects.[14] The analysis showed 17.6 jobs created per $1 million of expenditure. The Oregon study found coastal wetland projects to be more labor-intensive per dollar than forest or river investments that were more reliant on equipment for moving land and heavy objects.

In southern California, the Seal Beach Salt Marsh Sediment Augmentation Project provides an illustrative example of how costs can be allocated within coastal wetlands projects. The project, which received funding through the California Department of Fish and Wildlife's Greenhouse Gas Reduction Fund in 2015, has allocated approximately 58% of its funding to sediment augmentation activities—a combination of construction work and agricultural support work. Approximately 32% of the funding went toward environmental consulting and scientific monitoring work, while 10% covered program administration.[15]

Using these analyses, this report assumes that large pieces of coastal resilience spending will go to construction, activities related to agriculture (e.g., re-planting vegetation and augmenting soil), and environmental consulting. The chart to the right shows the spending assumptions that were modeled in California. It is believed that budget allocations within this category will be more heavily dedicated to labor than to consulting or other similar services.

COASTAL RESILIENCE / SEA LEVEL RISE EXPENDITURE INPUTS



The economic impact model for coastal resilience and sea level rise investments yields 15.92 full-time equivalent job-years supported per $1 million spent. With $1 billion in spending, 15,920 job-years would be supported. This category produces an economic multiplier effect of 1.94x, meaning that for every $1 of initial investment, an additional $0.94 in economic activity occurs. The job effects produced here are similar to those produced in the wildfire and forest health category. Within both types of expenditures, the mix of capital deployed versus labor deployed is assumed to be similar. Additionally, the model inputs for wages in construction and forestry support activities are similar.

Employment Impacts by Industry per $1 Million of Investment

TOP 15 IMPACTED INDUSTRIES - COASTAL RESILIENCE	DIRECT	INDIRECT	INDUCED	TOTAL
Industry Display	**Employment**	**Employment**	**Employment**	**Employment**
19 - Support activities for agriculture and forestry	4.71	0.00	0.00	**4.71**
56 - Construction of other new nonresidential structures	3.64	0.00	0.00	**3.64**
463 - Environmental and other technical consulting services	1.59	0.01	0.01	**1.62**
447 - Other real estate	0.19	0.09	0.10	**0.38**
457 - Architectural, engineering, and related services	0.22	0.09	0.01	**0.32**
509 - Full-service restaurants	0.00	0.04	0.20	**0.24**
510 - Limited-service restaurants	0.00	0.01	0.20	**0.21**
417 - Truck transportation	0.11	0.06	0.03	**0.20**
472 - Employment services	0.00	0.13	0.06	**0.20**
493 - Individual and family services	0.00	0.00	0.14	**0.14**
490 - Hospitals	0.00	0.00	0.13	**0.13**
511 - All other food and drinking places	0.00	0.02	0.10	**0.12**
520 - Other personal services	0.00	0.04	0.08	**0.11**
476 - Services to buildings	0.00	0.07	0.04	**0.11**
442 - Other financial investment activities	0.00	0.01	0.10	**0.11**
TOTAL EMPLOYMENT IMPACT	**10.47**	**1.61**	**3.84**	**15.92**

Analysis: Bay Area Council Economic Institute using IMPLAN

This analysis assumes sea level rise and coastal resilience investments will account for 20% of all spending in a climate resilience expenditure package. Extrapolating these findings out over the two assumed expenditure scenarios ($5 billion package and $8 billion package) yields the below results for job creation and overall economic impact. **Job impacts from the sea level rise and coastal resilience category range between 15,919 and 25,471 depending on the amount of overall spending.**

COASTAL RESILIENCE / SEA LEVEL RISE				
Total Package (millions)	$	5,000	$	8,000
Category Investment (millions)	$	1,000	$	1,600
EMPLOYMENT				
Direct		10,468		16,749
Indirect		1,606		2,570
Induced		3,845		6,152
Total Employment		**15,919**		**25,471**
OUTPUT				
Direct	$	900,000,000	$	1,440,000,000
Indirect	$	343,593,799	$	549,750,079
Induced	$	700,368,884	$	1,120,590,215
Total Output	**$**	**1,943,962,683**	**$**	**3,110,340,294**

Analysis: Bay Area Council Economic Institute using IMPLAN

CASE STUDY: San Francisco Bay Coastal Resilience

The San Francisco Bay is the defining geographic feature of the Bay Area region. The bay is also the largest estuary on the west coast, and it provides key ecological benefits to the region in terms of wildlife habitat and flood prevention. However, by 1998, nearly 80% of its historic tidal marshes and 42% of its tidal flats had been converted into agricultural and commercial uses or filled in to allow for development.[16]

Multiple policy and investment efforts in the last two decades have begun restoring the bay's wetlands and reversing this trend. Most notably, the San Francisco Bay Restoration Authority (SFBRA) was created through legislation in 2008. SFBRA is a regional agency created to fund shoreline projects that will protect, restore, and enhance San Francisco Bay. It has a unique capacity to raise funds from across nine counties, and in 2016, Bay Area voters passed Measure AA to fund approximately $500 million of resilience investments on the bay over 20 years. While that investment level is significant, there are additional resilience funding needs on the bay.

SFBRA began providing project funding in 2018. Projects that have received funding to date include those related to clean water, habitat restoration, levee construction and flood protection, public access, and special demonstration projects. The South San Francisco Bay Shoreline project has been one beneficiary of Measure AA funding. It is a multi-benefit flood protection project that will restore 2,900 acres of former salt evaporation ponds and improve public access to the bayshore in the Alviso area of the South San Francisco Bay.

SFBRA has thus far directed over $61 million to this project, to be paid out over five years. This funding will support the design and construction of a flood protection levee, opening the former salt ponds to tidal action and allowing for public access improvements. With a total project cost of $174 million (in 2015

Economic Impacts of San Francisco Bay Resilience Investments

$250 million - SF Bay	Employment		Output
Direct	2,350	$	250,000,000
Indirect	288	$	70,576,284
Induced	662	$	134,929,547
Total	**3,300**	**$**	**455,505,831**

$500 million - SF Bay	Employment		Output
Direct	4,701	$	500,000,000
Indirect	575	$	141,152,567
Induced	1,324	$	269,859,095
Total	**6,600**	**$**	**911,011,662**

Analysis: Bay Area Council Economic Institute using IMPLAN

dollars), the U.S. Army Corps of Engineers estimated the project would generate 2,731 jobs—or 15.7 jobs per $1 million spent.[17] Of the estimated project costs, 70.5% of expenditures are slated for construction, 21.4% on program administration and consulting, and 8.1% on real estate acquisitions.

The South Bay Salt Pond Restoration Project is another initiative partially funded by Measure AA, receiving over $8 million in the first two funding rounds. The 50-year effort launched in 2003 seeks to restore 15,100 acres of former salt evaporation ponds. The first phase of the project has focused on breaching and excavating existing levees to allow natural tidal flushing and to control invasive plant species. A study by the Center for American Progress estimated that 12.44 jobs were created for every $1 million of spending on this project.[18] The lower jobs impact found in this study is largely a product of the extensive excavation work required, which created needs for higher-wage positions in surveying and civil engineering, as well as needs for major equipment purchases.

To understand the job creation potential of additional investments along San Francisco Bay, this analysis uses two funding scenarios that could be included under the coastal resilience portion of a statewide climate resilience expenditure package: a $250 million investment and a $500 million investment.

The outputs shown above were created with similar industry inputs as used for the state's coastal resilience impacts; however, spending was placed only inside the nine-county Bay Area region and local government administration replaced state government.

The estimated job benefit is 13.2 job-years supported per $1 million of spending on the bay. This is slightly lower than in the overall coastal resilience analysis, as Bay Area wages are higher than state averages across all sectors, thus creating a scenario where more spending is needed to create the same number of jobs as elsewhere in the state. While the job impacts per $1 million spent are lower, investments that limit flooding and improve environmental health have a significant longer-term impact on the population of the Bay Area.

5

Extreme Heat / Community Resilience

14% of Total Climate Resilience Expenditure Package

The final expenditure category focuses on overall community resilience to climate change, with a particular emphasis on heat-related effects that are more likely to occur in the Central Valley and other inland parts of the state. In comparison to the expenditure categories listed above, these programs are more likely to include significant amounts of community input and investments made at the household or neighborhood level. Investment types are categorized below:

- **Transformative Climate Communities:** Administered by the Strategic Growth Council using cap-and-trade dollars, this program funds development and infrastructure projects that achieve environmental, health, and economic benefits for disadvantaged communities in California. Eligible uses for these dollars are very diverse, ranging from active transportation investments (e.g., bike paths and trails), to solar energy installation, to community gardens.
- **Urban greening and resilience:** Projects in this category could include natural infrastructure projects that limit exposure to extreme heat and flooding, such as stormwater capture technologies, urban stream restoration, permeable pavement projects, rain gardens, cool roofs, and stormwater retention basins.
- **Emergency and other community resilience infrastructure:** Construction and retrofit projects aimed at limiting the impacts of environmental emergencies could include cooling centers, clean air centers, hydration stations, emergency shelters, backup power, and other facilities to safeguard vulnerable populations during wildfires, extreme heat and bad air quality days, and other extreme events.
- **Resilience planning:** These investments could go to state conservancies, regional collaboratives, planning agencies, and community-based organizations to assess climate vulnerabilities within their communities. Funds could be used to update or create planning documents that facilitate investment in projects that address flood and fire resilience, sea level rise, climate adaptation, or environmental justice objectives.

Much of the research on the economic benefits of community resilience planning is centered around the savings created when disaster does strike. The most thorough study to date involving job impacts looked at a multitude of large- and small-scale greenhouse gas-reducing projects funded with California cap-and-trade funds.[19] This study also provides a more detailed menu of the types of projects that fall into the community resilience category: energy systems (e.g., microgrids),

transportation alternatives, energy-efficient buildings, green infrastructure, cool roofs and surfaces, and transit-oriented development.

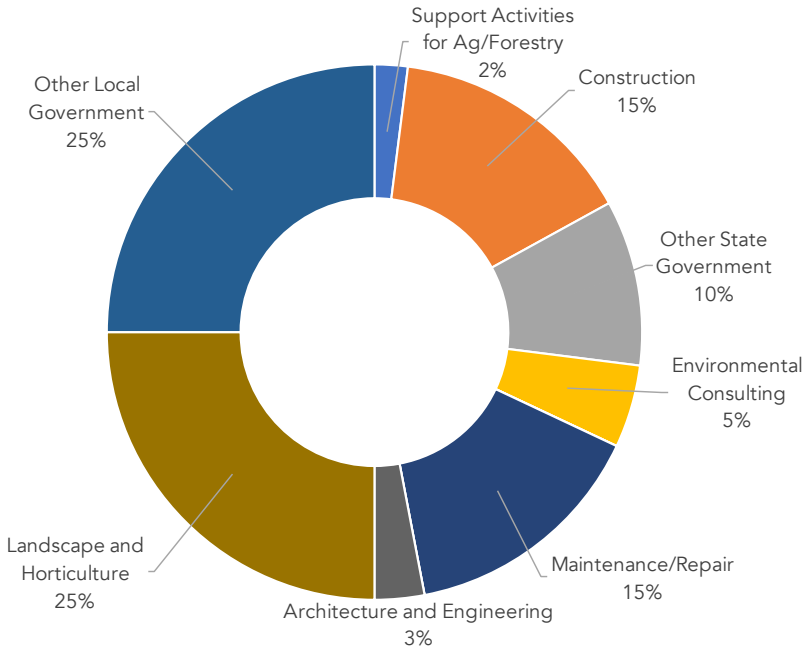
Of the programs analyzed, the following list represents those most closely associated with heat and community resilience programs. Job impacts per $1 million invested are displayed below:

- Low Carbon Transit Operations Program – 12.6 jobs per $1 million expenditure
- Affordable Housing and Sustainable Communities – 10.5 jobs
- Car Sharing and Mobility Options Pilot Program – 8.1 jobs
- Zero-Emission Truck and Bus Pilot Projects – 5.3 jobs
- Single Family/Small Multi-Family Energy Efficiency and Solar Water Heating – 16.8 jobs
- Single-Family Solar Photovoltaics – 8.2 jobs
- Large Multi-Family Energy Efficiency and Renewables – 9.8 jobs
- Urban and Community Forestry – 13.4 jobs

In California, the Transform Fresno initiative received funding through the Strategic Growth Council's Transformative Climate Communities program. The $216 million total investment was one-third funded with cap-and-trade dollars. The funding went toward 25 projects, with the largest expenditures related to a city college satellite campus, a mixed-use project near the future high-speed rail station, and shared mobility investments. The project list also includes new parks, tree planting, and a solar renewable energy investment. This list demonstrates the diversity of project types that could fall into the community resilience category of spending.

Because the climate resilience proposals made to date specify only broad funding details in this category with a wide-ranging list of uses, multiple assumptions are required to build an impact model. The most significant of these is a larger proportion of spending going toward program management and planning when compared to other categories. Additionally, more spending is allocated to the procurement of materials (e.g., trees, shrubs, energy grid investments) than to the labor needed to carry out the activities (e.g., construction and consulting).

HEAT / COMMUNITY RESILIENCE EXPENDITURE INPUTS



The economic impact model for extreme heat and community resilience investments yields 12.54 full-time equivalent job-years supported per $1 million spent. At $1 billion of total spending, expenditures in this category support 12,540 job-years.

The total economic output multiplier related to this spending is 1.88x, meaning that for every $1 spent, an additional $0.88 of economic activity occurs within the state. A higher degree of capital-intensive investments—such as building retrofit and construction for emergency infrastructure—and a larger share for program management costs compared to previous category modeling explains the large difference in employment impacts for community resilience projects.

Employment Impacts by Industry per $1 Million of Investment

TOP 15 IMPACTED INDUSTRIES - COMMUNITY RESILIENCE	DIRECT	INDIRECT	INDUCED	TOTAL
Industry Display	**Employment**	**Employment**	**Employment**	**Employment**
477 - Landscape and horticultural services	3.74	0.03	0.02	**3.79**
56 - Construction of other new nonresidential structures	1.56	0.00	0.00	**1.56**
60 - Maintenance and repair construction of nonresidential structures	0.66	0.12	0.01	**0.79**
534 - Other local government enterprises	0.72	0.01	0.02	**0.76**
463 - Environmental and other technical consulting services	0.44	0.01	0.01	**0.46**
19 - Support activities for agriculture and forestry	0.38	0.00	0.00	**0.39**
457 - Architectural, engineering, and related services	0.13	0.07	0.01	**0.21**
509 - Full-service restaurants	0.00	0.03	0.16	**0.19**
447 - Other real estate	0.00	0.10	0.08	**0.17**
510 - Limited-service restaurants	0.00	0.01	0.15	**0.16**
472 - Employment services	0.00	0.11	0.05	**0.16**
405 - Retail - Building material, garden equipment, and supplies stores	0.00	0.12	0.02	**0.13**
493 - Individual and family services	0.00	0.00	0.11	**0.11**
490 - Hospitals	0.00	0.00	0.11	**0.11**
442 - Other financial investment activities	0.00	0.02	0.08	**0.09**
TOTAL EMPLOYMENT IMPACT	**7.63**	**1.89**	**3.01**	**12.54**

Analysis: Bay Area Council Economic Institute using IMPLAN

This analysis assumes extreme heat and community resilience investments will account for 14% of all spending in a climate resilience expenditure package. Extrapolating these findings out over the two assumed expenditure scenarios ($5 billion package and $8 billion package) yields the below results for job creation and overall economic impact. **Job impacts from the extreme heat and community resilience category range between 8,776 and 14,042 depending on the amount of overall spending.**

EXTREME HEAT / COMMUNITY RESILIENCE				
Total Package (millions)	$	5,000	$	8,000
Category Investment (millions)	$	700	$	1,120
EMPLOYMENT				
Direct		5,342		8,548
Indirect		1,326		2,122
Induced		2,108		3,372
Total		**8,776**		**14,042**
OUTPUT				
Direct	$	630,000,000	$	1,008,000,000
Indirect	$	298,911,102	$	478,257,762
Induced	$	383,913,701	$	614,261,922
Total	**$**	**1,312,824,803**	**$**	**2,100,519,685**

Analysis: Bay Area Council Economic Institute using IMPLAN

6

Summary Findings

Across all four climate resilience spending categories analyzed, the modeling presented here shows between 12.54 and 16.26 full-time equivalent job-years produced from $1 million in spending. This number is consistent with much of the literature presented in this analysis. **When these estimates are extrapolated for a $5 billion total expenditure package in resilience investments, an estimated 74,498 full-time equivalent job-years are supported. For an $8 billion package, the number increases to 119,197 job-years.**

Labor-intensive activities, such as planting trees and removing debris, have the highest jobs output per dollar spent, largely resulting from their relatively lower wages compared to other labor inputs such as consultants and engineers. Capital-intensive activities, such as widening a bridge or installation of solar panels, have relatively lower jobs output per dollar spent, as dollars are spent on materials or equipment, rather than on wages. But these capital-intensive activities do have significant overall economic multiplier effects, as they produce economic activity at quarries, landscape companies, equipment leasing agencies, and manufacturing companies within the state.

The tables on the following page summarize the economic impacts of each investment category analyzed.

Economic Impacts per $1 Million in Resilience Spending

Spending Category	Expenditure ($)	Employment	Economic Output
Wildfire / Forest Health	1,000,000	16.26	$ 1,849,506
Water	1,000,000	13.77	$ 2,033,256
Coastal Resilience / Sea Level Rise	1,000,000	15.92	$ 1,943,963
Heat / Community Resilience	1,000,000	12.54	$ 1,875,464

Economic Impacts based on $5 Billion Resilience Spending

Spending Category	Expenditure ($)	Employment	Economic Output
Wildfire / Forest Health	1,750,000,000	28,456	$ 3,236,635,879
Water	1,550,000,000	21,346	$ 3,151,546,954
Coastal Resilience / Sea Level Rise	1,000,000,000	15,919	$ 1,943,962,683
Heat / Community Resilience	700,000,000	8,776	$ 1,312,824,803
TOTAL IMPACT	**5,000,000,000**	**74,498**	**$ 9,644,970,319**

Economic Impacts based on $8 Billion Resilience Spending

Spending Category	Expenditure ($)	Employment	Economic Output
Wildfire / Forest Health	2,800,000,000	45,530	$ 5,178,617,406
Water	2,480,000,000	34,153	$ 5,042,475,126
Coastal Resilience / Sea Level Rise	1,600,000,000	25,471	$ 3,110,340,294
Heat / Community Resilience	1,120,000,000	14,042	$ 2,100,519,685
TOTAL IMPACT	**8,000,000,000**	**119,197**	**$ 15,431,952,510**

Analysis: Bay Area Council Economic Institute using IMPLAN

Each of the expenditure categories analyzed here is also likely to produce long-term economic benefits, ranging from ecosystem service impacts on a small geographic scale to larger regional savings in the case of a natural disaster. These long-term benefits should play an important role in any cost-benefit analysis, though they are not analyzed here.

The data provided in this report are a near-term estimate of the job-creation potential of climate resilience investments that directly and indirectly flow from the initial spending. The results show that the impacts produced by these investments go well beyond the environment, and they can be an important stimulus for job creation across multiple industries that are key to California's overall economic success.

Notes

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Since 1990, the Bay Area Council Economic Institute has been the leading think tank focused on the economic and policy issues facing the San Francisco Bay Area, one of the most dynamic regions in the United States and the world's leading center for technology and innovation. A valued forum for stakeholder engagement and a respected source of information and fact-based analysis, the Institute is a trusted partner and adviser to both business leaders and government officials. Through its economic and policy research and its many partnerships, the Institute addresses major factors impacting the competitiveness, economic development, and quality of life of the region and the state, including infrastructure, globalization, science and technology, and health policy.

It is guided by a Board of Advisors drawn from leaders in the corporate, academic, non-profit, and government sectors. The Institute is housed at and supported by the Bay Area Council, a public policy organization that includes hundreds of the region's largest employers and is committed to keeping the Bay Area the world's most competitive economy and best place to live.

About this Report

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The report was authored by Jeff Bellisario, Executive Director of the Bay Area Council Economic Institute.

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